Seed production of Vegetable, tuber and Spice Crops

4. Seed Production of Vegetable, Tuber and Spice Crops (HPV 202) 3(2+1)

Introduction and history of seed industry in India. Definition of seed. Differences between grain and seed. Importance and scope of vegetable seed production in India. Principles of vegetable seed production. Role of temperature, humidity and light in vegetable seed production. Methods of seed production of cole crops, root vegetables, solanaceous vegetables, cucurbits, leafy vegetables, bulb crops, leguminous vegetables and exotic vegetables. Seed germination and purity analysis. Field and seed standards. Seed drying and extraction. Seed legislation.

Practical: *Study of seed structure, colour size, shape and texture. Field inspection of seed crops. Practices in rouging. Harvesting and seed extraction. Germination and purity analysis. Methods of seed production in cole crops, root vegetables, bulb crops, solanaceous vegetables, cucurbits, leafy vegetables, leguminous vegetables and exotic vegetables. Seed processing machines. Visit to seed production units.*

Lecture 1

Introduction to seed and seed quality

'All the flowers of all the tomarrows are in the seeds of today'

- Swedish proverb

Seed is the basic and critical input in crop husbandry, which determines the expected dividends from all other inputs. Agriculturally seed is the unit of propagation and can be any part of the plant (zygotic seed or vegetative propagules) which has the capability to regenerate into a new plant,but botanically it is defined as matured ripened ovule comprising living embryo embeded in the supporting food storage tissue with a protective coat . It is primarily responsible for maintaining the physical, physiological and genetic characteristics of any variety / hybrid of any crop. The differences between seed and commercial grain are as below

Seed	Grain
Should be germinable and vigorous	Need not be
Should be physically and genetically pure	Need not be
Should satisfy all the quality norms	Need not be
Should be free from pest and diseases	Need not be
Seed is the outcome of planned and specific programme	Need not be

Feistritzer (1975) described the **role of seed** as follows,

A carrier of new technologies

Introduction and popularization of any technology to enhance the crop productivity solely depend on seed. It may be the development of new varieties, evaluation of seed treating chemical, fertilizer, pesticide including the biotechnological developments.

A basic tool for secured food supply

In India for instance, the cultivation of high yielding varieties have helped to increase food production form 52 million tonnes to more than 200 million tonnes over a period of 50 years The successful implementation of the High Yielding Varieties Programme (HYVP) in India has led to a remarkable increase in production and to a new assessment of future development potential. As a result, food imports from other countries have been substantially brought down inspite of the rapid population increase.

The principal means to secure crop yields in less favourable production areas

In areas inherent with biotic and abiotic stresses, the supply of good quality seeds of improved varieties contributes to secure higher crop yields.

A medium for rapid rehabilitation of agriculture in cases of natural disaster

At times, floods and droughts focused on threats of famine and starvation. In such situations Seed Reserve Stocks contribute a lot to reclaim the ill effects of natural calamities.

Quality seed

The capacity of the seeds is fully exerted only when it possess its own quality in terms of physical,physiological, genetic and health aspects. Seed quality is a relative term and means the degree of excellence when compared to an acceptable standard. The seeds having required standards of purity, germination and other attributes are referred as quality seeds.

Characteristics of quality seed

Genetic purity

Genetic purity of seeds refers to the trueness to type. If the seed possesses all the genetic qualities that breeder has placed in the variety, it is said to be genetically pure. It has direct effect on ultimate yields. If there is any deterioration in the genetic make up of the varirty during seed multiplication and distribution cycle, there would definitely be proportionate decrease in its performance. It is, therefore, necessary to ensure genetic purity during production cycles.

Physical purity

Physical purity of a seed lot refers to the physical composition of seed lots. A seed lot is composed of pure seeds, inert matter, weed seeds and other crop seeds.

Higher the content of pure seed the better would be the seed quality. Pure seed considered together with seed germination determine the planting value of the seed.

Seed germination and vigour

Seed germination refers to the ability of a seed when planted under normal sowing conditions to give raise to a normal seedling. The seed vigour refes to the sum total of all the attributes that gives effective plant stand in the field.

Seed health

The health of seed refers to the presence or absence of disease organisms/insect pests on seeds. The quality of a seed lot very much depends on its health.

In addition it also should possess the following characters

- It should have good shape, size, colour, etc., according to specifications of variety
- It should be free from other crop seeds,
- It should be free from objectionable weed seeds.
- .It should be free from designated diseases
- It should posses high longevity and shelf life
- It should have optimum moisture content for storage
- It should have high market value

The availability of quality seeds in time and at affordable price is a prime factor to produce uniform, healthy and vigorous crop that results in higher productivity. In hoticulture, quality seed has got the following significance .

Significance of seed

- Ensures genetic purity of specific crop.
- Quality seeds alone ensures higher yield .
- Higher income to farmers
- Produce vigourous seedlings in nursery
- Tolerant to pest and disease to certain extent
- Maintains desired plant population
- Responds to added inputs like fertilizer, pesticide, irrigation and other crop management techniques
- Ensures uniform growth and maturity

- Withstands biotic and abiotic stresses

Seed Technology

Seed technology is an interdisciplinary science, encompassing a broad range of subjects *viz*., breeding, agronomy, physiology, pathology, entomology, microbiology and engineering. It involves research aspects of seed growth and development, seed physiology, seed dormancy , germination, techniques on seed enhancement, quality seed production, seed certification, processing, seed treatment, storage, seed longevity, testing, seed pathology and entomology, quality control, marketing and distribution. In brief the gole of seed technology in Agriculture sector is timely supply of quality seeds for reasonable price to farmers.

Questions

1. What is seed ?
2. Define seed as per ISTA
3. What are the characters of quality seed ?
4. What are the significance of seed ?
5. What is the role of seed in horticulture?
6. Differentiate the seed and grain
7. Seed is defined as
   a. Matured ovule b. Embryo enclosed in a seed coat
   c. Any propagation material d. All
   Ans: d
8. As per Indian Seed Act (1966), vegetative propagules also called as seed: true / false
   Ans: True
9. Seed need not be a viable one. (true / false)
   Ans: False
10. Quality norms are not required for seed production. (true /false)
    Ans: False
11. Genetic purity of seeds refers to the trueness to type. (true / false)
    Ans: True

Lecture No. 2

History and Development of Vegetable Seed Industry in India

India is the second largest producer of vegetables, which occupy 6.2 m ha producing about 94 million tonnes with an average productivity of 15 t/ha of fresh vegetables, yet the productivity is not sufficient to provide diet to our growing population. Low productivity of vegetables was observed due to poor availability of quality vegetable seeds. Since ages, Indian framers have been mostly dependent on local varieties and farm saved seeds, whose quality is not assured, this affected the vegetable production drastically. After Independence, greater emphasis was placed on the development of seed programmes during all the Five Year Plans and Annual Plans by Govt. of India. With establishment of AICRP (vegetables), tremendous progress has been made in development of High yielding varieties. It solely depended on the multiplication and distribution of seeds of the newly developed varieties. Originally, vegetable seeds were produced by public sector organization like NSC, SFCI, SSCs, SAUs, ICAR institutes etc., but at present its share is marginal and a large portion of vegetable seed demand in the country is still met by the private seed companies only. In most of the public sector endeavors, still the major share is of open pollinated varieties. Use of quality seeds of improved varieties/ hybrids of different vegetable crops has witnessed tremendous growth in vegetable productivity and total production. The development of vegetable seed industry in India initiated even before independence and can be tracked as below.

1876	A hand book on seed testing was published The World's first Seed Testing Station was established by Prof.F.Nobbe in Tharandt, Saxony, Germany.
1916	Supply of quality vegetable seeds was introduced by M/s. Sutton and Sons at Kolkata, India.
1924	International Seed Testing Association (ISTA) was established in Norway.
1925 -28	The Royal Commission on Agriculture analyzed (*for the first time*) Indian

	seed production system and its problems and encouraged supply of quality seeds to the farmers and the private sectors.
1939	Association of Official Seed Analysts was established for evaluation of seed testing procedures
1939 - 1945	In India, temperate vegetable seeds were imported
1942	Seed production of temperate vegetable varieties was started at Quetta (Pakistan), as the seed supplies were cut-off due to World War-II.
1942-1943	Seed production programme started at Katrain (Himachal pradesh) and Kashmir Valley and the Vegetable seed industry made a rapid progress.
1946	All India Vegetable Seed Growers, Merchants and Nurserymen's Association was established.
1947	Supplies of vegetable seeds were cut off from Quetta (Pakistan) after partition of the country.
1949	Seed production programme was started at Central Vegetable Breeding Station, Katrain, Kullu Valley by Govt. of India. Central Potato Research Institute was established at Shimla to develop varieties and production technology.
1951	First Five Year Plan started with an aim to multiply and distribute seeds.
1955	Central Vegetable Breeding Station, Katrain was transferred to the Indian Agricultural Research Institute, New Delhi with a view to intensify the improvement work on temperate vegetables and renamed as IARI, Regional Station.
1956	Second Five Year Plan started, with an idea to establish 25 acre farm in each Extension Service Block, setting up Seed Testing Stations to ensure vegetable seed quality standards, production of nucleus and foundation seed at block level, and distribution thereof among farmers.
1961	The first Seed Testing laboratory was established in IARI, New Delhi.
1961	The proposed Central Seed Corporation was approved by the Union Cabinet.

	Rock-Feller Foundation equipped the Seed Testing Laboratory, IARI, and was designated Central Seed Testing Laboratory. Systematic research work on temperate vegetables, sugar beet and chicory was initiated at Kalpa and Solan (Himachal Pradesh).
1961	Seed Multiplication Review Team stressed the need for intensive seed multiplication programmes for crop seeds.
1963	National Seeds Corporation was established to develop Indian Seed Industry.
1963	Scientific seed processing was initiated by NSC
1963-1964	NSC was made responsible for making available foundation seeds of crops including vegetables.
1966	Indian Seeds Act was passed by Government of India with a view to regulate quality of seeds on 29th December.
1967	The first Horticultural Research Institute in the country established by the Indian Council of Agriculture Research was called as Indian Institute of Horticultural Research is a premier Institute conducting basic, strategic, anticipatory and applied research on various aspects of fruits, vegetables, ornamentals, medicinal and aromatic plants and mushrooms.
1967	Seed Plot Techniques in potato was developed for raising healthy seed stocks.
1968	The Seed Rules were framed in India in consultation with ISTA. NSC established its own Seed Testing Laboratory.
1969	The Seeds Act came into force throughout the country on 2nd October with seed rules
1969	Establishment of Tarai Development Corporation (TDC) with world bank assistance with primary objective of production of quality seeds.
1970	All India Co-ordianted Vegetable Improvement Project (AICVIP) was established at IARI, New Delhi. A Center under AICVIP was stated at IARI, Regional Station, Katrain.
1971	The Central Seed Committee was framed by the Govt. of India to fix

	genetic purity standards of seeds. First Indian vegetable hybrid - *Pusa Meghadoot* in **Bottle gourd** was developed and released by the IARI, New Delhi.
1971	Indian Society of Seed Technology (ISST) was established to serve an educational link among Seed Technologists
1974	National Seed Project was launched by Govt. of India with the assistance of World Bank to develop seed production infrastructure.
1974-1975	NSC produced a record of 8000 tonnes of vegetable seeds of 28 kinds and 60 varieties. Similar quantity of vegetable seeds was produced by private seed sector.
1976	National commission on Agriculture submitted the report, reviewing all aspects of seed industry, including teaching, training and research. Maharashtra State Seed Corporation Ltd. was started under Companies Act with registered Head Office at Akola.
1983	Enactment of **Seed Control Order-** Seeds was declared an essential commodity.
1985	Y.S.Parmer University of horticulture and forestry was started at Solan
1986	Elevation of status of AICVIP, to the level of Project Directorate of Vegetable Research (PDVR).
1988	Announcement of New Seed Policy called New *Liberalized Seed Policy* by Govt. of India on seed development on 16th September. GOI liberalized vegetable seed imports, giving farmers very wide choice of seed. More conducive environment for international seed companies. A specially designed vegetable seed extraction machine (with axial flow) was developed at PAU, Ludhiana. Indian Minimum Seed Certification Standards published by the Central Seed Certification Board, Department of Agriculture and Co-op, Ministry of Agriculture, Govt. of India, New Delhi.
1989	There was 22.27% increase in vegetable production in India (over 1979 – 81) Seed Industry sought further incentives / concessions

1992	De-linking of PDVR from IARI and shifted to Varanasi (UP.)
1994	A separate NSP on vegetables was approved and initiated by IIVR (PDVR), Varanasi.
2001	The protection of plant varieties and Farmers' Rights bill was formulated to establish an effective system for protection of plant varieties, the rights of farmers and plant breeders and to encourage the development of new varieties of plants
2002	National Seed Policy – to provide appropriate climate for seed industry, safeguarding the interest of Indian farmers and conservation of agro biodiversity.
2004	The New Seed draft Bill was submitted to address all seed related issue which will replace all other existing Acts regarding seeds.
2005-06	National Horticulture Mission a centrally sponsored scheme was started by Government of India. It provides 100% assistance to the state mission during the Tenth Plan.
2007	Andhra Pradesh Horticultural University was started at West Godavari
2008	University of Horticultural Sciences was started at Bagalkot to promote horticultural studies
2010	National Conference on Production of Quality Seeds and Planting Material – Health Management in Horticultural Crops was held at New Delhi

Problems in seed industry

A large chunk of vegetable seed business is being handled by the unorganized seed sector, wherein seed traders directly purchase from growers and distribute with various trade names. There are few reputed and well established seed companies, which have their own R&D programmes for crop improvement and in-house seed quality assurance. These companies produce their own seeds as well as they import seeds from their foreign collaborators and market them in India. Control on production and marketing of vegetable seeds of private sector is limited particularly because of multiplicity of seed traders and a mushrooming growth of small local seed companies.

With an ever increasing demand for good quality seed to increase the vegetable production, there is a shift towards development of hybrids and hybrid seeds. So far, very

limited number of vegetable hybrids have been developed and released by public and private sectors. The majority of existing promising hybrids are from private sectors. At present, there are 54 public sector vegetable hybrids. Certain private sector seed companies *viz.,* Namdari seeds, Syngenta, Bejo Sheetal, Mahyco, Century, Ankur, Indo American Hybrid Seed Company, etc. have contributed tremendously in developing promising F_1 hybrids. Hybrid seeds of private seed companies are most common and popular with vegetable growers despite the cost factor because of assured seed availability and enhanced productivity. Most of the private seed companies are concentrated in southern India especially Karnataka, Maharashtra and Andhra Pradesh due to favorable weather conditions for production of quality F_1 hybrid seeds of tomato, brinjal, chilli, cauliflower, cabbage, okra, melons, cucumber and gourds. All F_1 hybrid seeds of temperate vegetables *viz.,* late cauliflower, cabbage, garden beet, temperate carrot, radish and turnip are produced in the states of Himachal Pradesh and Jammu and Kashmir.

Questions

1. National organization involved in seed production is

   a. ISST b. TDC

   c. TUCAS d. NSC

   Ans: d

2. Indian Society of Seed Technology (ISST) established during

   a. 1971 b.1975 c. 1970 d. 1976

   Ans: a

3. Central Potato Research Institute was located at

   a. New Delhi b. Shimla c. Varanasi d. Solan

   Ans:b

4. Write complete form for ISTA International Seed Testing Association (True/False)

   Ans: True

5. UHS, Bagalkot is located in the state Karnataka (True/False)

   Ans: True

Lecture No.3

Scope for vegetable seed production in India

India is the second largest producer of vegetables only next to China. In India vegetables are grown in 6.2 million ha with a production of 94 mt. Our vegetable requirement in the country is estimated at 225 mt by 2020. Substantial increase in yield and quality of vegetable crops depends upon a number of factors viz., quality seed, fertilizers, irrigation and plant protection measures and suitable agronomic practices. Among these use of quality seed plays a pivotal role. As per Manusmnti – an ancient Hindu Scripture, "Good seed on good land yields abundant produce" adds age-old recognition to the importance of good quality seed in crop production.

Economically, the cost of seed is less but it is realized only on possession of good quality characters. The importance of seed quality is emphasised as "seeds of hope may turn into seeds of frustration" if they are not of high quality. It is therefore, important to use the seed confirming to the prescribed standards in terms of high genetic and physical purity, physiological and health quality.

In most of the public sectors, the major concentration is on open pollinated varieties of which wheat and rice account for about 60 per cent. Majority of the promising hybrids of vegetables are from the private sector as they mostly deal with high value, low volume seeds. Thus, private companies have good scope and opportunity to sell seeds, as large area is still being sown with farm saved seeds. Private sector seed companies account for about 67 per cent of seed production and farmers keep their own seed. Government agencies including public sector corporations at the central and state hardly contribute 33 per cent of the total seed requirement. However, the estimated requirement of vegetable seeds at present is about 20,000 t for tropical and subtropical kinds and 200 t for temperate ones, which will constantly increase in the years to come. Among the vegetables, garden pea constitutes 6,000 to 7,000 t, bhendi around 5,000 t, onion 2,500 t.

Annual sale of seed of Indian Seed Industry

Indian Seed Industry ranks 6 in domestic seed sales. Value of the seeds sold in the domestic markets of India is USD 1500 million or Rs.6675 crores. The present value of

the seeds exported from India is around Rs.111.3 crores. India is at 29th place in export of seeds. This amounts to 0.35% of the world seed exports and 0.12% of the India's agricultural exports.

World: Value of domestic seed markets (top ten countries) – 2010

Country	**Domestic Market Value**
U.S.A	12000
China	6000
France	2370
Brazil	2000
Germany	1950
India	**1500**
Japan	1250
Italy	715
Argentina	695
Canada	550

The commercial world seed market is assessed at USD 42 billion**.**
(Source: International Seed Federation – 2010.)

India is bestowed with varied agro climatic conditions / zones, experienced and dedicated farmers, viable seed industry, legislations etc., favouring the production of quality vegetable seeds. Our strengths and the weaknesses in vegetable seed production are as below.

Strength of Indian seed sector

- A well developed and knitted seed multiplication and distribution systems linked with several ICAR institutes / SAUs / NSC / SFCI etc.
- A network of 20 seed certification agencies at national level central & referral laboratory and 108 notified seed testing laboratories in state level to legally assure the quality seeds moving in the seed market.
- Over 6000 varieties & hybrids of different crops suitable for varied agro-climatic conditions were registered in National catalogue. This makes the selection easier for taking up production in a particular area.
- Our county is bestowed with varied agro climatic conditions, which can be exploited for taking up seed production of vegetables at any time of the year in one or other part of the country.

- Strong Network of Public & of Private stake holders of Seed Industry with Research and Development facilities
- A very fast development of private seed companies which are helpful in bridging the gap between demand and supply of vegetable seeds in the country.
- Proactive Government Policies and Programmes

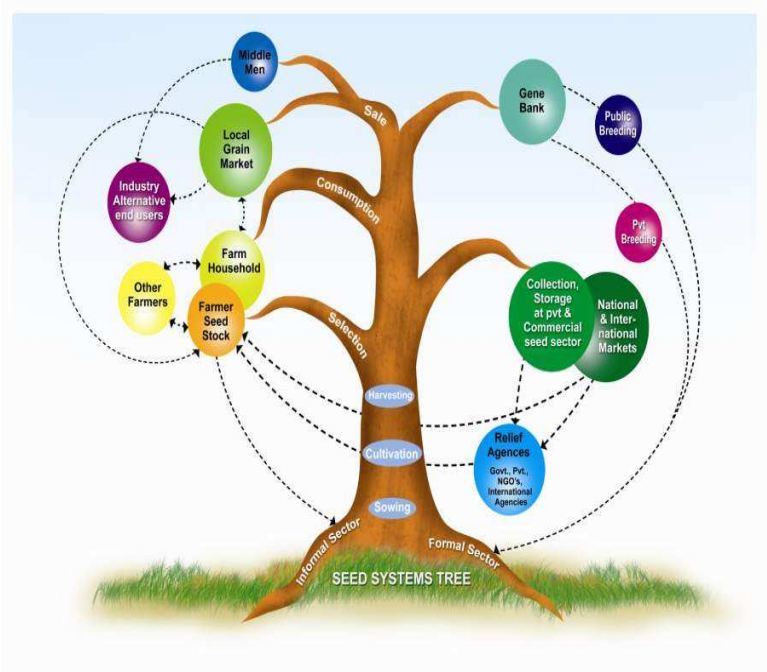
Weaknesses

- Vegetable seed production in the country has been vulnerable to vagaries of weather resulting in production of poor quality seeds.
- Availability of realistic data on actual area under vegetable and requirements of vegetable seeds is inappropriate.
- There is no proper planning for cropping system and restriction for planting a particular crop, maintenance of isolation distance is difficult.
- Very low or no indents for new improved varieties due to ignorance about the performance of newly developed improved varieties.
- Non-availability of adequate nucleus and breeder seeds in the seed production chain.
- Problems in lifting of produced seeds against indents.

Seed improvement programmes in India

Support of World Bank to Indian Seed Programme

The world bank supported the Indian seed programme to the amount of US $ .7M in NSP-1, US $ 34.9M in NSP-II, later on huge outlay was also provided under NSP-III to develop infrastructure in SSCA,SSC,NSC/SFCI STL's and NARS. Private companies also benefited from this programme by getting refinance loan from NABARD.



National Efforts on Seed Development

- ICAR has strengthened the seed research programme through launching of special project on Promotion of Research and Development efforts on vegetables hybrids during 1992.
- Formulation of New Seed Bill 2004.
- Establishment of - NSRTC an exclusive seed quality control and Central capacity building centre.
- PPV&FR Authority for protection of Intellectual Property Rights on new crop varieties.
- Formulation of National Seed Plan - Envisages role of Central, State Govt., ICAR/SAUs, SSCs' to produce more quality seeds.
- Launching of National Seed Mission.
- Member of OECD, ISTA & ITPGRFA.
- 61 varieties of 19 crops included in OECD varietal list – July 201.
- Breeder Seed Production Programme**:** ICAR has provided revolving fund of Rs.1500 lakhs. The income generated out of revolving funds can be utilized for

the development of infrastructure for the breeder seed programmes to make the programme self-sustainable.

Strategies for seed improvement

Exploitation of Hybrid Vigour

It is the best approach for varietal increase in production of crops. The area under hybrids is about 27 per cent while their contribution to yield is 40 per cent.

Description of Notified Varieties

The implementation of plant variety protection would necessarily require detailed characterization of all varieties. The variety registration would have on DUS criteria. Efforts are being made to characterize all the crop varieties under seed production chain.

Enhancement of Seed Replacement Rates

The socio-economic status of the farmer does not permit to purchase quality seeds. Therefore the seed replacement rate is very low. The realistic indents and production of breeder seed of different crop varieties by maintaining quality can enhance SRR.

Seed Replacement Rate is the rate at which the farmers replace the seeds instead of using their own seeds.

Seed Replacement Rate of major vegetables

Crop	SRR (%)
Brinjal	63.4
Cabbage	100
Cauliflower	86.4
Chilli	83.7
Gourds	73.5
Melons	89.2
Okra	92.4
Tomato	99.3
Beans	62.2
Onion	87.3
Peas	93.5
Others	72.6

Enhancement of Seed Multiplication Ratio

SMR is nothing but the number of seeds to be produced from a single seed when it is sown and harvested, which can be altered by adoption of proper seed and crop management techniques. However, according to expert group of seeds (1989), the seed multiplication ratios for different crops are as follows.

Crop	SMR
Okra	1:100
Tomato	1:400
Brinjal	1:450
Chillies	1:240
Watermelon	1:100
Pumpkin	1:160
Bittergourd	1:41
Bottlegourd	1:99
Ridgegourd	1:83
Cucumber	1:200
French bean	1:9
Clusterbean	1:50
Peas	1:19
Onion	1:171
Radish	1:100
Carrot	1:83

Identification of suitable area for seed production

Diversification of seed production areas in terms of seasons and regions helps in enhancing the seed production. The search for disease free areas is much warranted to maintain seed health and also to check the spread of the disease from one area to another. Dry and cool regions could be used for effective seed storage at much lower cost and lesser risk on account of seed viability. According to Rai (1997) strategies for improvement in seed programmes are

1. Popularization of quality seed
2. Liaison between Scientists and Department of Agriculture
3. Intellectual Property Right
4. Variety Characterization
5. Strengthening of hybrid programme
6. Exploitation of CMS system for reducing cost of hybrid seed

7. Production of disease free seed
8. Seed processing
9. Packaging and storage
10. Biotechnology and bio-safety
11. Human resource development
12. Seed demand and forecasting
13. Export of seed
14. Five Generation system of seed multiplication (Nucleus – Breeder – Foundation I – Foundation II – Certified) should be strictly followed.
15. Seed Village Scheme need to be promoted.
16. Contract seed production at the farmers' field could be encouraged.
17. Providing incentives and adequate infrastructure facilities like power, irrigation, credit etc., for private seed producers
18. Seed Bank may be established to meet the demand during natural calamities.

Questions

1. Seed replacement rate of tomato

   a. 89.2 % b. 92.4 % c. 99.3 % d. 62.2 %

   Ans: c

2. The seed replacement rate of hybrids

   a. 40% b. 75% c. 50 % d. 100%

   Ans:d

3. The seed multiplication ratio of brinjal

   a. 40% b. 45% c. 50% d. 100%

   Ans:b

4. Private sector seed companies contribute 67 per cent of total seed requirement. (True/False)

   Ans: True

5. Government agencies contribute 33 per cent of the total seed requirement. (True/False)

   Ans: True

Lecture No. 4

Principles and practices of vegetable seed production

Seed production programmers are said to be successful only when higher quantity of genetically pure seeds are obtained. To achieve this task genetic and agronomic principles are to be followed during seed production of any crop.

1. Genetic principles

These principles highly depend on genetic characters of seed which can modify its performance in production programme. In seed production genetic characters are evaluated through genetic purity. Hence following principles are to be considered to obtain true to type seeds.

a. Seed production in adopted area

b. Approved seed source and generation system of seed multiplication

Seed source should be from authenticated and approved public or private sector agencies. Always use higher class of seed for production of seeds. (eg. breeder for foundation and foundation for certified seed)

Generation system of seed multiplication

Generation system of seed multiplication is nothing but the production of a particular class of seed from specific class of seed up to certified seed stage. The choice of a proper seed multiplication model is the key to further success of a seed programme. This is basically depends upon,

i. The rate of genetic deterioration
ii. Seed multiplication ratio and
iii. Total seed demand

Based on these factors different seed multiplication models may be derived for each crop and the seed multiplication agency should decide how quickly the farmers can be supplied with the seed of newly released varieties, after the nucleus seed stock has been handed over to the concerned agency, so that it may replace the old varieties. In view of the basic factors, the chain of seed multiplication models could be,

(i). THREE Generation model: - Breeder seed - Foundation seed - Certified seed

(ii). FOUR Generation model:- Breeder seed - Foundation seed (I) Foundation seed (II) – Certified seed

(iii). FIVE:- Generation model -Breeder seed - Foundation seed (I) - Foundation seed (II) – Certified seed (I) - Certified seed (II)

GENERATION SYSTEM OF SEED MULTIPLICATION AND QUALITY CONTROL (NOTIFIED VARIETIES AND HYBRIDS)

Agency	Class of seed	Quality control system
Concerned breeder or Sponsoring institution Breeder himself (no specified tag)	Nucleus seed	Maintenance
Concerned breeder or Sponsoring institution	Breeder seed (Golden yellow tag)	Breeder seed
State Department of Agriculture	Foundation seed	State seed National Seeds corporation Certification seed Cooperative and Private sectors (White tag) Field inspection and Central and State seed testing to check minimum required standards of genetic, physical purity germination
FARMERS	Certified Seed Truthful labeled seed	(Azhar blue tag) (Opal green)

Three Generation model - (BS-FS-CS) - FOR CROSS POLLINATED CROPS

Four Generation model - (BS-FSI-FS II-CS) - FOR SELF POLLINATED CROPS

c. Previous crop requirement

This is very much required to avoid volunteer plants which can interrupt with genetic purity. Hence the land selected should not be grown with same crop of other varieties.

d. Prevention of natural crossing

In sexually propagated crops natural crossing is another most important source of genetic contamination. This occurs due to crossing with undesirable plants, diseased plants and off types. This phenomenon is highly applicable to often and cross pollinated crops. The extend of genetic contamination in seed fields due to natural crossing depends upon the breeding system, isolation distance ,varietals mass, pollinating agent, insect activity, wind velocity ,humidity and temperature.

Table .1: Isolation distance required for the production of foundation and certified seeds of various crops.

Sl. No.	Name of group (Crops)	Isolation in metres	
		Foundation	Certified
1	Cole crops		
	Cabbage	1600	1000
	Cauliflower	1600	1000
	Chinese cabbage	1600	1000
	Knol-khol	1600	1000
2	Fruit Vegetables		
	Brinjal	200	100
	Capsicum (chillies)	400	200
	Tomato	50	25
	Okra	400	200
3	Bulbous vegetables		
	Garlic	10	5
	Onion	1000	500
4	Root vegetables		
	Beetroot	1600	800
	Carrot	1000	800
	Radish	1600	1000
	Turnip	1600	1000
5	Tuber vegetables		
	Sweet potato	10	5
	Potato	10	5
6	Rhizomatous vegetables		

	Ginger	10	5
	Turmeric	10	5
7	Legume vegetables		
	Cluster bean	50	25
	Cowpea	50	25
	French bean	50	25
	Indian bean	50	25
	Lima bean	50	25
	Peas	10	5
8	Leafy vegetables		
	Amaranths	400	200
	Beet leaf	1600	1000
	Coriander	800	400
	Fenugreek	50	25
	Lettuce	-	-
	Spinach	1600	1000
9	Cucurbits (All crops)	1000	500

e. Mechanical mixture

Seeds should be physically pure *ie.,* free from other crop seeds or other varieties of the same crop. It may often takes place at the time of sowing if more than one variety is sown with the same seed drill and also during post harvest handling of seed. Care on prevention is required as these will affect the genetic purity and also population maintenance.

f. Vigorous roughing

Removal of unwanted, non true to type and diseased plants from the seed field is known as roughing. It should be done throughout the life cycle, but much care has to be given prior to the stage at which they could contaminate the seed crop.

g. Adoption of quality control system

Seed must be produced only on adoption of generation system as recommended by Seeds Act 1966 to avoid genetic deterioration.

2. Agronomic principles

The success of Seed production depends on the crop management techniques starting from sowing to harvest. Care on each of the seed agronomic factors influences the seed production programme including seed quality characters. The major agronomical principles are

- Selection seed production plot
- Preparation of land
- Seed treatment
- Time of planting
- Method of planting
- Seed rate and depth of sowing
- Nutrition
- Irrigation
- Weed control
- Plant protection
- Harvesting conditions

Questions

1. Foundation seed is the progeny of

   A.TFL Seeds b. Foundation Stage –1 c. Nucleus Seed d. Breeder Seed

   Ans: d

2. The colour of certified seed tag

   a.Blue b. red c. Green d. white

   Ans: a

3. What is generation system of seed multiplication?

4. List out genetic principles of seed production?

Lecture No. 5

Factors affecting quality seed production

The seed production of varieties and hybrids of vegetables should be carried out carefully in the region where these are well adopted. . The climatic factors have direct bearing on the quality seed production. These includes, light (duration, intensity and photoperiod), temperature (low, moderate, high and very high), rainfall / snowfall (total as well as distribution) and wind (direction and velocity). Climate is the most important factor and generally for seed production and dry temperate climate is most suitable. For example, seed production of cabbage is only possible in dry temperate areas where chilling requirements are met Different vegetables need different climate for successful seed production and can be classified into temperate and tropical types. Climate may enhance bolting in the normal bulb crop of onion. Photoperiod also affects bulb crop and seed production in onion. The various factors affecting quality seed production includes,

1. Agro climatic factors / Ecological factors – edaphic and climatic factors
2. Production factors
3. Post harvesting handling of seed
4. Seed quality control factors

I. Agro climatic /Ecological factors

a. Edaphic factors

Soil for seed production should have optimum moisture, good texture and structure. Different vegetables have different soil requirements and in general, loams are the best. Clay soils in high rainfall area become sick and cause lack of aeration which affects seed quality. Soil pH should be around 7, as neutral. The problematic soil like saline soil and acidic soil are to be avoided for seed production. pH affects seed production in sensitive plants like legumes and vegetables .

Fertile soils are highly preferable for seed production. Soil should have adequate macro and micro nutrients and microbial load for producing vigorous and viable seeds. For example Boron deficiency causes black rot in cole crops particularly cabbage and cauliflower and hollow heart in garden pea. Molybdenum causes physiological disorder like whiptail in crucifers. Excess nitrogen results more of vegetative growth that leads to

more proneness to diseases and insects resulting reduction in seed quality and yield. N, P and K in balanced dose increases seed yield and improves seed quality and induce resistance.

The seed production should be avoided under soil moisture stress or poor drainage conditions. Ill drained soils causes chlorosis and wilt diseases. The soils should be free from soil borne pathogen and nematodes especially for seed production in horticultural crops.

For producing good quality, soil should free from pathogens. For example bacterial wilt inoculum available in most soils infests solanaceous vegetables tomato, brinjal and chilli. Fusarium wilt in many vegetables spreads from seed to soil. Wilt gets established through planting material (seeds) and thus spreads further from the soil. Soil should also be free from weed seeds.

Climatic factors

1. Temperature

Temperature plays a major role in seed production. Seed germination, seed crop growth and maturity of vegetable seeds are influenced by temperature. Too high temperature during seed crop maturity brings forced maturity and poor seed quality. Optimum temperature is required from sowing to the day of harvest. For *e.g*. cole crops seed production requires low temperature (4-10°C) at initial stage and high temperature (15-20°C) at reproductive stage i.e. during seed development and maturation. Higher temperatures and strong winds cause desiccation of pollen grains and drying of stigma results in poor seed set and seed quality. High temperature adversely affects seed production due to drying of anthers in lab-lab; flower shedding in tomato and chillies and production of higher percentage of hard seed in leguminous vegetables. Over wintering (chilling) / vernalization is needed for cabbage, cauliflower, beets, carrots, turnips etc, to have shift from vegetative to reproductive phase which helps in quality seed production. . In some vegetables, high temperature inhibits development of ovules and fruits and causes shedding of flower buds and young pods / fruits. Higher temperature results in shriveling of seeds lower yield and poor seed quality. Temperature between 24 - 38°C is most favourable for activities of pollinators particularly bees. Pollinators are an important component in vegetable seed production and without these quality seed

production is not possible particularly in cross and often cross-pollinated vegetables. These pollinators stop working at low (below 20° C) or high temperature (beyond 38° C), heavy rains, strong winds which hampers quality seed production.

2. Humidity

Higher relative humidity more than 90 per cent cause heavy flower drop and during maturation will lead to production of blonded seeds (eg peas,) Relative humidity reduced lesser than 40 per cent leads to production of hard seeds. Flowering, pollination and seed setting in temperate vegetable needs low humidity and dry weather and moderate to low humidity in sub-temperate and tropical vegetable varieties. High humidity and low temperature also encourages production of diseased seeds. Slightly warm dry climate is suitable for production of disease free seed.

3. Rainfall

Excessive rain, apart from affecting pollination, leads to a higher incidence of diseases resulting in mould attack and seed discoloration. Activity of pollinators (bees) is practically nil during rains and when flowers are wet. It may also results in delayed maturity and at the time of maturation leads to pre-germination or sprouting of seeds in standing crops (eg. peas, beans). Strong wind and heavy rainfall at or near harvest may cause heavy seed losses through shattering and also complicate the harvesting operations (e.g. amaranthus). Rain at physiological maturity affects the initial quality and storability

4. Cold

Temperatures below 10°C may not be suitable for tropical crops. It will affect anthesis, pollen germination, pollen fertility delayed growth and maturity, incomplete exertion, reduced filling, choking of panicle and incidence of pest and disease.

5. Wind

Wind is necessary for pollination in wind pollinated crops. Improves seed setting in highly cross pollinated crops like onion and crucifers. At times winds act as a source of contamination and protection of seed crops has to be done using barriers. . Heavy winds may carry pollen too far or prevent deposition on stigma thus reducing seed set. Dry winds also desiccate pollen resulting in loss of viability and development of hard seeds in legumes. Heavy winds results in lodging and shattering of seeds / pods.

6. Insect activity

Insects are beneficial as well as harmful in seed production. In alfalfa alkali bees are reared to increase tripping which is a mechanism where in the alignment of a bee on the keel petal pushes forward the stigma, which brushes the pollen. In dwarf sunflower, and onion rearing 6 honeybees hives / ha increases the seed production by 30 per cent. Similarly the insects acts a source of contamination and in insect pollinated crops one kilometer distance is required as isolation. Insects damage seeds right from the pod stage till harvest and account for 20-30% of the seed production losses e.g. in cucurbit red pumpkin beetle and beetle in pulses are pollen eater.

II. Production technology

1. Selection of suitable production environment based on adoptability

Crop specific temperate, sub tropical and tropical environment should be selected based on their genetic adoptability as it results in better survival capacity of a variety under given environmental condition. For example temperate crops will not set seed in tropical conditions and the virus free production of seed potato is possible only in plains though the multiplication rate is higher at hilly areas. In general the area selected should have the following characteristics

- Free from volunteer plants, weed plants and other crop plants.
- In the proceeding season the same crop should have not been grown.
- Avoid areas where isolation is a problem.
- Having a well distributed rainfall in the cropping period.
- Avoid areas of very high and low rainfall.
- Prevalence of cool and dry weather is preferable.
- Avoid high temperature and relative humidity areas where germination is poor.
- Avoid heavy windy areas.
- Avoid coastal belts and marshy places and heavy windy areas.Avoid areas of endemic diseases and pests.
- Select compact areas for hybrid seed production.
- Available of skilled labourers especially in hybrid seed production of crops.
- Near the processing operations with transporting facilities and marketing facilities.

2. Selection of land

- Select well leveled field for uniform maturity.
- Select nearest to irrigation sources.
- Select fertile fields.
- Avoid weedy fields particularly the presence of abnoxious weeds.
- Avoid problem fields like alkaline, saline and sodic soils.
- Avoid sick fields.

3. Selection of season

- Proper season for specific kind of crop.
- Off season is better to avoid isolation problem.
- Selection of crop and varieties
- The variety should be adapted to the agro climatic conditions of the region.
- The variety should really be a high yielder. The variety should be a popular one.
  Select varieties having wide adaptability.
- Select photo and thermal insensitive varieties, drought resistant, pest and disease resistant one.
- Should possess other desirable attributes namely, earliness of the crop, seed quality etc.

4. Selection of Seeds

The seed used for raising a seed crop should be of known purity, appropriate class (farmers can produce certified seed). Breeder Seed can be produced only by the university and Foundation Seed by State Seed Farm / and invariably obtained from an authorized official agency while purchases of seed the following should be carefully examined.

For

B.S - N.S

F.S - B.S are the basic material for seed

C.S - F.S production

Commercial - C.S Other details on the tag - agency, purity, germination. Validity period. Verify that all the bags of the same variety.

5. Preparation of land: The land for the seed crop must be prepared well. Good land preparation helps in improved germination, deep ploughing results in destruction of potential weeds. It also aids in water management and good uniform irrigation. Perfect leveling is very important.

Isolation of seed crops: The seed crop must be isolated from other contaminating crops. The isolation of a seed crop is usually done by providing distance between seed fields and contaminating fields.

Types of isolation

- Physical or distance isolation - expressed is in meters.
- Time isolation - taking up of sowing in different dates (*i.e*) 30 days for most of the crops except in crops having indeterminate growth habit.
- Barrier isolation - if the above said isolation is not possible we can go for barrier isolation by erecting tall shelter trees.
- Physiological isolation - differ in flowering due to change in altitude.

6. Pre-sowing treatment

Seeds should be appropriately treated. Pre-sowing seed treatments with nutrients. The following points should be considered.

- Duration of soaking
- Soaking water to seed ratio.
  Old seed or new seed.
- Quantity of micro, macro nutrients or growth regulators. Seed treatment to break dormancy.
- Leaching

Scarification - acid and mechanical, Chemical treatment

Stratification : Seed hardening with different chemicals.

7. Seed rate and nursery

Seed rate should be based on seed lot viability and vigour. If not there will be lot of gaps in the field. Indirect sown crop or seedlings may not be sufficient to cover the targeted area to transplant or if high the seed will be wasted. Line sowing is advisable for seed crop adopting correct spacing then only we can achieve required population producing equal opportunity to each plant to develop and mature which is not possible in broadcasted crop.

1. Time of planting

The seed crops should invariably be sown or transplanted at an optimum age of seedling at their normal planting time. At the time of planting there should be sufficient soil moisture for germination to take place. Lower seed rates than usual for raising commercial crops are desirable because they facilitate roguing operations and inspection of seed crop.

2. Method of planting / sowing

The seed crops should invariably be sown in rows with the exception of thickly sown crops where the sowing could be done by broadcasting. The sowing of seed crops in rows helps in conducting effective plant protection measures, roguing operations and field inspections. For hybrids planting of two parent's namely female parent line and male parent line has to be done in a definite proportion e.g. 5:1 or 9:1. If the hybrid seed production involves male sterile lines, border rows of the male parent may also be sown (or) transplanted.

3. Depth of sowing

Depth of sowing is extremely important in ensuring good plant stands. Small seeds like cucurbits, solanaeceae and malvaceae vegetables should usually be planted shallow but large seeds could be planted a little deeper. Seeds would emerge from greater depths in sandy soils than in clay soils, and also in warm soil as compared to cold.

In dry soils, seeds should be planted slightly deeper so that they come in contact with moisture.

4. Weeding

Either manually or by using chemical means. Once or twice manual weeding during early stage of crop growth will help in controlling weeds and will provide favourable conditions for root formation and development.

5. Irrigation

Optimum and timely irrigation is must. Over irrigation can promote vegetative growth, lodging, nutrient imbalance while under irrigation delay flowering, stunted growth reduced filling and immature drying. Hence irrigation at critical stages like sowing, life irrigation, flowering and fruit, pod formation, seed filling and seed maturation is must. With holding irrigation at harvest promotes earlier and quicker ripening, irrigation can also be used for staggering and achieving synchronization in hybrid seed production.

6. Nutritional factors

Lack of N delay the field emergence, lack of P delay flowering, K is responsible for filling and lusture the crops. Zn is essential for fertilization. Selenium is responsible for germination in onion. Cu deficiency leads to poor embryo growth. Manganese deficiency causes marsh spot in peas. Boron deficiency results in poor seed development and hollow heart in peas. Iron deficiency causes sterility, Molybdenum also contribute bleaching in peas.

7. Roguing

Roguing in most of the field crops may be done at any of the following stages as per needs of the seed crop.

a. Vegetative / pre-flowering stage
b. Flowering stage
c. Fruit / pod formation stage.

- The rouging at vegetative / pre-flowering stage in cross-pollinated crops is extremely important to avoid genetic contamination.
- The roguing *at flowering stage is equally* important, perhaps even more important than at the vegetative stage. *In hybrid crops*, where male sterility is being used,

special care is required in the removal of pollen shedders. In many crops removal of ear heads infested by seed borne diseases.

- Roguing at maturity stage is also equally important in the removal of the various contaminants affecting the physical purity of the seed.
- In root and vegetative crops a roguing at harvest time for confirmation of fruit / tuber / root characteristics is necessary.
- Sometimes, inspection is also being attended before seed extraction to select true to type fruits and pods to ensure genetic purity.

8. Diseases and pest control

The seed crop should be maintained without any pest and disease attack. The leaf curl virus and yellow vein mosaic infestation drastically reduce the yield and quality in tomato and bhendi, respectively. The fruit / pod bores infestation causes seed discolouration and result in poor quality in terms of viability and storability. Similarly bruchid attack in lab-lab leads to very poor storability. There is the heavy damage in flowering and seed set in crucifer vegetables due to diamond back moth incidence.

9. Harvest - The time of sowing should be adjusted in such a way that the maturation does not coincide with rainy season or at high humidity weather periods.

- The moisture content.
- Physiological maturity.
- Avoid delayed or premature harvest.
- Once over harvest in agricultural crops.
- Staggered harvest in the horticultural crops.
- Harvesting symptoms according to the different crops.

III. Post harvest handling of seed crop

1. Harvesting and threshing

In vegetables, the harvests are to be taken in different pickings. For getting higher yield, the first and last one or two pickings may be taken for vegetables. This may promote further growth of the plant to put for the more number of fruit/pods. In addition, the seed recovery and quality will be poor in the above pickings. From the harvested

produce the seeds should be extracted following suitable extraction methods viz., wet extraction method for tomato, brinjal, bitter gourd, snake gourd and dry extraction method for bhendi, chilli, crucifers, ribbed gourd, pea and beans.

2. Drying and grading

Direct exposure of the seed to sunlight may affect its quality therefore if necessary seed may be dried under diffused sunlight in a shed with opening on all sides. Artificial drying is done by blowing dry air at 70-85°F but never exceeding 110°F. Grading is done with various types of grader.

3. Seed treatment

Seed treatment with the fungicides and insecticides to arrest the carry over of pathogens and insects with the seed or their fresh entry in to it.

4. Packaging, labelling and sealing

It is necessary to use right type of containers with (seed moisture content at proper level) labelling and sealing in the prescribed manner.

5. Movement and storage

Precautions should be taken to avoid seed deterioration while in transit and or in storage. Ideal storage for long term is dry and cool condition. Ideal condition can be maintained if the sum of RH and Temperature does not exceed 100.

IV. Seed quality control factors

1. Seed moisture

The seed moisture affects seed storability. Seeds with low moisture store longer and remain free from insect pests.

2. Germination per cent

Seeds are sown to provide next generation crops. Germination percentage thus, indicates the potential of seeds for developing and establishing into seedlings in the nursery bed (open or polythene) or in the main field. This attribute is given as germination per cent. The combination of pure seed per cent and germination per cent is called as Pure Live Seed (PLS) having better viability.

3. Vigour

It indicates the ability of seed to emerge in varying environments or micro-climate of fields where it is grown. It is generally believed, but not always true, that high germination percentage is associated with high seed vigour.

4. Storage life

Seed moisture content is the most important factor influencing loss of viability during storage. Most of the vegetable seeds which are costly are packed in suitable moisture vapour proof attractive containers and are not or least affected in storage or in transit but the seeds of some large sized seeds e.g. garden pea, beans etc. are packed in porous containers, hence the seed moisture content fluctuates with the change in relative humidity of the atmosphere.

5. Seed health

Vegetable seed should be free from seed borne diseases and insects infestation. Insect infestation normally destroys the embryos thus making the seeds unfit for sowing. Similarly most of the virus and bacterial diseases are seed borne. They are not only contaminate the crop but also help in spreading the disease fast. Hence, seeds must be free from pest and disease and treated with pesticide/fungicide to prevent contamination and spread.

6. Mechanism of control

The generally accepted system of seed certification involves inspections, sample testing, also enforcement of minimum standards which constitute the mechanism of quality control in seed.

Questions

1. Isolation distance for foundation seed crop of tomato is

   a. 50m b. 100m c. 400m d. 600m

   Ans: a

2. For foundation seed production the seed source used is breeder seed (True/False)

   Ans: True

3. For certified seed production the seed source used is foundation seed (True/False)

   Ans: True

4. Cole crops seed production can be easily carried out in plains : True / False

   Ans: False

5. Between cabbage and cauliflower seed production plots isolation is required: True / False

   Ans:True

6. Boron deficiency causes black rot in cole crops (True/False)

   Ans: True

7. Molybdenum causes whiptail physiological disorder in crucifers. (True/False)

   Ans: True

8. Boron deficiency causes hollow heart in peas (True/False).

   Ans: True

9. Protect the seed crop from all possible sources of contamination during the growing period by providing isolation (True/False).

   Ans: True

10. Insects are useful for pollination especially in seed production of cross pollinated crops (True/False).

    Ans: True

11. Zn is essential for fertilization (True/False).

    Ans: True

12. Time isolation is allowed in certification programme (True/False)

    Ans: False

13. Manganese deficiency causes marsh spot in peas. (True/False)

    Ans: True

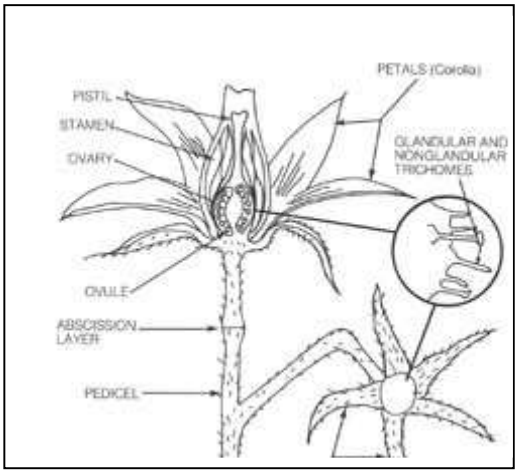
Lecture No. 6

Varietal and hybrids seed production in solanaceous vegetables

1. TOMATO (*Solanum lycoperricum L.*)

Botany

Tomato is self pollinated crop. Self fertilization is favoured by the position of receptive stigma within the cone anthers and the normal pendant position of the flower. Anthesis starts at 6.30 a.m. and continues upto 11.00a.m. Anther dehiscence occurs 1-2 days after opening of corolla. Tomato is a typical day neutral plant. It requires temperature of 15-20° C for fruit setting.



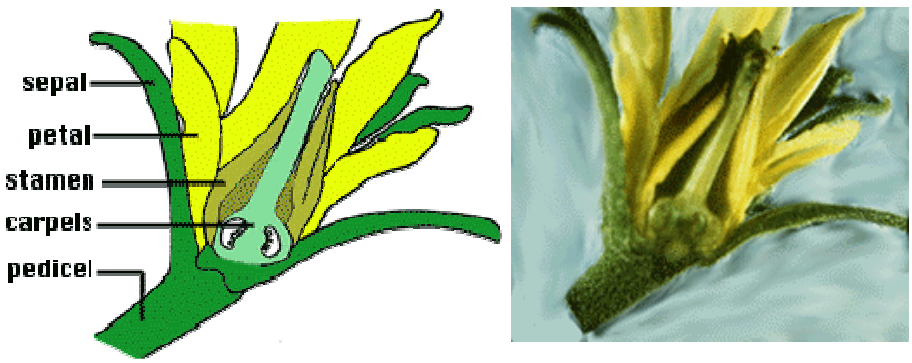


Fig. 1. Structure of tomato flower

Method of seed production: Seed to Seed.

Stages of seed production

Tomato is a self pollinated crop, hence either three or four generation model could be adopted as below

Varieties

Breeder seed → Foundation Seed → Certified Seed

Breeder seed → Foundation Seed I → Foundation Seed II → Certified Seed

Hybrids

Breeder seed → Foundation Seed → (Multiplication of parental lines)

Certified Seed (Production of F1 hybrids)

Varieties

Indeterminate varieties

Pusa Ruby, Solan Gola, Yaswant (A-2), Sioux, Marglobe, Naveen, Ptom-9301, Shalimar- 1, Shalimar-2. Angurlata, Solan Bajr, Solan Sagun, Arka Vikas and Arka Saurbh.

Determinate varieties

Roma (EC-13513), Rupali, MTH-15, Ptom-18, VL-1, VL-2, HS 101, HS 102, HS 110, Pusa Early Dwarf, Pusa Sheetal, Floradade, Arka Meghli, CO.1, CO.2, CO.3 (Marutham), PKM.1, Py1,

Hybrids

COTH-1, 2 and 3 Pant, Hybrid-2, Pant Hybrid-10, Kt-4. Pusa Hybrid-l-4, Arka Shreshta, Arka Vardan, Arka Abhijit, Navell 1 &2 (Sandoz), Rupali, Sonali, MTH 6

Season

It is highly suitable both for kharif (May – June) and rabi season (November - December).

Land requirement

Selection of suitable land for tomato seed production is important where the previous crop should not be the same variety to avoid the contamination due to volunteer plants.

Isolation requirement

For Seed production of tomato, varieties require minimum of 50 M for foundation seed and 25 M for certified seed. For hybrid seed production, it requires minimum of 200 M for foundation (parental line increase) and 100 M for certified hybrid seeds.

Seed rate:

i) Varietal seed production– 300 to 400 g/ha

ii) F_1 hybrid seed production - Male parent 25 g/ha; Female parent 100 g/ha.

Seed Treatment

The seed required for one hectare are to be inoculated with *Azosprillum.* For this, the seeds should be first mixed with the required quantity of rice gruel and then with 150 g of *Azosprillum* after shade drying it can be used for sowing.

Nursery

Sow the seeds in raised nursery bed of 20 cm height, in rows of 5 cm gap and covered with sand. Eight and ten nursery beds will be sufficient to transplant in one acre. Apply 2 kg of DAP 10days before pulling out of seedling.

Transplanting

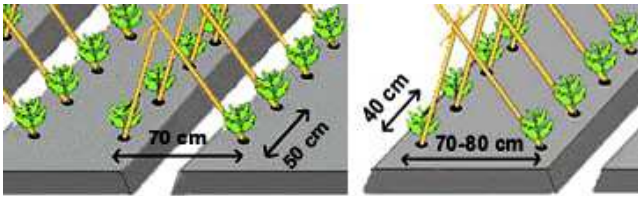
Transplanting should be done with the seedlings are 20-25 days old, preferably at evening time.

Spacing

It varies with varieties from 60 x 30cm to 60 x 45 cm. and in hybrid seed production 90 x 60 cm for female parent and 60 x 45 cm for male parent.

Planting ratio

For hybrid seed production, the female and male parents are normally planted in the ratio of 12:1 or 12:2.



Female **Male**

Figure 2. Spacing and staking options for female and male lines

Manuring

After thorough preparation of a field to fine tilth, apply 25 tons of FYM per ha. Apply 100 : 100: 100 Kg of NPK/ha of which, 50% of the N is applied as basal dressing and remaining 50% of N as top dressing in two split doses at just before flowering and fruit formation stages.

Roguing

The roguing should be done based on the plant characters (determinate / indeterminate), leaf, branching and spreading characters and also based on fruit size, shape and colour. The plants affected by early blight, leaf spot and mosaic (TMV) diseases should be removed from the seed production field.

Specific field requirements

Factors	Foundation	Certified
Off types – variety (max)	0.1 %	0.2%
Hybrid (max)	0.01%	0.05%
Plants affected by seed borne diseases (max)	0.1 %	0.5%

Pest and disease management:

Pests

Fruit borer - *Helicoverpa armigera* and *Spodoptera litura* (common for both)

Simultaneously growing 40 days old American tall marigold and 25 days old tomato seedlings @ 1:16 rows.

i. Setting up pheromone traps @ 12/ha.
ii. Collection and destruction of damaged fruits and grown up caterpillars.
iii. Spraying of triazophos 35 EC 2 ml/lit or carbaryl 50 WP 2 g/lit or *Bacillus thuringiensis* 2g/lit or quinalphos 2.5 ml/lit.

iv. Release *Trichogramma chilonis* @ 50000/ha release coinciding with flowering time and based on ETL. For *Helicoverpa armigera:* H.a.NPV 1.5 x 1012 POBs/ha. For *Spodoptera litura*: S.l. NPV 1.5 x 1012 POBs/ha. Providing poison bait with carbaryl 1.25 kg, rice bran 12.5 kg, jaggery 1.25 kg and water 7.5 lit.

Serpentine leaf miner: Spraying Neem Seed Kernel Extract 50 g/lit.

Whitefly

1. Installation of yellow sticky traps to attract the adult.
2. Spraying of dichlorvos 76 WSC @ 1 ml/lit or triazophos 40 EC 2 ml/lit or fish oil rosin soap 25 g/lit or dimethoate 2 ml/lit or methyl demeton 25 EC 2 ml/lit along with wetting agent.
3. Removing alternate weed host *Abutilon indicum*

Nematode

Application of Carbofuran 3 G at 10 g/sq.m at sowing and 1 kg *a.i*. /ha in the main field one week after transplanting. Treating the seeds with antagonistic fungi *Trichoderma viride* at 4 g/kg seed along with press mud at 5 kg/m2 for nematode disease complex

Diseases

Damping off (nursery)

Treating the seeds with *Trichoderma viride* 4 g/kg or *Pseudomonas fluorescens* 10 g /kg of seed 24 hours before sowing. Application of *Pseudomonas fluorescens* as soil application @ 2.5 kg/ha mixed with 50 kg of FYM Stagnation of water should be avoided. Drenching with Copper oxychloride at 2.5 g/lit at 4 lit/sq.m.

Leaf spot

Spraying of Zineb or Mancozeb 2 g/lit.

Leaf curl

Spraying systemic insecticides like Methyl demeton or Monocrotophos or Dimethoate at 2 ml/lit to kill the insect vector, whitefly.

Tomato spotted wilt virus

Carbofuran 3 G 1 kg a.i./ha in nursery at sowing and second application at 1.25 kg *a.i.*/ha 10 days after transplanting in mainfield and three sprays of triazophos 1.5 ml/lit @ 25, 40, 55 days after transplanting.

Crossing technique for production of hybrids

In tomato the hybrid seed production is normally done by 'Emasculation and Hand Pollination'. Emasculation is done before the anthers are mature and the stigma has become receptive to minimize accidental self pollination. Thus emasculation is generally done in the evening, between 4 PM and 6 PM, one day before the anthers are expected to dehisce or mature and the stigma is likely to become fully receptive.

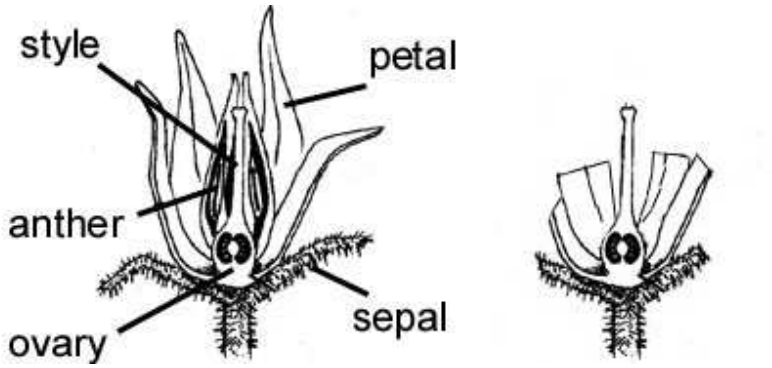


Fig. 3. Tomato flowers before and after emasculation. The anther and surrounding cap are removed to prevent self-pollination. The petals and sepals are cut to identify the flower for future pollination.

Fig. 4. A seed producer is carefully preparing a flower for hybridization.

Emasculate the bud by hand with the help of needle and forceps. Remove the calyx, corolla and staminal column or anthers, leaving gynoecium *i.e.*, stigma and style intact in the flower. Emasculated flowers should be covered immediately with red coloured paper cover to protect against contamination from foreign pollen and also for easy identification of emasculated bud during dusting. Remove the red paper cover of the emasculated bud and dust the pollen gently over the stigmatic surface using cotton or camel brush, etc.,. After dusting, the emasculated flowers are again covered with white or other coloured paper cover for two to three days. Pollen collected from one male flower can be used for dusting 5 to 7 emasculated flowers.

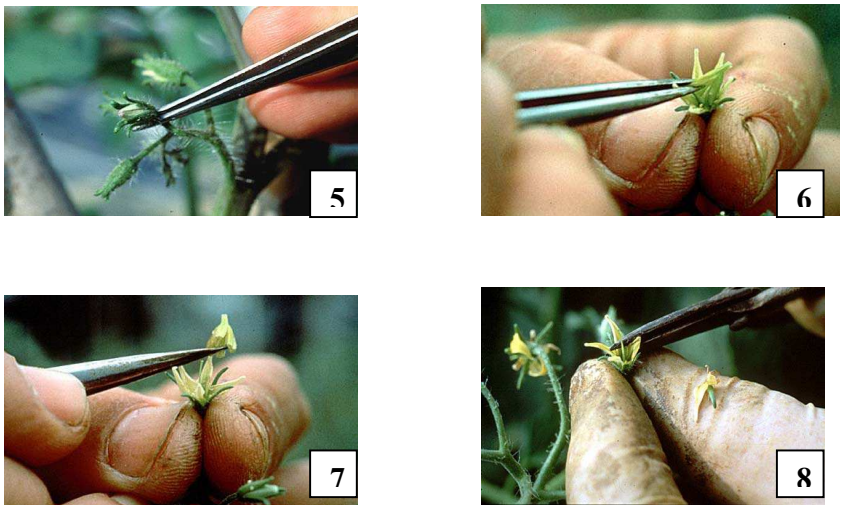


Fig. 5-8. Emasculation of tomato: selection of buds, removal of anther cone, and cutting of petal

Fig. 9-13. Pollen is collected, dried, and prepared for making hybrid crosses

Fig. 14-16. Pollination of emasculated flowers

Fig. 17. Ripening seed crop

However use of chemical hybridizing agents (MH-1000 ppm) or CMS lines are also practiced.

Harvesting and seed extraction

The fruits are harvested after full maturity of the fruit when turn in to red color fruits from first and last one or two harvests should not be used for seed extraction. The fruits from in between 6-7 harvest should be used for seed extraction. The seed viability is depends on the method on which the seeds were extracted and hence, it is more important to choose proper methods of seed extraction. Before seed extraction, the fruits are to be graded for true to type and selection of medium to large size fruits for getting higher recovery of quality seeds.

The acid method of seed extraction is the best method for tomato seed extraction. In this method, the fruits are to be crushed into pulp and taken in a plastic containers (or) cement tank. And then add 30 ml of commercial Hydrochloric acid per kg of pulp, stir well and allow it for ½ hour. In between this duration the pulp may be stirred well for one or two times. This facilitates the separation of seed and pulp. After ½ hour, the seeds will settle down at the bottom and then the floating fraction is to be removed. The collected seeds should be washed with water for three or four times.

Table 1. Comparison of different seed extraction methods

	Fermentation	**Acid**	**Alkali**
Method	Mix fruit pulp with water - 24 - 48 h	HCl @10ml / Kg of pulp - 20-30 minutes	Washing soda @ 900mg/4 l of water- equal volume – overnight soak
Salient features	▪ Low cost. ▪ Unskilled labour. ▪ More time taken. ▪ Low seed recovery (0.5 to 0.6 %) ▪ Dull seed colour. ▪ Seed borne pathogens	▪ Cost is more. ▪ Skilled labour. ▪ Lesser time. ▪ High seed recovery (0.8 to 1 %). ▪ Bright colour market value higher. ▪ Seed borne pathogen removed ▪ Improper washing leads to injury to seeds	▪ Recovery 0.7 to 0.8 per cent. ▪ Luster of the seeds will be lost. ▪ Improper washing leads to injury to seeds

While following acid method we must use only plastic or stainless steel containers or cement tank. Care must be taken to avoid the usage of iron or zinc

containers, which will affect the viability potential of the seeds and as well, damage to the containers due to chemical reaction with acid.

For large scale seed extraction we can use the tomato seed extractor developed by Tamil Nadu Agricultural University. The seeds extracted by this machine may again be treated with commercial Hydrochloric acid @ 2-3 ml/kg seed with equal volume of water for 3-5 minutes with constant stirring. And then seed should be washed with water for three to four times.

It is easy to dry the seeds extracted by acid method and also remove the fungus growth over the seed coat, thus seeds possess golden yellow colour and high vigour. The seed extracted by fermentation method posses poor vigour and off colour due to fungal activity.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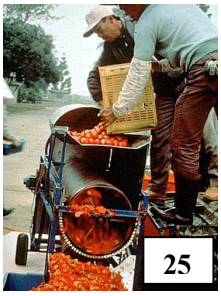
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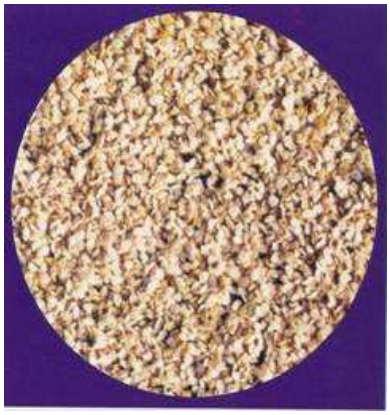
Fig. 19-29. Seed Extraction

Fig. 30-32. Seeds are sun-dried, spread and loosened in a flat container, then rebagged and placed into an air drier.

Fig. 33. Seeds storage

Seed cleaning and processing

After proper drying, the seed processing is essential. This will be helpful for maintaining high vigour and viability by way of removing immature and small seeds. In processing, we have to remove broken, immature and diseased seeds, other crop and weed seeds, mud and other inert matters. For processing tomato seeds, BSS 10 x 10 wire mesh sieve should be used.



Storage of unprocessed seeds results in poor viability. In processing, the sieves must be cleaned while changing to other variety otherwise it leads to physical admixture results in genetic contamination. Hence, utmost care must be taken during processing of seeds to maintain quality.

Seed treatment

The seeds may be treated with captan or Thiram @ 4g/kg of seeds. The seeds can also be treated with halogen mixture @ 5g/kg of seed and it is a ecofriendly seed treatment.

Storage containers

Seeds could able to absorb moisture from atmosphere. Hence for storing seeds in the coastal region (or) river sides we should use moisture vapour proof containers i.e. 700 gauge polyethylene bags. For seed storage every time new containers must be used.

Seed Yield: 100-120 Kg/ha

Seed Standards (variety and hybrid)

Factors	Foundation	Certified
Pure seed (mini)	98%	98%
Inert matter (maxi)	2%	2%
Other crop seeds (maxi) no/kg	5/kg	10/kg

Weed seeds (maxi)	None	None
Germination (mini)	70%	70%
Moisture (maxi)	8%	8%
For VP container	6%	6%

BRINJAL (*Solanum melongena* L.)

Botany

Brinjal is often cross pollinated crop. Brinjal flower opens mainly in morning. Anthesis starts at 5.53 a.m. and continues upto 7.35 a.m with peak at 6.05 a.m. The dehiscences of anthers begin 30 minutes after anthesis. The stigma is receptive from 2 days before anthesis and upto 8 days. Brinjal produces 4 types of flowers with different style length. (Long style, short style, medium style and pseudo short style). For seed production and better yield, the long and medium style is desirable. To increase the production of long and medium style application of more nitrogen or spraying of growth regulators during pre-flowering and flowering stages may be followed.

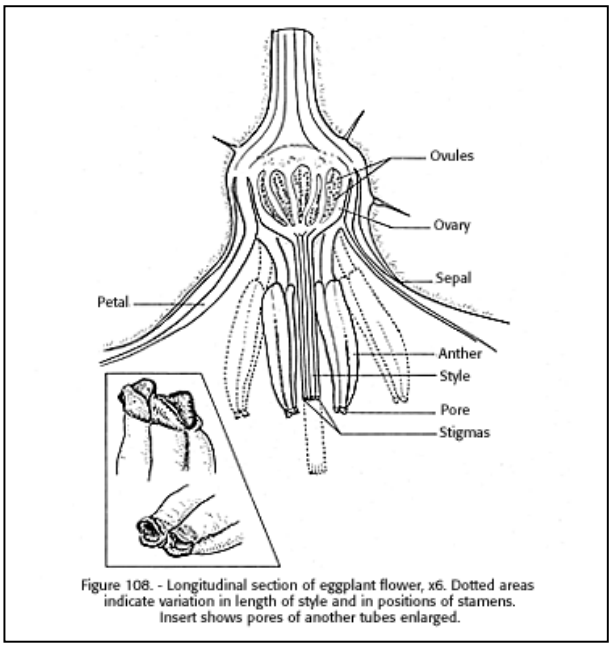


Fig. 2. Structure of brinjal flower

Method of seed production: Seed to Seed.

Stages of seed production

Breeder seed → Foundation Seed I → Foundation Seed II → Certified Seed.

Varieties

CO.1, CO.2. MDU 1, PKM.1, KKM.1, PLR. 1. AU1, Pusa purple long, Arka nidhi, Pant smart, Arka neelkanth, Arka shrish.

Hybrids

COBH1, Arka Navneet (IIHR 22-1 x Supreme), Pusa H-5, Pusa H-6, MHB 10, MHB 39 (Mahyco), Azad Hybrid.

Season

The brinjal seed production can be taken up in the following two seasons. May-June and December- January

Land requirement

The land should be free of volunteer plants.

Isolation

For varieties, 200 M and 100 M of isolation distance is required for foundation and certified seed, respectively. For hybrid seed production minimum of 200 M isolation distance should be maintained.

Seed rate

Varieties - 400 - 500 g/ha

Hybrids - 200 g/ha (Female)

- 50 g/ha (Male)

Seed treatment

Seed treatment with *Trichoderma viride* @ 4g kg-1 before sowing can be practiced against the incidence of damping off disease. Drenching of copper oxy chloride at 0.1% at weekly interval minimize this disease.

Nursery

Sow the seeds in raised nursery bed of 20 cm height, in rows of 5 cm gap and covered with sand. Eight and ten nursery beds will be sufficient to transplant one acre. Apply 2 kg of DAP 10days before pulling out of seedling.

Transplanting

Seedlings are transplanted when they are 30-35 days old (12-15 cm height) preferably in the evening time. Spacing of 75 x 60 cm (non spreading) and 90 x 60 cm (spreading) varieties, 90 x 60 cm for female parent and 60 x 45 cm for male parent of hybrids.

Manuring

The field should be thoroughly ploughed for fine tilth and apply 25 tons of FYM/ha. The other fertilizer requirement for brinjal variety and hybrid are same as followed for tomato seed production.

Roguing

The roguing should be done based on the plant characters, leaf, branching and spreading characters and also based on fruit size, shape and color. The plants affected by phomopsis blight, leaf spot and little leaf virus disease should be removed from the seed production field.

Specific Field Standards

Factors	Foundation	Certified
Off types – Variety (max)	0.1%	0.2%
Hybrid (max)	0.01%	0.05%
Designated diseased plant (max)	0.1%	0.5%

The designated diseases in brinjal are Phomopsis blight caused by *Phomopsis vexans* and little leaf caused by Datura virus -2.

Pest and disease management

Nematode and Damping off disease

Seed treatment with antagonistic fungi *viz., Trichoderma harzianum* 4 g/kg seed or *T. viride* 4 g/kg seed along with application of press mud at 5 kg/m2 or Carbonfuran 3 G 10 g/m2. Application of Carbofuran 3 G at 10 g/sq.m at the time of sowing and *Pseudomonas fluorescens* at 10 g/m2 for nematodes and damping off disease.

Epilachna beetle

Collection and destruction of the beetles, grubs and pupae. Spraying of carbaryl 50 WP 2 g/lit.

Whitefly

Monitoring the whitefly with yellow sticky trap at 12/ha. Spraying of Neem oil 3% plus Teepol (1 ml/lit) or spraying of Neem Seed Kernel Extract 5 %.

Shoot and fruit borer

Removal of the affected terminal shoot showing boreholes and collection and destruction of affected fruits. Spraying any one of the following chemicals starting from one month after planting at 15 days interval

1. Carbaryl 50 WP 2 g/lit + Wettable Sulphur 50% WP 2 g/lit.
2. Triazophoe ml/lit + Neem oil 3 %.
3. Quinalphos 25 EC 2 ml/lit + Neem oil 3 %.
4. Neem Seed Kernel Extract 5 %.
5. Avoid using synthetic pyrethroids.

Ash Weevil

Application of carbofuran 3 G at 15 kg/ha 15 days after planting.

Aphid:

Methyl demeton 25 EC 2 ml/lit or dimethoate 30 EC 2 ml/lit. Release 1^{st} instar larvae of Green lace wing bug (*Chrysoperla carnea*) @ 10,000 per ha.

Red Spider mite

Spraying of dicofol 18.5 EC 2.5 ml/lit or wettable sulphur 50 WP 2g/lit.

Diseases

Damping off

Treating the seeds with *Trichoderma viride* 4 g/kg or *Pseudomonas fluorescens* 10 g /kg of seed 24 hours before sowing. Application of *Pseudomonas fluorescens* as soil application @ 2.5 kg/ha mixed with 50 kg of FYM. Stagnation of water should be avoided. Drench with Copper oxychloride at 2.5 g/lit at 4lit/sq.m

Leaf Spot

Spraying of Mancozeb 2 g/lit.

Little Leaf

Removal of the affected plants in the early stages and spraying of methyl demeton 25 EC 2ml/lit or dimethoate 30 EC 2 ml/lit to control the vector.

Hybrid seed production

The planting ratio of female and male parents adopted for hybrid seed production is normally 5:1 or 6:1.For production of hybrid seeds, crossing programme is done using emasculation and dusting methods as followed in tomato.

Emasculation and pollination

Emasculation is done in the afternoon hours. Of the four types of flower, only the flower buds having long or medium style are emasculated. In brinjal, flowers appear both as solitary or in cluster, in the noncluster fruited cultivars, generally single flower in a cluster of 3-5 is long or medium styled. After selecting the long or medium styled buds, the corolla is opened gently from the side, length of the style is glanced and then the anthers are picked off separately by upward pull with the forceps. The emasculated flowers are protected by thin cotton wool.

Using a needle, the anther cone is carefully removed without disturbing the style. These emasculated flowers have to be covered by butter paper bags. Similarly the flowers of male parent from which pollen is going to be collected have to be bagged on the previous day evening. Next day morning by 6 am the flower buds are collected before opening. Anthers are separated and kept in petridish covered by glass. These petridishes are kept against sunlight to facilitate dehiscence of anthers and release of pollen grains. The butter paper cover on the emasculated flower is removed and the pollen is transferred to the stigmatic surface with the help of a camel hair brush or by smearing the dehisced anther on the stigma. A part of sepals of the pollinated flowers are cut with the help of a scissors for identification mark that they are hybridized flowers. After hand pollination these flowers are rebagged. Since the stigma is receptive for 4 days, the bags should be removed after about 8-10 days only when the fertilized ovary will prominently seen. After full maturity and ripening of the fruits, seeds are extracted. On an average a quantity of 400 kg of hybrid seeds can be obtained from one hectare.

Male sterile lines

Use of male sterile lines reduces the cost of seed production. In brinjal functional male sterile mutants was also reported. This is at a recessive character determined by single gene. It is therefore, easy to transfer this character into desirable standard varieties to be used as female parent for hybrid seed production.

Harvesting and processing

Harvesting is done when fruits are fully ripe (when the fruits turn into yellow colour) *i.e.,* 45 days after flowering. The harvested fruits are to be graded for true to type and off type and fruit borer infested fruits are discarded. The graded fruits are cut in 2-3 pieces or whole fruits will be put in a cement tank with water and crushed manually and then allow it for fermentation for 1-2 days. Then the floating pulp portions are to be removed, the seeds settled at the bottom should be collected and washed with water and then the seeds are treated with commercial Hydrochloric acid @ 3-5 ml/kg of seed. The mixture is kept for 10-15 minutes with frequent stirring. Then the treated seeds are to be washed with water for 3-4 times. Afterwards seeds are dried under shade for 2-3 days over a tarpaulin and followed by sun drying for 1-2 days to reduce the seed moisture content to 8 per cent. Then the seeds are cleaned and graded with BSS 12 sieve. The processed seeds are treated with fungicides or Halogen mixture @ 5g/kg of seed.

To upgrade the seed lot water floatation technique and specific gravity grading are commonly used. Seeds can be stored in aluminium foil pouches by which the viability can be maintained upto 18 months under ambient condition, by dressing the seeds with 2 g of thiram / kg of seed.

Optimum stage of harvest

Seed treatment

Seeds must be treated with fungicides before storage. The seeds may be treated with Captan or Thiram @ 4g/kg of seeds. The seeds can also be treated with halogen mixture @ 5g/kg of seed and it is an ecofriendly seed treatment.

Storage containers

Seeds could absorb moisture from atmosphere. Hence storing seeds in the coastal region (or) river sides we should use moisture vapour proof containers *i.e*., 700 gauge polyethylene bags. For seed storage every time new containers must be used.

Seed Yield: 100-200 Kg/ha

Seed Standards (Variety & Hybrid)

Factors	Foundation & Certified
Pure seed (mini)	98%
Inert matter (maxi)	2%
Other crop seeds (maxi) no/kg	None
Weed seeds (maxi)	None
Germination (mini)	70%
Moisture (maxi)	8%
For VP container (maxi)	6%
Genetic purity required for tomato & brinjal hybrids	90%

CHILLI (*Capsicum annuum*)

Botany

Cross pollinated vegetable. The flower is protogynous. Flowers open in the morning between 5.00 a.m and 6.00 a.m Anther normally dehisce between 8.00 a.m and

11.00 a.m. Pollens are fertile on the day of anthesis and stigma is receptive for about 24 hours after flower opening.

Method of seed production: Seed to seed

Stages of seed production

Breeder seed→Foundation seed→ Certified seed.

Varieties

Samba Varieties: K1, CO1, Pusa Jwala, PKM1, CO3, K2, Pant C1, G4

Gundu Varieties: CO2, G5 (Andhra Jyoti), PMK1, PLR1, CO4

Notified Varieties: G5, Chanchal, CO1, CO2, Hot Portugal, Jawhar mirch 218, Jwala, K1, K2, MDU1, Pant C1, Panjab lal , PKM1, Sanauri, Sindhur

Hybrids

KT.1, (Pusa Deepti), Solar Hybrid 1, Solar Hybrid 2. Early Bounty, Indira, Lario, Hira, Bharat.

Season

June-July, February-March, September- October.

Land requirement

There is no land requirement as of previous crops, but the land should be free from volunteer plants. Generally areas affected by wilt or root rot may be avoided. Crop rotation must be followed to avoid endemic solanaceous pests.

Isolation requirement

Minimum isolation distance of 400 M for foundation and hybrid seed and 200 M for certified seed production are necessary.

Seed rate

Seed required for one hectare is 500 g to 1 kg for variety; for hybrids - Female - 200 g and male - 50 g.

Seed Treatment

Seeds should be treated with captan @ 2g/kg or *Trichoderma viride* @ 4g /kg of seed and also seed treatment with *Azospirillium* @ 0.1 % improved the seedling vigour in chilli.

Nursery

Sowing the seeds in raised nursery bed of 20 cm height, in rows of 5 cm gap and covered with sand. Eight and ten nursery beds will be sufficient to transplant one acre. Application of 2 kg of DAP 10 days before pulling out of seedlings.

Transplanting

The seedlings of 30-35 days old are ready for transplanting. Transplanting may be done on the ridges in the evening.

Foliar spray

To arrest the flower drop, NAA (Planofix) can be sprayed @ 4ml/litre of water. Very light irrigation is also done to arrest the flower drop.

Manuring

Application of 50 tonnes of FYM/ha for irrigated crop. Basal 100:70:70 kg of NPK and 50 kg of N at 15 days after transplanting and 50 kg N at 45th days after transplanting.

Roguing

Field inspection and roughing should be done both for varieties and hybrid at different stages based on the plant height and its stature, flower colour and pod characters. The plants affected with leaf blight, anthracnose and viral diseases should be removed from the seed field.

Specific Field Standards:

Factors	Foundation	Certified
Off types (max)	0.1%	0.2%
Designated diseased plant (max)	0.1%	0.5%

The designated diseases are caused by *Collertotictum capsici* and leaf blight caused by *Alternaria solani.*

Pest and disease management:

Pests

Fruit borer

Spraying of carbaryl 50 WP 3 g/lit or chlorpyriphos 20 EC 3 ml/lit or quinalphos 25 EC 2 ml/lit.

Thrips

Spraying of dimethoate 30 EC 2 ml/lit or methyl demeton 25 EC 2 ml/lit or formothion 2 ml/lit or dust quinalphos 1.5 D at 20 kg/ha thrice at fortnightly intervals.

Aphids

Acephate 75 SP 1 g/lit or methyl demeton 25 EC 2 ml/lit or phosalone 35 EC 2 ml/lit.

Yellow Muranai mite

Spray dicofol 18.5 EC 2.5 ml/lit or ethion 50 EC 4 ml/lit or wettable sulphur 50 WP 6 g/lit.

Rootknot nematode

Application of TNAU formulation of VAM (containing 1 spore/g to control root knot nematode in nursery).

Diseases

Damping off

Treating the seeds with *Trichoderma viride* 4 g/kg or *Pseudomonas fluorescens* 10g /kg of seed 24 hours before sowing. Apply *Pseudomonas fluorescens* as soil application @ 2.5 kg/ha mixed with 50 kg of FYM. Stagnation of water should be avoided. Drenching with Copper oxychloride at 2.5 g/lit at 4 lit/sq.m

Leaf spot

Spraying of Mancozeb 2 g/lit or copper oxychloride 2.5 g/lit.

Powdery mildew

Spraying of Wettable sulphur 3 g/lit or Carbendazim 1 g/lit, 3 sprays at 15 days interval from the first appearance of symptom.

Die-back and fruit rot

Spraying of Mancozeb 2 g/lit or copper oxychloride 2.5 g/lit thrice at 15 days interval starting from noticing the die-back symptoms.

Chilli mosaic

Raising two rows of maize or sorghum for every five rows of chilli crop against wind direction.

Hybrid seed production

The crossing operation can be performed as per the methods outlined for tomato and brinjal hybrid seed production. However, hand emasculation and pollination is some what difficult since the flowers are minute. Hence use of male sterile lines can also be employed for hybrid seed production.

Emasculation and Pollination

Emasculation may be done either early in the morning or in the previous afternoon before opening of flower and petals still covering the anthers and stigma. With the help of a pair of forceps the petals are parted carefully and the anthers are removed separately. The emasculated flower buds are protected by thin cotton wad or bag or by thin cloth loosely wrapped around the branch, enclosing leaves and flowers and securely fastened.

Pollen collection is normally done late in the morning. Pollens from the previously protected flowers may be collected by a vibrator or after plucking the flowers from intended male parents, and gently tapped by finger for the collection of pollens in a petridish or watch glass.

The best time of pollination is early morning or late afternoon of the following day of emasculation. Pollination may be done by touching the freshly dehisced anthers

to the stigma by forceps, by dusting pollens over the stigma or by transferring the pollens with brush or needle very carefully. The petals may be cut off to facilitate pollination. Bagging of the flowers should be done to prevent pollen contamination.

Use of male sterility

Both genic and cytoplasmic – genic male sterility have been reported. The first public sector hybrid CH 1 was developed at Punjab Agricultural University, Ludhiana by utilizing male sterile in MS – 12. This male sterile line has been developed by utilizing the male sterile line introduced from France. At IIHR, Bangalore, three cytoplasmic and genic male sterile lines have been identified from Korean hybrids and indigenous sources.

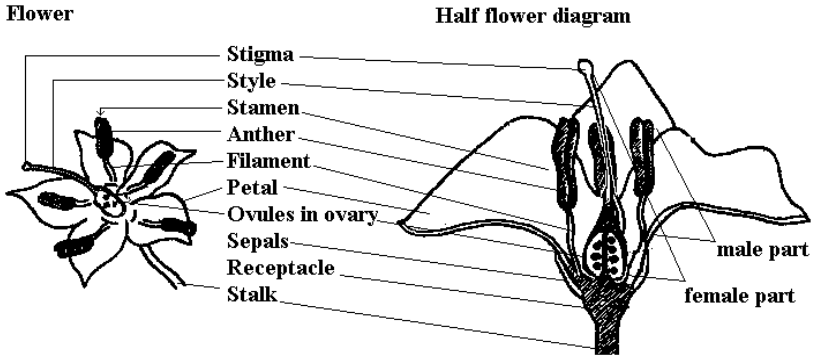


Fig. 3. Structure of chilli flower

Harvesting and processing

Harvesting should be done in different pickings. First and last two pickings can be harvested for vegetable purpose. The well ripened fruits with deep, red colour alone should be collected in each picking. After harvest, fruit rot infected fruits are to be discarded. The harvested pods are to be dried under shade for one (or) two days and then under sun for another 2 or 3 days. Before drying pods are to be selected for true to type and graded for seed extraction. The seed are extracted from graded dried pods. The pods are taken in gunny bag and beaten with pliable bamboo sticks. The seeds are cleaned by winnowing and dried to 10% moisture content over tarpaulin. Then seeds are processed

with BSS 8 wiremesh screens. For large scale seed extraction, the TNAU model chilli seed extractor may be used.

Seed storage

Seeds obtained from the first picking stored well for a longer time than those obtained from fifth and sixth pickings. The rate of deterioration was also faster in seed obtained from the later pickings. The seeds stored in PAFP pouches recorded higher germination for thirty months after storage as compared those in cloth bags.

Seed Yield: 100 to 200 kg/ha.

Seed Standards (Variety & Hybrid)

Factors	Foundation	Certified
Pure seed (mini)	98%	98%
Inert matter (maxi)	2%	2%
Other crop seeds (maxi) no/kg	5/kg	10/kg
Weed seeds (maxi) no/kg	5/kg	10/kg
Germination (mini)	60%	60%
Moisture (maxi)	8%	8%
For VP container (maxi)	6%	6%

Questions

1. Which is self pollinated crop

   a.Tomato b. Brinjal c. Chilli d. None

   Ans:a

2. Best seed extraction method for tomato is

   a. Acid b. Alkali c. Manual d. Machine extraction

   Ans:a

3. Isolation requirement for brinjal hybrid seed production is

   a. 200m b.400m c. 100m d.1200m

   Ans:a

4. Hybridization technique followed in tomato is

a. Use of chemicals b. Use of CMS lines

c. Emasculation and dusting d. Self incompatability

Ans:c

5. Heterostyle present in

a. Tomato b. Brinjal c. Chilli d. None

Ans:b

6. To arrest the flower drop in brinjal spraying can be done using

a. NAA b. IAA c. IBA d. GA

Ans:a

7. COBH 1 is a hybrid of

a. Tomato b. Brinjal c. Chilli d. None

Ans:b

8. Pollination behaviour of Chilli is

a. Self b. Cross c. Often d. None

Ans:b

9. Minimum germination requirement for Chilli is

a. 70 b. 80 c. 90 d.60

Ans:d

10. Protogynous flowers occur in

a. Tomato b. Brinjal c. Chilli d. None

Ans:c

Lecture 7

Varietal and hybrid seed production in bhendi and onion

Bhendi (*Abelmoschus esculentus*)

Botany

Bhendi is often cross pollinated crop. Anthesis is between 9 and 10 hr and is preceded by maximum anther dehiscence between 8 and 9 hr. The stigma remains receptive on the day of anthesis. Cross pollination to an extent of 12 per cent is due to protogynous.

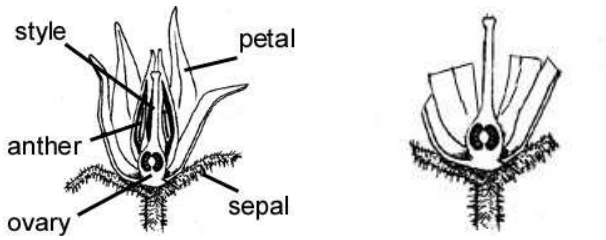


Figure 1. Flower before and after emasculation. The anthers are removed to prevent self-pollination. The petals and sepals are cut to identify the flower for future pollination.

Method of seed production

Seed to seed

Stages of seed production

Breeder seed → Foundation seed → Certified seed

Varieties

CO.1, CO.2, MDU.1, Parbhani Kranti, Arka Anamika, Pusa A-4, Pusa Savani, Punjab-7, JK Harita, Parbhawa

Hybrids

CO. 3, Mahyco hybrid, Shoba

Season

June-July, September- October and February- March

Land requirement

Select field on which bhendi crop was not grown in the previous season, unless the crop was of the same variety and certified. Field should be free from wild bhendi (*Abelmoschus* sp.)

Isolation requirement

Seed field must be isolated from other varieties at least by 400 M for foundation and hybrid seed production and 200 M for certified seed production.

Seed rate

Varieties	: 8-10 kg/ha
Hybrids	: 4 kg/ha (Female)
	: 1 kg/ha (Male)

Main field manuring

Apply 12.5 tons of FYM/ha before ploughing. Apply 150:75:75 kg NPK/ha, of which 50% of the N should be applied as top dressing in two split doses at flowering and 10 days later.

Planting ratio

For hybrid seed production, female and male parents are normally planted in the ratio of 4:1.

Roguing

Minimum of three inspections for varieties and 4 inspections for hybrids should be at 1. Vegetative, 2 & 3. Flowering and 4. Fruit maturity stages. The rouging should be based on the plant characters, hairyness, fruit character like fruit colour, number of ridges, fruit length etc., and the off type and mosaic attacked plants should be removed from the seed field. Wild bhendi if present should be removed before flowering.

Rogue plant

Specific field standards

Factors	Foundation	Certified
Off types (max)	0.1 %	0.2%
Objectionable weed (max)	None	None
Diseases affected plants(max)	0.1%	0.5%

Objectionable weed is wild *Abelmoschus* sp.

Designated diseases – yellow vein mosaic (*Hibiscus* virus-1)

Pest and disease management

The major pest attacking bhendi are jassids, aphids and white fly, which can be controlled by spraying rogar or dimecron or thiodon. The pod borer and red spider mites can be controlled by spraying thiodon and kelthane, respectively. The diseases such as yellow vein mosaic and powdery mildew can be controlled by spraying systemic insecticides and karathane, respectively.

Plant protection - Pests

Fruit borers

Integrated Pest management

- ❖ Spray carbaryl 50 WP 2 g/lit or monocrotophos 36 WSC 2 ml/lit combined with or neem seed Kernel extract 5 %.

1. Set up pheromone trap at 12/ha.
2. Collection and destruction of affected fruits.
3. Release of egg parasite *Trichogramma* at 1.0 lakh/ha.
4. Release of 1st instar larvae of green lace wing bug *Chrysoperla carnea* @ 10,000/ha.
5. Spray *Bacillus thuringiensis* 2 g/lit.

Leaf hopper

Monocrotophos 36 WSC 2 ml/lit or dimethoate 30 EC 2 ml/lit combined with neem seed kernel extract 5 %. 49

Nematode

Application of Carbofuran 3 G 1 kg a.i /ha or Phorate 10 G 1 kg a.i./ha and Neem cake 400 kg/ha at sowing in furrows along with fertilizers.

Diseases

Yellow vein mosaic virus

Spray monocrotophos 2 ml/lit to kill the vectors *i.e*., white flies.

Powdery mildew:

Dust Sulphur 25 kg/ha or spray Dinocap 2 ml/lit or Tridemorph 0.5 ml/lit or Carbendazim 1 g/lit or Wettable sulphur 2 g/lit immediately after noticing the disease and repeat after 15 days or four sprays of Triademephon (0.5%) at 10 days interval from 30 days after sowing.

Hybrid seed production

In bhendi, since the flowers are large in size, hand emasculation and pollination is the best suitable method for seed production. The emasculation and dusting can be done as per the methods outlined in tomato. The male and female parents are raised in blocks at the ratio of 9:1 (Female: Male).

Pollination of emasculated bud

Harvesting and threshing

Fruits should be harvested when they have dried (30-35 days after crossing). The pods which expose hairline crack and turned in to brown colour on drying alone are picked by hand and the seeds are separated manually. Then the seed are cleaned, dried and treated with captan/ thriam. (2g / kg of seed)

Optimum stage of harvest

It can be upgraded by water floatation technique (*i.e.* the seed is immersed in a column of water (1:10 by volume).Stirred well and floaters (9-10%) containing insect damaged and ill-filled seeds are removed. The sinkers blackish olive green in colour that sinks down to the bottom are separated and dried.

In okra, the seed coat colour ranged from green to grey and finally to black. The discoloured seeds may not be acceptable as seed for sowing because of poor physical

appearance and high expected incidence of seed borne fungi. The normal green colour seeds have better storage potential.

Bhendi seeds dried to 7 per cent moisture, treated with captan (2g kg-1 of seed) and stored in a sealed 700 gauge polyethylene bag could maintain 80 percent germination up to 24 months of storage.

Processing

Seeds are to be processed with BSS 7 wire mesh sieve.

Seed standards hybrid /varieties

Factors	**Foundation**	**Certified**
Pure seed (min)	99%	99%
Inert matter (max)	1%	1%
Other crop seeds (max) no/kg	None	5/kg
Weed seeds (max) no/kg	None	None
Objectionable weed (max)	None	None
Other distinguishable varieties (ODV) (max)	10/kg	20/kg
Germination (mini)	65%	65%
Moisture (maxi)	10%	10%
For VP container (maxi)	8%	8%

BULB CROP

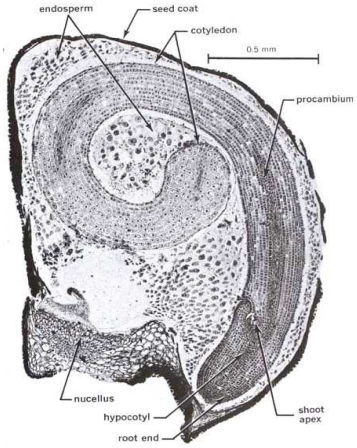
Onion (*Allium cepa*)

Botany

Onion is the biennial crop and takes two full seasons to produce seeds. In the first year bulbs are formed and in the second year stalks are developed and produced seeds. It is a long-day plant. The day length influences bulb onion, but has little effect on induction of seeding. It appears to be day-neutral for seed production. It requires cool conditions during early development of the bulb crop and during early growth of seed stalk. Varieties bolt readily between 10 to15° C. In the early stages of growth, a good supply of moisture is required and temperatures should be fairly cool. During bulbing,

harvesting and curing of seed, fairly high temperatures and low humidity is desirable. Seed production is widely adapted to temperate and sub-tropical regions.

Onion flower and Seeds



Stages of seed production: Breeder seed → Foundation seed → certified seed

Varieties

Bellary Red, Rampur local, Pusa white, Kalyanpur, Red Round Punja 48, Pusa red, Pusa Madhvi, Arka Niketan, Arka Kalyani

Season

The optimum sowing season is middle of June to Middle of July in the plains.

Isolation Requirements

Onion is largely cross-pollinated crop with up to 93 per cent natural crossing but some self-pollination does occur. It is chiefly pollinated by honey-bees. For pure seed production, the seed fields must be isolated from fields of other varieties of onion and fields of the same variety not conforming to varietal purity requirements for certification atleast by 1000 meters for foundation seed production and 500 meters for certified seed production.

Method of Seed Production

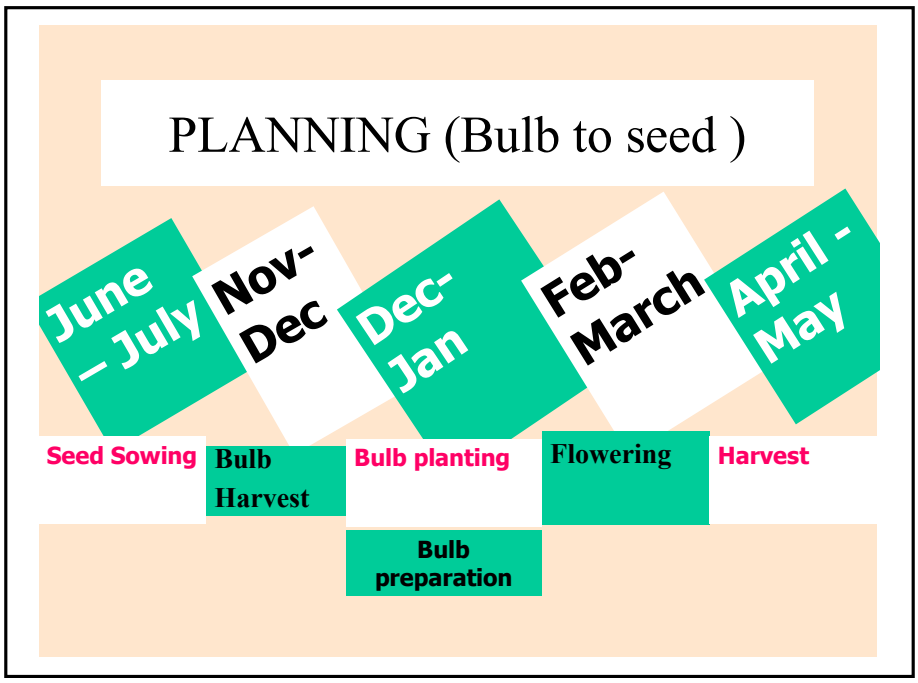
There are two methods of seed production

1. Seed to seed method

In this method, the first season bulb crop is left to over-winter in the field so as to produce seed in the following season.

2. Bulb to seed method

The bulbs produced in the previous season are lifted, selected, stored and replanted to produce seed in the second year. Mostly the bulb to seed method is used for seed production because of the following advantages over the seed to seed method. a) It permits selections of "true-to-type" and healthy bulbs for seed production. b) Seed yields are comparatively very high. The seed to seed method, however, can be practiced for varieties having a poor keeping quality.



Bulbs to Seed Method

Production and storage of bulbs (first year)

Sowing time (nursery)

Middle of October to middle of November in the plains and April to June in the hills. 1/20 hectare nursery is sufficient for raising seedlings for one hectare.

Seed rate

Eight to ten kg per hectare.

Seed treatment

Soaking of bellary onion (cv. Rampur Local) seeds with 100 ppm GA_3 for 3 hrs increased the germination (from 50 to 90 per cent) and vigour.

Fertilization

Add 20 tonnes of well-rotted farmyard manure at the time of land preparation and 250 kg super phosphate (single) and 45 kg potassium sulphate at the time of planting. 250 to 375 kg of ammonium sulphate or CAN may be applied as top-dressing in two to three doses during the growing period.

Transplanting

Eight to ten weeks old seedlings are planted in small beds in well-prepared fields.

Spacing

Spacing depends upon variety and bulb size and varies from 10 to 15 cm.

Irrigation

Fortnightly irrigation during winter weekly irrigation during hot weather. Irrigate sparly during maturity.

Interculture

Keep field free from weeds. Frequent inter culture is essential for good bulb development. For controlling weeds, post-emergence application of tenoran at 2 kg per hectare in 800 liters of water, two to three weeks after transplanting is recommended. Oxadiazon one kg active ingredient per hectare has also given for effective control of weeds.

Insect and disease control

Insect: Onion thrips

Spray malathion 50 EC at 600 to 700 ml per hectare or thiodan 35 EC at 600 to 700 ml per hectare. Three to four applications may be required. Onion maggot can be controlled by spraying with sevimol.

Diseases: Damping-off

Use treated seed. In cases of seedlings mortality, drench nursery with 0.3 per cent captan or thiram or dithane Z-78 at weekly intervals.

Purple blotch

Spray with copper fungicides such as blitox 50 at 0.2 per cent.

Plant protection - Pests

Thrips and onion fly

Methyl demeton 25 EC 1 ml/lit or dimethoate 30 EC 1 ml/lit or monocrotophos 36 WSC 1 ml/lit with Teepol 0.5 ml/lit.

Cutworm

Drench the soil with chlorpyriphos @ 2 ml/lit.

Diseases

Leaf spot

Spray Mancozeb 2 gm/lit or Copper oxychloride 2.5 gm/lit. Add Teepol 0.5 ml/lit of spray fluid.

Harvesting and curing of bulbs

Well-matured bulbs should be harvested. Maturity is indicated by the tops drooping just above the bulb, while the leaves are still green. After harvesting, the bulbs should be topped leaving a half inch neck. Before storage, a thorough selection and curing of bulbs should be done. The length of time required for curing depends largely on weather conditions and may take three to four weeks.

Harvest ready onion

Storage

The essentials of successful storage are

a. The bulbs should be well-matured, dried and cured before storage.
b. Storage should be well-ventilated.
c. Storage should be done in shallow trays with perforated bottoms.

d. Storage temperatures should range 0 to 4.5° C until three to four weeks prior to planting, when the temperature should be increased to around 10° C.

Planting of bulbs and seed production (second year)

Time of planting bulbs

The best time for planting bulbs is the second fortnight of October.

Preparation of land

Prepare the field to good tilth. One deep ploughing, followed by three to four harrowings and land levelling are enough.

Seed rate

The seed yield is affected by the size of the bulb. The bigger the bulb size, the higher is the seed yield. However, very large sized bulbs, if used, will need very high seed rate. If bulb size of 2.5 to 3.0 cm diameter, is used for planting, approximately 15 quintals of bulbs per hectare are required.

Fertilization

Same as described for first year.

Method of planting and spacing

Bulb selection

Selected bulbs are planted 8 to 10 cm deep in the soil at a distance of 45 x30 cm. The size of beds depends upon the source of irrigation. The sprouted bulbs are planted as such. In unsprouted bulbs, the upper half portion should be removed, leaving the disc-like stem and roots intact. The removal of the upper tops hastens sprouting.

Foliar application

Foliar application of GA3 (100 ppm) (or) IAA (100 ppm) increase the seed setting per centage.

Interculture

Insect and disease control:- Same as described for first year.

Roguing

First year: It is desirable to begin roguing in the field before bulbs are harvested, since it is then possible to detect any plants having a different foliage colour or plant type or late maturing bulbs. After harvesting, the bulbs should be carefully rogued for colour and such off-types as thick-necks, doubles, bottlenecks, as well as any other types which do not conform to varietal type.

Second year: plant only selected true-to type bulbs and remove plants not conforming to varietal characters before flowering.

Specific field standard

Field standard	
Other variety bulbs (max.)	0.2%
Off types (max.)	0.2%

Harvesting and processing

The maturity of seed ready for harvest is indicated when (April-May). On full maturity, the seeds turn into black colour. The matured seed bunches are harvested before shattering and dried .under shade. Normally two to three harvest are required depends up on the maturity of the seed. Harvest the seeds at intervals by cutting the seed head with 10-15 cm of stem attached. The harvested umbels are heaped for a few days for drying before threshing. This helps in proper curing of seed then the seeds are separated from the capsules by hand threshing or using pliable sticks. The seeds are cleaned, graded by using 10 x 10 BSS sieve, dried to 6-8 % moisture content and treated with Bavistin / Thiram @ 2-3 g/kg of seed.

Harvestable maturity

Seed Yield

The average seed yield varies from 850 to 1000 kg per hectare.

Seed standards: (Variety & Hybrid)

Factors	Foundation	Certified
Pure seed (min)	98%	98%
Inert matter (max)	2%	2%
Other crop seeds (max) no/kg	5/kg	10/kg
Weed seeds (max) no/kg	5/kg	10/kg
Germination (min)	70%	70%
Moisture (max)	8%	8%
For VP container (max)	6%	6%

Questions

1. Isolation requirement for bhendi certified seed production is

   a. 200m b.400m c. 100m d.1200m

   Ans: a

2. For hybrid seed production of bhendi, male and female lines are raised in

   a. Use of chemicals b. Use of CMS lines

   c. Emasculation and dusting d. Block method

   Ans: d

3. Objectionable weed in bhendi is

   a.*Abelmoschus sp*. b. *Cuscuta* c. Saranai d. *Solanum melongena*

   Ans: *b*

4. Designated disease in bhendi

   a.Yellow vein mosaic b. Leaf blight c. Root rot d. Fruit borer

   Ans: a

5. Minimum germination requirement for bhendi is

   a.65 b. 80 c. 90 d.60

   Ans: a

6. True- to type, healthy seed are produced by

   i. Seed to Seed method

   ii. Bulb to Seed method

   Ans: Bulb to Seed method

7. Minimum germination requirement for onion is

a. 70 b. 80 c. 90 d.60

Ans: a

8. Pollination behaviour of bhendi is

a. Self pollination b. Often – cross pollination

c. Cross pollination d. None of the above

Ans: b

9. Breeding tool used for onion hybrid seed production

GMS b. CMS c. CGMS d. Emasculation & dusting

Ans: b

10. The physiological maturation symptom of bhendi is

a. Yellowing of fruit b. Hairline crack in fruits

c. Hardening of fruits d. Change of seed color into black

Ans: b

11. Too closer spacing in onion leads to downy mildew (True/False)

Ans: True

12. On full maturity, the onion seeds turn into black colour (True/False)

Ans: True

13. Why does cross pollination is a rule in onion?

Ans: Protoandrous flowers

Lecture No.8

Varietal and hybrid seed production in gourds

Botany

Cucurbits are generally cross pollinated crops. Anthesis and pollination starts in about 40-45 days after sowing. Sequence of flowering follows a set pattern first 4-6 flowering nodes bear the male flower and later female flower. Ratio of male and female 25-30:1 to 15:1 which results in greater number of female f1owers per plant and increase the fruit set percentage. Sex ratio is highly influenced by environment. Abundance of light tends to produce more number of staminate flowers and lower light promotes pistillate flowers. High temperature and long days tends to keep staminate phase.

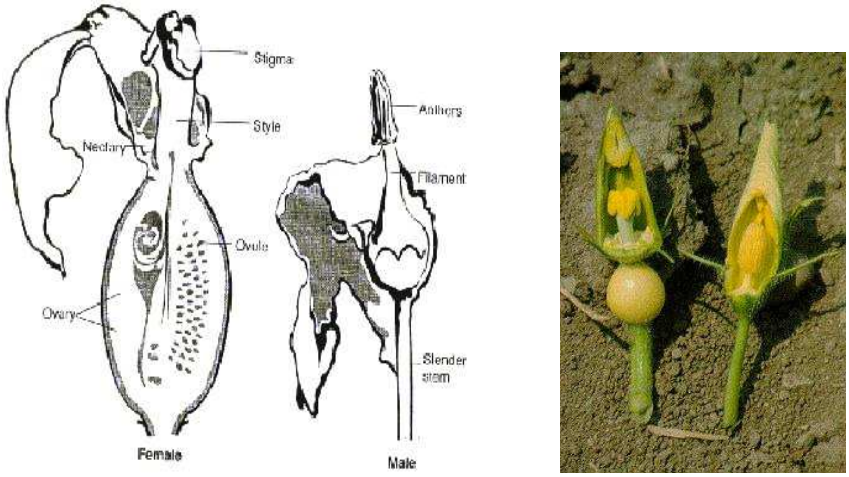


Fig. 1.**Female flower (left) and male flower (right) and ovary at the base of the female flower**

Land Requirements

There are no land requirements as to previous crop, but the land should be free of volunteer plants. Generally the soil should be well drained and aerated.

Isolation Requirements

Most of the cucurbits are monoecious in character and a few are dioecious. A number of hermaphrodite and andromonoecious cultivars are also available in some crops. Pollination is largely done by insects. For pure seed production maintain isolation distance all around seed field is necessary to separate it from fields of other varieties, fields of the same variety not conforming to varietal purity requirements for certification, from wild cucurbit species, and to separate musk melon from long melon and vice versa, and pumpkin from summer and winter squashes and vice versa as follows.

Class	**Minimum distance (meters)**
Foundation	1000
Certified	500

Hybrid seed production

In cucurbits, the presence of heterotic combinations, flower size and colour, pollen production capacity of male plant and longer duration of stigma receptivity, easiness in emasculation and pollination, attraction of insect as a means of pollen transfer, seed setting and their economic feasibility in production as well as adoption supports the production of F1 hybrid seed.

Picking of male flowers and artificial pollination

In monoecious plants, emasculation is not required. Female and pollen parent lines are planted alternately in an isolated field. The male flowers from the female parent are pinched before they open. Pistillate flowers of the female parent are artificially pollinated with the pollen of the male parent using cotton puffs by manual labour.

Picking of male flowers and insect pollination

Female and pollen parent lines are planted alternately in an isolated field. The male flowers from the female parent are pinched before they open. Female flowers are left on the seed parent and allowed to be pollinated by insects from the pollen parent.

Use of gynoecious lines

The gynoecious (female parent) and monoecious (pollen parent) lines are planted alternately. Since the percentage of gynoecisous plants in different gynomonoecious

lines is variable, all the monoecious plants are removed at the early stage. Seed is collected only from gynoecious plants that have been left for seed production.

Maintenance of gynoecious lines

In gynoecious lines, only pistillate flowers are produced and so it requires staminate flowers for self pollination. For production of staminate flowers, GA-3 100ppm is sprayed thrice at 15 days interval from 2nd leaf stage or single foliar spray of silver nitrate 600ppm is done before 1st flower open. It induces staminate flowers for fertilization of pistillate flowers. At physiological maturity / ripening, fruits are harvested and seeds are extracted. Such seed when sown in next generation will produce only pistillate flower.

Use of genetic male sterility system

Genetic male sterility system has been utilized for commercial hybrid seed production. Since genetic male sterile line is maintained heterozygous forms, 50% fertile plants are to be removed at flowering. The other 50% having non-dehiscent empty anther are retained in female rows. The female and male are grown in 4:1 ratio. However, to maintain the good plant population in female rows, it is suggested that seed parent should be sown with double seed rate. It is also advised that female line seedling should be raised in polythene bags and transplanted at flower appearance in order to avoid the fertile plants in female rows. The pollination is done by honey bees and 1 to 2 medium sized hives are good enough to ensure the good pollination and fruit set at female rows.

BITTER GOURD

Bitter gourd (*Memordica charantia* L) is also called as Balsom pear.

Varieties

CO 1, MDU 1, Pusa Visesh, Pusa Do Mausami, VK1 Priya, Arka Harit, Konkan, Preethi

Hybrids

CBGH 1, Pusa Hybrid 1

Season

June-July and January - February.

Sowing

Sowing pre-germinated seeds to maintain optimum field population, the seeds are soaked in water for 24 hours. Then place the seeds in moistened sand and cover the seeds with sand and left for 3 days. Maintain the sand in wet condition. After 3 days the seeds with protruding radicle are separated and used for sowing.

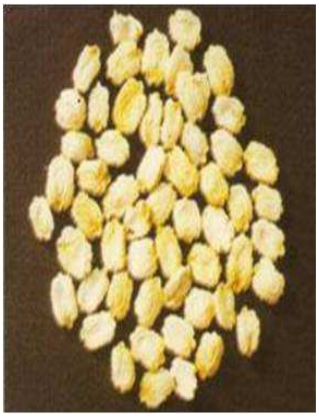


Fig. 2. Good quality seeds **Ill filled seeds**

Seed rate

1.8 kg /ha

Spacing

45 x 45 x 45 cm at 2.5 x 2 m, sowing of three seeds per pit at 2cm depth micropylar end facing upward is favorable for better field emergence.

Manuring

Application of 10 kg FYM per pit

Top dressing

i. Urea 22 g / pit during 1st flowering.
ii. Urea + potash 18 + 5 gm/pit at 20 days after flowering.
iii. Urea 18 gm + potash 5 gm/ pit at 40 days after flowering.

Foliar application

Spraying ethrel 200 ppm from 4 leaves stage onwards at one week interval for four times.

Weeding

Field has to be maintained clean by frequent hand weeding in order to remove objectionable weed species like *Mimordica balsamina* L.*, M. cochinchinens* and *M. diocia* ex wild.

Main field maintenance

Each plant has to be provided with stacking 20-25 days after sowing for training the vines over the pandal. Training operation has to be carried out daily until the fruiting stage.

Irrigation

Irrigated the crop before dibbling the seeds and thereafter once in a week.

Roguing

During vegetative, fruit formation and fruit harvest phases, roguing is attempted based on plant characters like height of plant, leaf shape, size, surface of leaf and fruit characteristics like length of fruit, size, shape and colour.

Plant protection

Pests

Beetles, fruit flies and caterpillars

Spray malathion 50 EC 1ml/lit or dimethoate 30 EC 1ml/lit or methyl demeton 25 EC 1ml/lit or fenthion 1000 EC 1ml/lit. Avoid copper and sulphur dust since these chemicals cause injury to the plants.

Diseases

Powdery mildew

Spray Dinocap 1ml/lit or Carbendazim 0.5 g/lit.

Downy mildew

Spray Mancozeb or Chlorothalonil 2 g/lit twice at 10 days interval.

Harvest

The harvest starts from 60-65 days after sowing and matured fruits can be harvested once in a week. The fruits with yellow or yellowish orange colour should be harvested for seed extraction.

Fig. 3. Optimum stage of harvest

Seed extraction

Fruits are cut longitudinally and the seeds are removed along with mucilaginous material and then the seeds are washed with water.

Fig. 4. Separation of seeds

Drying

The seeds are dried under shade for one or 2 days followed by drying under sun to reduce the moisture content 7-8% for storing in cloth bag and 6% for moisture vapour proof containers.

Grading

For grading the seeds BSS 4 x 4 size sieves are used

Storage

Seed treating chemicals captan or thiram 4 gm /kg of seeds or halogen mixture @ 5 g/kg of seeds is recommended.

SNAKE GOURD

Snake gourd (*Trichosanthes anguina* L) is also called as Chicinda.

Varieties

CO 1, CO 2, MDU 1, PKM 1 and APAU Swetha

Season

June - July; December - January

Pre-sowing seed treatment:

Pre germination of seeds by soaking in double the volume enhances the seed germination.

Seed rate

1.5 kg /ha.

Fig. 1. Snake gourd plant

Spacing

Pit of size 45 x 45 x 45 cm at 2.5 x 2.0 m spacing is optimum

Manuring

Application of 10 kg FYM and 100 g of 6:12:12 NPK mixture per pit as basal and 10 g N/pit at 30 days after sowing is generally recommended.

Foliar application

Maleic hydrazide @ 400 ppm at 2 leaves stage and 5 leaves stage enhances the seed yield and quality or application of ethrel @ 100 to 200 ppm at weekly intervals from 4 th leaf stage for four times increases the female flower production. During the course of fruit development apply urea @ 12 kg / ha, super phosphate 4 kg /ha, potash 2 kg /ha and micronutrients 400 g/ha.

Irrigation and weeding

Basin is irrigated before dibbling the seeds and thereafter once in a week the pits are irrigated. Hoeing and weeding thrice is essential.

Main field maintenance

Each plant has to be provided with stacking 20-25 days after sowing for training the vines over the pandal. Training operation has to be carried out daily until the fruiting stage. Pandal is not essential for all varieties (eg. MDU 1, CO 2)

Roguing

During vegetative, fruit formation and fruit harvest phases, roguing is attempted based on plant characters like height of plant, leaf shape, size, surface of leaf and fruit characteristics like length of fruit, size, shape and colour.

Plant protection

Pests

Leaf beetles, and leaf caterpillars

Spray malathion 50 EC 1 ml/lit or dimethoate 30 EC 1 ml/lit or methyl demeton 25 EC 1 ml/lit or fenthion 100 EC 1 ml/lit will prevent the pest incidence. Avoid copper and sulphur dust since these chemicals cause injury to the plants.

Diseases

Powdery mildew

Spray Dinocap 1 ml/lit or Carbendazim 0.5 g/lit.

Downy mildew

Spray Mancozeb or Chlorothalonil 2 g/lit twice at 10 days interval.

Harvest

Fruits can be harvested at visible yellow to orange skin initiation stage.

Seed extraction

Manually the immature seeds can be removed as water floaters during wet extraction. After drying the seeds the immature and small sized seeds should be removed as air blown rejects. 16/64" round perforated or BSS 4 x 4 (6.2 mm) sieve may be used

Storage

Seeds dried to 7 to 8 % moisture content and dry dressed with thiram / captan 75% wettable powder or halogen mixture @ 3 g / kg of seeds, can be stored in cloth bag up to 10 months and over 18 months in moisture vapour proof containers.

RIBBED GOURD (*Luffa acutangula*)

Fig. 1. Ribbed gourd plant

Varieties

CO 1, CO 2, PKM 1 and Pusa Nasdar

Season

June-July and January- February

Spacing

After proper ploughing, at a spacing of 2.5 x 2 m distance take pits having45 cm length, width and height.

Manuring

Ten days after pit preparation, apply 10 kg FYM and urea 20 g, super phosphate 90 g and potash 15 g per pit. Then mix the above nutrients with soil and fill the pits and level them. Since, it is vining in nature better to erect the pandal at 2 m height. It will facilitate for better growth and yield and also easy for roguing operation.

Sowing

Seed required for ha (2.5 kg) may be treated with fungicides before sowing. Then five seeds may be sown in a pit at equal distance. After the germination, retain three vigourous seedlings per pit and remove two seedlings.

Irrigation

After sowing pits should be irrigated. After the seedling emergence, field should be irrigated once in a week.

Weeding

In ribbed gourd, one or two manual weeding is necessary before the flowering stage.

Growth regulator spray

Spraying of ethrel at 250 ppm (*i.e.*, 2.5 ml of ethrel in 10 lit of water) for four times starting from 15 days after sowing and followed by weekly intervals will facilitate more female flower production.

Top dressing

Two split doses of urea as 22g/pit at flowering stage and another 18 g urea plus 5 g potash / pit each at 20 and 40 days after flowering.

Plant protection

To control leaf cutting beetles and fruit flies and borers spray Malathion 50 EC 1 ml or Dimethioate 30 EC 1 ml or Fenthion 100 EC 1 ml/lit of water.

Powdery mildew

Spray carbendazim 0.5 g or Dinocob 1 ml/lit of water.

Roguing

During vegetative, pod formation and pod harvest phases, roguing is attempted based on plant characters like height of plant, leaf shape, size, surface of leaf and fruit characteristics like length of fruit, size, shape and colour. Plants showing symptoms of yellow mosaic are also removed.

Harvest

The change of pod colour to brown is the indication for harvest. Once there is a symptom of hair line cracks on the edges of the pod, it should be harvested without any delay. The harvests will be done in different pickings

Fig. 2. Fruits selected for seed extraction

Pod grading

After the pod harvest and before the seed extraction, only healthy pods of true to type and free from pest/ disease infestation is to be selected for seed extraction.

Fig. 3. Removal of small and other variety fruits

Seed extraction

For seed extraction, fruits are cut opened or make holes at the distal end of the pod and separate the seeds easily. Separated seeds are to be pre-cleaned manually by removing the white and pale yellow coloured ill filled seeds.

Fig. 4. Seed extraction

Processing

The seeds are to be processed with 16/64" round perforated metal sieve or BSS 4 wire mesh sieve.

Fig. 5. Ill filled seeds

Storage

Seeds dried to 7 to 8 % moisture content and dry dressed with thiram / captan 75% wettable powder or halogen mixture @ 3 g / kg of seeds, can be stored in cloth bag up to 10 months and over 18 months in moisture vapour proof containers.

ASH GOURD

Ash gourd (*Benincasa hispida cogn*) is otherwise called wax gourd.

Varieties

CO1, CO 2, APAU Shakthi and S 1.

Season

January – February and June - July

Seed rate

1.5 kg / ha.

Seed treatment

Seeds soaked in KNO3 @ 1 % for 12hr are found to improve the germination.

Spacing

45 x 45 x 45 cm at 2.5 x 2 m, sowing of three seeds per pit at 2cm depth

Manuring

100 g of the mixture (6:12:12) per pit as basal and 10 g N / pit 30 days after sowing.

Foliar application

Maleic hydrazide @ 400 ppm at 2 leaves and 5 leaves stages enhances the seed yield and quality or ethrel @ 100-200 ppm at weekly intervals from 4 leaves stage for 4 times.

During the course of fruit development apply urea 12 kg / ha, super phosphate 4 kg/ha, potash @ 2 kg /ha and micronutrients 400 g / ha.

Irrigation

After sowing pits should be irrigated. After the seedling emergence, field should be irrigated once in a week.

Weeding

In ash gourd, one or two manual weeding is necessary before the flowering stage.

Roguing

During vegetative, fruit formation and fruit harvest phases, roguing is attempted based on plant characters like height of plant, leaf shape, size, surface of leaf and fruit characteristics like length of fruit, size, shape and colour.

Plant protection

To control leaf cutting beetles and fruit flies and borers, spray Malathion 50 EC 1 ml or Dimethioate 30 EC 1 ml or Fenthion 100 EC 1 ml/lit of water.

Powdery mildew

Spray carbendazim 0.5 g or Dinocob 1 ml/lit of water.

Harvest

Fruits can be harvested 80-85 days after anthesis when stalk becomes dry and ashy coat prominent.

Fig. 1. Optimum stage of harvest

Seed extraction

Fresh fruits can be used for extraction. On fresh extraction immature seeds can be removed as floaters. Cutting the fruits into longitudinal bits and soaking in concentrated HCl acid at 1 part acid in 6 parts water for 30 minutes and wash the seeds with water 2 to 3 times to remove the acid.

Fig. 2. Seed extraction

Grading

Using 16 / 64" round perforated metal sieve or BSS 4 x 4 wire mesh sieve grade the seeds.

Storage (Fruit & seed storage)

i. Half matured fruits available at the last harvest can be removed and stored over sand bed at ambient conditions. On dry storage seed develops and can be used for seed extraction. It facilitate early field release.

ii. Fruits weighing not less than 2 kg without bruishes and proper protection from insect pathogen and rodents can be stored over sand for more than 6 months. The loss in fruit weighing amount to 35% with germination of 80-90%

iii. Seeds should be dried to 8% moisture and treated with thiram 4 g kg^{-1} of seeds or halogen mixture 5 g / kg and stored in moisture vapour proof container for longer storage.

PUMPKIN (*Cucurbita moschata*)

Varieties

CO 1, CO 2

Season

January – February and June - July

Spacing

After proper ploughing, at a spacing of 2.5 x 2 m distance take pits having 45 cm length, width and height.

Manuring

Ten days after that, apply 10 kg FYM and urea 30 g, super phosphate 72 g and potash 19 g per pit. Then mix the above nutrients with soil and fill the pits and level them.

Sowing

Seed required for one ha (1kg/ha) may be treated with fungicides before sowing. Then five seeds may be sown in a pit at equal distance.

Growth regulator spray

Spraying of ethrel at 200 ppm for four times starting from four leaves stage and at weekly intervals (i.e. 2.0 ml of ethrel in 10 lit of water) is recommended.

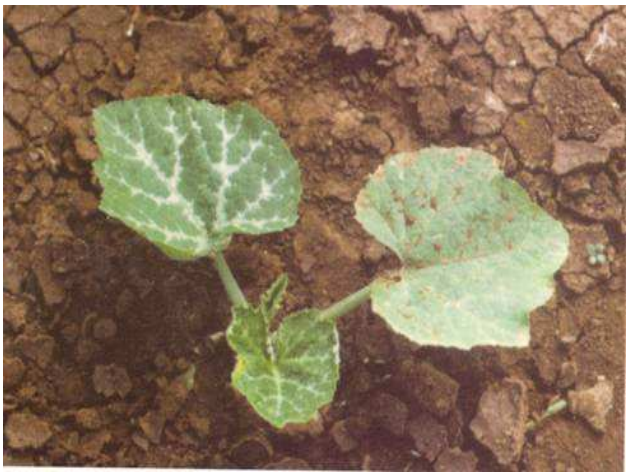


Fig. 1. Optimum stage for spraying of growth regulators

Top dressing

Apply 22g urea / pit 30 days after sowing as top dressing.

Plant protection

Red pumpkin beetle

Spray methyl demeton 1 ml/lit.

Powdery mildew

Spray carbendazim 0.1 %.

Yellow vein mosaic

White flies spread this disease. To control the insect vector spray monocrotophos or chlorpyriphos 2 ml plus 2 ml neem oil per lit of water.

Roguing

During vegetative, fruit formation and fruit harvest phases, roguing is attempted based on plant characters like height of plant, leaf shape, size, surface of leaf and fruit characteristics like length of fruit, size, shape and colour. Plants showing symptoms of yellow mosaic are also removed.

Harvesting

Maturity index in pumpkin is change in fruit colour to orange or pale yellow colour.

The harvests will be done in different pickings in pumpkin. Fruits confirming the genetic purity with medium to large size fruits should alone be used for seed extraction.

Fig.2. Correct stage for harvest

Seed extraction method

Fruits weighing less than 1.5 kg should be rejected and can be sold out in the market as vegetable. Seed extraction is easy in pumpkin. First cut the fruits into two halves by crosswise. Then remove the seed by scraping and wash with water.

Fig. 3. Fruits selected for separation of seeds

Fig. 4. Seed separation by cutting the fruits

Seed cleaning and processing

After proper drying seed processing should be done using BSS 4 wire mesh sieve or 16/64″ round perforated metal sieves.

Fig. 5. Small and illfilled seeds

Fig. 6. Good quality seeds

Seed treatment

Prior to storage, seeds are mixed with Carbendazim 4g/kg or halogen mixture at 5g / kg and stored with moisture content of 6-8% in moisture vapour proof containers like thick polythene bag of 700 gauge or in tin / plastic containers that are sealed tightly. In case of short term storage (4-6 months) cloth or gunny will be sufficient.

Minimum seed certification standards prescribed for cucurbits

Field standards

Factors	Foundation	Certified
Offtypes (maximum limit)	0.10%	0.20%

Seed standards

Factors	Foundation	Certified
Pure seed (min)	98%	98%
Inert matter (max)	2%	2%
Other crop seed (max) no/kg	None	None
Total weed seed (max) no/kg	None	None
Germination (min)	60%	60%
Moisture (max)	7%	7%
For VP Container (max)	6%	6%

Questions

1. Why foliar spray is given to cucurbits during two and four leaf stage?

Ans: To increase female flower production

2. Does Musk melon cross with long melon?

Ans: Yes

3. 16/64 round perforated is used to grade which crop seed?

Ans: Ash gourd

4. How do you identify female flowers in ridge gourd?

Ans: Flowers with miniature fruit

5. Name the chemicals used to induce female flowers in bitter gourd?

Ans: Etherl

6. What is the minimum seed germination percentage as per IMSCS for pumpkin?

Ans: 60%

7. What is the method used for wet seed extraction in gourds?

a. Cutting and scraping b. Acid method

c. Manual scooping and washing with water d. None of the above

Ans: c

8. Harvestable maturity symptom for ashgourd?

a. Green colour b. Orange colour c. Ash coat formation d. Brown colour

Ans: c

9. Optimum moisture for bittergourd seeds storage?

a. 8% b. 12% c. 6 % d. 145%

Ans:c

10. Harvestable maturity for ridge gourd is complete drying of fruits. (True/false)

Ans: True

Lecture No. 9

Varietal and hybrid seed production in amaranthus and moringa

Amaranthus (*Amaranthus tricolor / A. cruentusl, A. blitum var. oleracea*)

Botany

Amaranthus is self pollinated crop and flowers are protogynous with stigma in pistillate flowers becoming receptive several days before opening of staminate flowers. Arrangements and sequence of anthesis favours a combination of self and cross pollination *viz.,* the maturation takes place from bottom to top. The transfer of pollen among the cymes of same inflorescence is favoured by wind leading to self fertilization. The dehiscence of anthers and release of pollen grains are maximum between 11a.m to 1p.m.

Since it is a monoecious plant bearing both male and female flowers on the same inflorescence and hence it was very important that emasculation was done before anthesis to avoid setting of the female parent in hybridization programme. After emasculation, the flower heads are bagged with butter paper bags.

Fig. 1. Inflorescence of amaranthus

Varieties

CO-1, CO-2, Chotti Chauli, Badi Chauli, CO-3, CO - 4, CO- 5 Pusa Kirti, Pusa Kiran, Pusa Lal Chaulai,

Isolation Requirement

A minimum isolation distance of 400 meters and 200 meters for foundation seed and certified seed class respectively is required.

Season

February- March, May-June

Seed rate

1.5-2.5 kg per hectare

Method of sowing

Amaranthus seeds are very small and therefore mixed with fine soil or sand for even distribution. Seed crop should be sown in rows 25-30 cm apart. At the time of sowing there should be enough moisture in the field for proper germination.

Manuring

Generally the crop is grown on residual fertility of the previous crop. However when manured, 20-25 tons of FYM per ha may be applied at the time of land preparation. Later on 100 kg Ammonium sulphate per ha may be top dressed between rows just before irrigation.

Irrigation

Irrigation is given once in a week. Flowering and seed filling are the critical stages of irrigation.

Roguing

A minimum of two inspections during vegetative stage followed by flowering stage is to be carried out. Rouge out off types and wild *Amaranthus spp.* from seed fields prior to flowering and during flowering.

Field standards

Factors	**Foundation**	**Certified**
Off types	0.10%	0.20%
Objectionable weed plants	0.010%	0.020%

Objectionable weed: Wild Amaranthus *(Amaranthus spinosus* L.*)*

Harvesting and threshing of seeds

The crop is harvested when most of the leaves turn yellow. The plants after cuttings are left on the threshing floor for few days to dry. When the plants are fully

dried the seeds are separated by beating them with sticks. The seeds are then cleaned by winnowing.

Plant protection - Pests

Leaf eating caterpillar

Carbaryl 50 WP @ 2 g/lit.

Seed yield

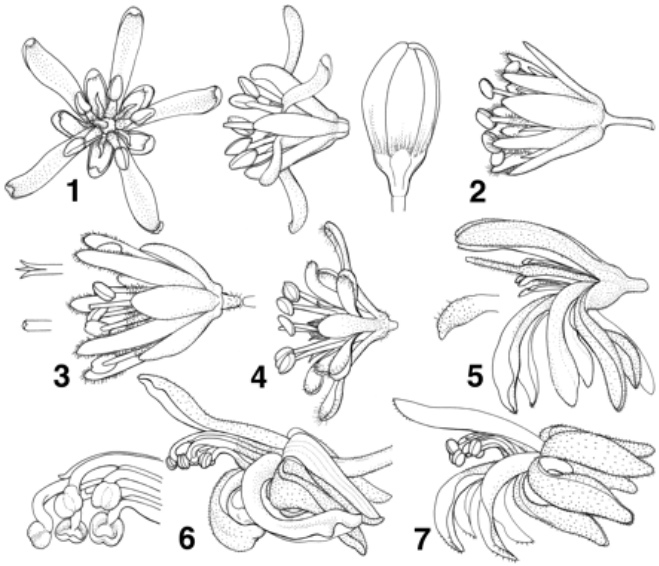
2-3 quintals per hectare.

Seed standards

Factors	Foundation	Certified
Pure seed	95%	95%
Inert matter	5%	5%
Other crop seed	5/kg	10/kg
Total weed seed	10/kg	20/kg
Objectionable weed seed	5/kg	10/kg
ODV	10/kg	20/kg
Germination	70%	70%
Moisture	8%	8%
For VP Container	6%	6%

Moringa (*Moringa olefera)*

Botany



The plant is highly cross pollinated due to heteromorphism and bees being the pollinators. Anthesis commences as early as 4.30 a.m and continues till 6.30 a.m with a peak at 5.30 a.m. The stigma becomes receptive a day before flower opening and

continuous to be receptive on the day of opening.

pecies

Method of seed production

Seed to Seed

Varieties

KM1**,** PKM 1 and PKM 2

Land requirement

Good drainage facility is must for moringa

Isolation requirement

A distance of at least 1000m for foundation and 500m for certified seed production is necessary

Season

Early season (July – August), Mid season (September), Late season (October-November), Best season is September- October (so that flowering starts during summer which facilities better pollination and seed set)

Pit preparation

The field should be ploughed twice for good tilth. Pit size with 45 x 45 x 45 cm, one week prior to sowing / planting should be prepared. Spacing between the pits must be 2 ½ x 2 ½ m. Filling up of pit with application of 15 kg FYM or compost per pit along with field soil

Sowing

Seeds are readily germineable (non dormant). However, soaking the seeds in water, overnight will hastern the germination processes. Placing two seeds per pit in the sowing depth of 2.5 cm is practiced. Normally the seeds germinate within seven days.

Simultaneously filling the FYM and soil mixtures in poly bags and placing one seed per bag and keeping it as reserve for gap filling. At least 50 seedlings are needed for gap filling.

Seed rate

450 g/ha

Irrigation

The field should be irrigated once in a week up to three months and once in ten days thereafter. Water stagnation should be avoided. During pod development, irrigation once in five days is enough for better pod development.

After cultivation

Pinching is done when the plant is 90 -100 cm height for better establishment of side branches. Two pinching may be done at 20-25 days intervals.

Flowering

Flowering starts 5-6 months after sowing. Pod and seeds takes three months to develop. During flowering, irrigation should be restricted to avoid flower dropping and liberal irrigation should be given during pod development. Application of micronutrient and spraying of planofix (NAA) to arrest the flower shedding is followed.

Manuring

Application of 100 g urea, 100 g Super Phosphate and 50 g MOP per pit is recommended, three months after sowing again 100 g urea per pit at the time of flowering should be given.

Plant protection

Pests

Fruit fly

Spraying of dichlorvos (1 ml/lit) or fenthion 1.5 ml/lit to control fruit flies when pods are about 20 – 30 days old.

Bud worm, leaf caterpillar and leaf webber

Dust carbaryl 10 D at 25 kg/ha or spray carbaryl 50 WP @ 2 g/lit.

Hairy caterpillar

1. Use flame torch when the caterpillars settle on the tree trunk.
2. Spray chlorpyriphos 20 EC or quinalphos 25 EC @ 2 ml/lit.

Disease

The disease like root rot can be controlled by root drenching with copper oxychloride @ 0.2%.

Roguing

Based on the plant stem characters, during early stage, the rouges should be completely pulled out and gap may be filled. During pod development and maturity stages, based on pod character the roguing should be done for example the pods with more than 70 cm and cylindrical shape alone should be harvested incase of PKM1. Pods with tri-faced shape should be rejected.

Field Standards

Factors	Foundation	Certified
Off types	0.10%	0.20%
Plants affected by seed borne pathogens	0.10%	0.50%

Harvesting and processing

The change of pod colour to brown is the maturity index; at that stage the seed colour will be black. 3-4 pickings may be done. After harvest, the pods are dried under the sun for 2 days and the seeds are extracted manually by split open the pod. Sun drying the seeds should be followed during morning and evening hours. The small, ill filled, brown coloured and damaged seeds are separated manually or graded by using 24/64" round perforated sieves. The seeds are dried to 7-8% moisture content level. The seeds are treated with capton / thiram @ 4 g per kg of seed and packed in cloth / polythene bags. Normally seeds are viable for one year.

Seed yield

Approximately 150 pods per tree with 15 seeds per pod. *i.e.*, 500g seed per tree and approximately 250 kg /ha

Ratooning

One rationing can be allowed for certified seed production as per the certification procedures. However, more ratooning can be practiced for truth fully labeled seed production. The trees are cut at a height of 90 cm and followed the same cultural operations as followed for the main crop. Application of 25 kg FYM/pit and irrigation immediately after rationing is necessary.

Seed standards

Factors	Foundation	Certified
Pure seed	96%	95%

Inert matter	4%	5%
Germination	70%	70%
Moisture	8%	8%

Questions

1. Pollination behaviour of amranthus cross pollination (True/false)

   Ans: True

2. Germination percentage of moringa 70 (True/false)

   Ans: True

3. In seed certification rationing is allowed in moringa (True/false)

   Ans: True

4. Mention varieties of moringa

   Ans: PKM1, PKM2 and KM1

Lecture No. 10

Varietal and hybrid seed production in leguminous and exotic vegetables

Vegetable cowpea (*Vigna unguiculata* L.)

Botany

Vegetable cowpea is a self-pollinated crop. The flowers of cowpea are hermaphrodite and opens between 7.00 to 9.00 am. The time of dehiscence of anthers is from 10.00 am to 12.45 pm. The dehiscence takes place before flower opening.

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Fig.1. Seed crop of vegetable cowpea

Isolation distance

50 m for foundation seed and 25 m for certified seed production.

Climate and Soil

Vegetable cowpea is a warm season crop and therefore it can be grown both in spring and in rainy seasons in the plains of India. It cannot tolerate cold weather, heavy rainfall and water logging.

Method and time of sowing

The seeds are dropped in the furrow in such a way that maintains distance approximately 10 to 15 cm in the rows which are at 40 to 60 cm apart for rainy season crop whereas summer crop is sown at the row distance of 25 to 30 cm.

Seed rate

The requirement of seed for spring season crop is 20 to 25 kg/ha and for rainy season crop is 12-15 kg/ha.

Manuring

Vegetable cowpea responds well to an addition of manure and fertilizers. Application of 25 to 30 t/ha FYM improves the yield and quality of cowpea. About 20-25 kg nitrogen and whole dose of phosphorus (50-60 kg/ha) and potassium (50-60 kg/ha) are applied in soil during the last field preparation (6.1). Cowpea is highly sensitive to Zn deficiency. Application of 10 to 15 kg zinc sulphate per hectare would be beneficial.

Roguing

The seed crop of cowpea is rogued out for all off-types and diseased plants form the crop before flowering and during flowering. When the pods mature, at this stage off-types can be detected.

Field standards

Factors	Foundation	Certified
Off types	0.10%	0.20%
Designated Diseases	0.20%	0.20%

Plant protection

Pests

Aphids

Spray dimethoate 30 EC 1 ml/lit or methyl demeton 25 EC 1 ml/lit.

Diseases

Powdery mildew

Dust Sulphur 25 kg/ha or spray wettable sulphur 2 g/lit.

Harvesting

The seed crop of cowpea matures in 75 to 125 days, depending upon the season and the variety. The pods turned into straw colour. Entire plant is harvested at the ground level and are allowed to dry in the field or heaped at one place in threshing floor for drying.

Threshing and winnowing

The dried material is threshed by thresher or trampled. By winnowing all inert matter, chaffy seeds etc. are taken out.

Drying

Cleaned seed of cowpea is spread on tarpaulin for drying till 10 percent moisture remained in seed.

Seed yield

Seed crop of cowpea produces about 10-15 quintals of seed per hectare.

Seed standards

Factors	Foundation	Certified
Pure seed (max.)	98%	98%
Inert matter (max.)	2%	2%
Other crop seed (max.)	None	None
Total weed seed (max.)	None	None
Other distinguishable varieties (max.)	5/kg	10/kg
Germination (max.)	75%	75%
Moisture (max.)	9%	9%
For vapour proof container (max.)	8%	8%

Cluster bean (*Cyamopsis tetragonoloba* (L.) Taub)

Botany

Cluster bean is a self-pollinated crop having about 9 per cent maximum natural out crossing. The plants are normally fully fertile; a few semi-sterile ones have also been reported.

Fig. 2. Inflorescence and pods of cluster bean

Isolation distance

Isolation distance of 50 metres for foundation and 25 metres for certified seed is essential.

Sowing

Cluster bean can be sown twice in a year, February - March in Northern plains and December - January in Southern plains.

Seed rate

In order to sow one hectare area about 30-40 kg seed of cluster bean is required.

Nutrition

The yield of cluster bean has been maximum when the crop was applied with 40 kg nitrogen and 60 kg phosphorus per hectare. The application of micronutrient to cluster bean crop proves very beneficial. Two sprays of molybedenum at 0.15 per cent at 15 and 30 days after seedlings emergence give better yield.

Roguing

The first roguing should be done before flowering, the second one during flowering and fruiting stage and the third roguing at maturity.

Field standards

Factors	Foundation	Certified
Off types	0.10%	0.20%
Designated Diseases	0.20%	0.20%

Harvesting

When cluster bean pods attained full maturity (they turn grey in colour) the harvesting is done either by cutting entire plant at ground level or the plants are cut just below the first pod from ground level. Seed quality will be higher when seed crop is harvested after taking two pickings of fresh pods for vegetable use.

Seed extraction

It is done by threshing followed by cleaning (winnowing).

Drying

Cleaned seed is again allowed to dry in open sun on tarpaulin to 9.0 percent moisture.

Seed yield

Under good crop management, about 10-12 quintals of seed yield is obtained per hectare.

Plant protection

Pests

Leaf hopper

Methyl demeton 25 EC 1 ml/lit or dimethoate 30 EC 1 ml/lit.

Pod borer

Carbaryl 50 WP 2 g/lit

Diseases

Leaf spot

Spray Mancozeb 2 g/lit.

Powdery mildew

Spray Wettable sulphur 2 g/lit or dust with Sulphur 25 kg/ha. Repeat it at 15 days intervals.

Seed standards

Factors	Foundation	Certified
Pure seed (max.)	98%	98%
Inert matter (max.)	2%	2%
Other crop seed (max.)	None	None
Total weed seed (max.)	None	None
Other distinguishable varieties (max.)	5/kg	10/kg
Germination (max.)	75%	75%
Moisture (max.)	9%	9%
For vapour proof container (max.)	8%	8%

French (garden) bean (*Phaseolus vulgaris*)

Botany

The French bean is also known as garden bean, snap bean, kidney bean, haricot bean, navy bean, string bean. French bean flowers are cleistogamous, but they are self-compatible and self-pollinated although some chances of cross-pollination (1.1%)

Fig. 3. Inflorescence and pods of French bean

Isolation distance

Isolation distance of 50 metres for foundation seed and 25 metres for certified seed crop.

Method and time of sowing

French bean can be sown twice in a year, i.e., in January - February and July - September in the plains and March - June in the hills.

Distance of sowing

Bush types are planted at 45-60 cm x 10-15 cm (row x plant) whereas pole types at 100 cm x 22-30 cm.

Nutrition

Nitrogen at higher level decreases nodulation. But nitrogen at low level enhances microbial activity in the soil and plants while phosphorus at double the level than nitrogen required for better up take of nutrient and nodulation. Similarly, potassium plays important role for higher seed yields. Potassium has also been found to induce early flowering.

	N (kg/ha)	P (kg/ha)	K (kg/ha)	FYM (t/ha)
Hills	180	125	100	30
Plains	100	100	50	12.5

Roguing

Roguing is performed at four stages. They are

1. Before flowering

The first roguing is done before flowering. This is based on plant habit, vigour, according to type (bush type or pole type), leaf shape and colour. Besides, severely affected plants by diseases particularly seed borne diseases.

2. At flowering

At this stage, plants are removed on the basis of vigour and flower colour, and plants affected with seed borne diseases.

3. At pod developing stage

At this stage, plants are removed based on pod characters such as pod shape, colour and plants affected with seed borne diseases.

4. At maturity

At this stage, later flowering and late maturing off-types can easily be detected, which are removed.

Field standards

Factors	Foundation	Certified
Off types	0.10%	0.20%
Designated Diseases	0.20%	0.20%

Harvesting

Harvesting is done when pods are fully ripe and have turned yellow i.e. about to shatter. Crop is harvested manually or by machine. The harvested plants are staked for 7-10 days for drying.

Threshing

Fully dried matter is threshed either by bullock or by threshing machine.

Seed yield

The average seed yield of French bean is about 12 to 18 quintals per hectare.

Plant protection

Pests

Aphids and thrips

Treat the seeds with carbofuran 3 G at 10 g/kg of seed or monocrotophos 36 WSC 10 ml/kg of seed using adhesive. Spray monocrotophos 36 WSC or methyl demeton 25 EC or dimethoate 30 EC each at 1 ml/lit. In hills, glass house white fly occurs during May - August. Spray monocrotophos 36 WSC 1 ml/lit. Place 20 yellow sticky traps coated with castor oil in polythene sheet to attract the white flies.

Pod borer

Spray carbaryl 50 WP thrice at fortnightly intervals at the rate of 2 g/lit. Dust with carbaryl 10 D at the rate of 25 kg/ha or endosulfan 35 EC @ 2 ml/lit.

Ash weevil

Spray endosulfan 35 EC @ 2 ml/lit.

Whitefly

Spray methyl demeton 25 EC or dimethoate 30 EC or monocrotophos 36 WSC or phosphamidon 40 SL @ 1 ml/lit of water.

Diseases

Powdery mildew

Spray Wettable sulphur at 2 g/lit or dust Sulphur at 25 kg/ha.

Rust

Dust Sulphur at 25 kg/ha.

Anthracnose

Spray Mancozeb at 2 g/lit or Carbendazim 1 g/lit or Chlorothalonil 2 g/lit.

Leaf spot

Spray Mancozeb 2 g/lit.

Root rot

Drench with Carbendazim 1 g/lit.

Seed standards

Factors	Foundation	Certified
Pure seed (max.)	98%	98%
Inert matter (max.)	2%	2%
Other crop seed (max.)	None	None
Total weed seed (max.)	None	None
Other distinguishable varieties (max.)	5/kg	10/kg
Germination (max.)	75%	75%
Moisture (max.)	9%	9%
For vapour proof container (max.)	8%	8%

Exotic Vegetables

Lettuce (*Lactuca sativa* L.)

Botany

Lettuce is one of the most important vegetable crops in temperate countries.Lettuce is an annual crop, when the vegetative growth reaches a mature stage, stem elongation occurs and reproductive development begins. Stems vary in length and thickness. A single stem is usually formed but additional stem may be formed from axillary buds. Caulin or stem leaves are usually narrow and closing at the back.

The inflorescence is a corymbose panicle, composed of many capitula or flower heads, indlucing a terminal head. Each capitulum consists of several florets, usually from 12 to 20, but as few as seven and as many as 35. The florets are all ray type, perfect and fertile, and are surrounded by three to four rows of brackets, forming an involucre. Each floret consists yellow, liqulate petal with five teeth. The lower part is fused as a tube and surrounds the sexual parts.

Each floret has a double carpet, consisting of an elongated style and a divided stigma. There are five stamens, the anthers are fused to form a tube. The flowers open only once, in the morning, remaining open for about 1 hr on a warm sunny morning and for several hours when it is cool and cloudy. As the flower opens, the style elongation while the anthers dehisce from within and the shed pollen is swept upwards by the style and stigma hairs.

The ovary is below the corolla, when fertilized it forms and embryo surrounded by nuclear and endosperm tissue and a thin pericarp. The whole is called an achene and is a form of fruit rather than a seed. The achene is topped by a hair like pappus. Achene matures about 2 weeks after fertilization. They may be black, grey, white, brown or yellow.

Fig. 1. Inflorescence of lettuce

Climate and soil

Temperature, light is the important climatic factors, influence the germination, growth and development and flowering. Yield and quality of lettuce seed is mainly depends on the temperature prevail during maturation and development.

Land and isolation

Land

Land to be used for seed production shall be free of volunteer plants.

Isolation

Lettuce is mainly self pollinated crop but one to six per cent cross pollination due to insects have been reported. Seed fields must be separated from fields of other varieties, and fields of same variety not conforming to varietal purity requirements of certification, at least by 50 metres for foundation seed production and 25 metres for certified seed production.

Sowing season

In Tamil Nadu sowing is done during September – October, whereas it is in March – April in areas of severe winter.

Seed rate

Direct sowing: 1-1.5 kg ha-1

Transplanting: 400-500 g ha-1

Pre-sowing seed management

The lettuce seed germination is strongly temperature dependant. As temperature rises even to 2 or 3°C above the optimum, lettuce germination can sharply decline from 100% to nearly 0% due to the phenomenon known as thermoinhibition. This inhibition of germination upon imbibition at a super optimal temperature is not permanent. If the temperature returns to an appropriate degree for germination, the seeds are able to resume germination. As expanded period of imbibition at supra optimal temperatures may induce a secondary dormancy called thermo dormancy. In this case, the seed become dormant and will not germinate even if they are returned to favourable temperatures for germination. The ability of lettuce seed to germinate at high temperature is termed as thermo tolerance.

Nursery preparation

Seed beds are sterilized with formalin to protect from soil borne diseases or drenched with 0.2% Brassicol or captan. Seeds are sown in July either in line or broadcast. For transplanting one hectare, about 60-70 sq.m. area of seed bed is sufficient. Soon after sowing, seed bed is irrigated with rose can. Beds are irrigated on alternate days and seedlings are sprayed with 0.2 per cent Dithane M-45 or Difoltan at 10-15 days interval. After 5-6 weeks of sowing seedlings are ready for transplanting.

Main field preparation

Land should be prepared by ploughing thoroughly although it is not necessary to pulvarise the seedbed to a fine texture, since granular surface results in better germination than a powdery one.

Manures and fertilizer

Application of 25-50 kg N and 100-150 kg P2O5 per hectare are recommended, depending upon the soil fertility. In Tamil Nadu blanket recommendation of 30:60:60 kg NPK ha^{-1} is recommended.

Spacing

Plant growth, seed yield and seed quality attributes were significantly influenced by spacing. Normally seedlings are transplanted at a distance of 30-45 x 20-30 cm.

Seed sowing

Seeds are sown either on raised beds (50- 55 cm wide) or in rows spaced equally across the field. Dept of sowing is also very important in lettuce shallow (< 10 mm)

sowing. The sowing can take up in dry soil and then the field can be irrigated. Another procedure is pre irrigating the beds, so that the seed is placed in moist soil a few days after irrigation.

Weed management

Weed caused heavy loss in yield. After 2-3 weeks of crop emergence, removal of weeds is essential. For the control of weeds, hand weeding is a common practice and 3-4 hand weedings are adequate throughout the crop period.

Irrigation

Frequent and light irrigation have been found more effective for high quality seed production. Life irrigation should be given on 3rd day. Under semiarid conditions, the crop should be irrigated at the time of thinning and again after deheading, followed by another irrigation at the time of flowering.

Deheading

The important operation in lettuce seed production is deheading. So the seed stalk is free to bolt instead of being trapped within the tight head, where it often breaks and rot. More common method of deheading is to peel back the leaves on each plant by hand to expose the growing point. This method does not cause injury to the stem, but it is laborious and costly. If gibberellic acid is applied properly bolting might occur before the plant from heads, making deheading unnecessary.

Plant protection measures

Aphid – spraying of any systematic insecticide can be used.

Damping off– seed treatment with 2% cereson

Downy mildew – spraying of 0.2% Dithane Z-78 can be used.

Roguing

Off type plants should be removed as soon as they are detected. Trueness of type is especially important in the heading varieties of lettuce. Plants are rogued based on uniformity of maturity, head size, leaf cover, foliage colour, and leaf type. Rogued plants should be destroyed completely by cutting atleast 2.5cm below the ground surface. Since shoots may develop on plants cut off. just below the lower leaf, causing contamination if they produced seed. The practice of harvesting a seed crop after removing a crop of market lettuce, followed by some growers, is not desirable. If plants are not carefully

rogued before the heads are harvested for market the percentage of off type plants producing seed may be very large.

Field standards

Factors	Foundation	Certified
Off types	0.10%	0.20%

Maturity and harvesting

In lettuce it is difficult to determine the precise time for harvest because flowering of the plant continues for a period of 70 days. More than 90% of the total seed yield came from the first 2 flowering peaks, which occurred during the first month. Seed produced from the first 2 flowering peaks were heavier than those produced later in the season.

The seed coat colour changes from white to black on the eight to ninth day after anthesis. Dry seed weight continues to increase until 14-16 days after anthesis and then start decline. Lettuce seeds start to germinate 9-10 days after anthesis.

Germination reached the maximum at 14 days after anthesis. The seed weight increased towards maturity and maximum weight was reached when the seeds and the pappus protrude out of the capsule, which was 14-17 days after anthesis.

There are two ways of harvesting lettuce seed. One is the 'shake method', at the time of maturity, the plant is bent over and the seed head shaken in to container so that the ripe seed fall off. This procedure has the advantage of minimizing loss of seed. It also allows the separation of seeds into lots based on time of maturity. Another method is cutting the plants by hand, which is carried out carefully keeps shattering losses of seed to a minimum. Stems are cut several inches above the ground and then the plants are placed in small piles. Crops are usually harvested early in the morning when plants are still moist with dew, which to keep shattering to a minimum.

Threshing

The seeds should be threshed as soon as the plants are dried sufficiently, which may require 3-4 days in hot dry weather. The best quality seeds were produced by harvesting without cutting off the stem followed by Pneumatle grading.

Yield

Seed yield: Head type - 225-450 kg ha^{-1}

Seed processing

Grading

Seed polymorphism is a common phenomenon which affects uniformity of crop stand. Therefore, the optimum seed size needs to be determined to ensure better field performance.

After threshing, lettuce seed usually require cleaning. Normally the seeds first go through a farming mill followed by separator. Indent separators are also used and care should be taken to avoid mechanical admixture and contact of seed with moisture.

Seed treatment and storage

Lettuce seed is orthodox in nature and can be stored for longer period under controller conditions.

Seed certification standards

A minimum of three inspections shall be made

Seed standards

Factor	Standard for each class	
	Foundation	Certified
Pure seed (minimum)	98%	98%
Inert matter (maximum)	2%	2%
Other crop seed (maximum)	None	None
Weed seeds (maximum)	5 no. / kg	10 no. / kg
Other distingulshable varieties (maximum)	10 no. / kg	20 no. / kg
Germination (maximum)	70%	70%
Moisture	8%	8%
For vapour proof container (maximum)	6%	6%

Questions

1. Botanical name of cowpea is *Vigna unguiculata* (True/False)

   Ans: True

2. Pollination behaviour of cowpea is self pollination (True/False)

   Ans: True

3. Isolation required for certified seed production of cowpea 25m (True/False)

   Ans: True

4. Seed rate for cluster bean is 30-40 kg/ha (True/False)

   Ans: True

5. French bean is also known as garden bean (True/False)

   Ans: True

6. Mentioned two exotic vegetables grown in India?

   Ans: Lettuce and Leek

Lecture No.11

Seed production in Cabbage and Cauliflower

Cabbage (*Brassica oleracea* var. Capitata)

Botany

Cabbage is highly cross-pollinated crop and pollination is entomophilous. Pollen fertility is maximum on the day of anthesis. Stigma is receptive 2-3 days before to the day of anthesis. Anthesis occurs 8.00 -10.00 hr.

Method of seed production

Cabbage requires two seasons to produce seeds. In the first season the heads are produced and in the following season seed production follows. Two methods are followed.

1. *In-situ* method - for certified seed production
   (Seed to seed method)
2. Transplanting method - for nucleus seed production
   (Head to seed method)

In-situ method

In this method, the crop is allowed to over-winter and produce seeds in their original position, where they are first planted.

Transplanting method

In this method the matured plants are uprooted and the outer whorls removed. Then the plants are replanted in a well prepared new field. In cabbage, during seed production, three methods have been followed to facilitate flowering and seed production.

1.Stump method

When the crop in the first season is fully matured, the heads are examined for true to type. The plants with off type heads are removed. Then the heads are cut just below the base by means of a sharp knife, keeping the stem with outer whorl of leaves intact. The deheaded portion of the plant is called 'stump'. The stumps are either left

in-situ or replanted in the second season. After over wintering (dormancy breaking), the buds sprouts from the axis of all the leaves and leaf scars.

Advantage

- Gives extra income by way of sale of heads
- Crop matures 12-15 days earlier
- Seed yield is slightly high

Disadvantage

Flower stalks are decumbent and requires very heavy staking

2.Stump with central core intact method

When the crop is fully matured in first season, off type plants are removed and rejected. Then the heads are chopped on all sides with downward perpendicular cuts in such a way that the central core is not damaged. When the head start bursting after over wintering, two vertical cross cuts are given to the head, taking care that the central growing point is not injured. In the absence of such cuts, the heads burst out irregularly and sometimes the growing tip is broken.

Advantages

- Shoots arising from main stem are not decumbent, hence very heavy staking is not required
- Seed yield is high

Disadvantages

- The chopped heads cannot be marketed

3.Head intact method

In this method, when the crop is fully mature in first season, the heads are examined for true to type. The plants with off type heads are removed from the field and rejected. The head is kept intact and only a cross cut is given to facilitate the emergence of stalk.

Advantages

- Saves time and labour
- Very heavy staking is not required

Disadvantages

- Seed yield is slightly low as compared to other methods

Stages of seed production: Breeder seed → Foundation seed → Certified seed

Varieties/ Hybrids

Early: Golden Acre, Pusa Mukta, Chaubatia Early

Mid: Pride of India, Pusa Drum Head, Aru Glory, Green Express

Late: Large Late Drum Head, September, Green Challanger, BSS-50, BSS-32, BSS-44, BSS115, Sri Ganesh Gol

Red cabbage: Red Acre

Season: Early varieties (Golden acre) second fortnight of July -10th, 25th July

Medium varieties second fortnight of June – 1st – 15th June

Late varieties first fortnight of June -15th – 30th June

Land requirement

In the hills, select field on which the same kind of crop or any other cole crop was not grown in the pervious two years, unless the crop within the previous two years, was field inspected by the certification agency and found not to contain seed born diseases infection beyond the maximum permissible limit.

Isolation requirement

The seed field must be separated from fields of other varieties at least" by 1600 m for foundation class and 1000 m for certified class seed production.

Seed rate: Early varieties - 600 g/ha

Late varieties - 400 g/ha

Seed treatment

Some seed borne pathogens such as black rot, black leg and alternaria leaf spot start invading the seedlings blight from germination of seed. Pre-drying of seeds at 40 ^{0}C for 24 hr followed by an air treatment at 75 ^{0}C for 5-7 days is an effective method to disinfect cabbage seeds infected by black rot without any seed damage. Hot water treatment to seeds at 50^{0}c for 30 minutes is done to prevent seed-borne pathogens. Immediately after the treatment, the seeds should be used for sowing within 24 hr. After hot water treatment seed can be treated with a fungicide like Captan before sowing to protect the seedlings from damping – off and downy mildew respectively.

Nursery

Seeds may be sown on raised nursery beds 15 - 20 cm height in rows with 10 cm spacing. Twenty five nursery beds of 2m x 1m size are enough for one hectare. Thin sowing should be done to avoid damping - off.

Transplanting:

Three to four weeks old seedling (25-30 days old) are transplanted, preferably in the evening with a spacing of 60 x 60 cm for late varieties, 60 x 40 cm for medium varieties and 45 x 45 cm for early varieties .

Transplanting at 2nd fortnight of August for early varieties and 1st week of August for both medium and late varieties are advisable.

Main field manuring

The field should be prepared to fine tilth by deep ploughing, three to four harrowing followed by levelling. Cabbage crop requires heavy manuring. At the time of land preparation, 50-60 t of FYM/ha should be applied. 200-300kg Super phosphate and 90 kg of potash should be applied before transplanting of seedlings. Two doses of 75-100 kg Ammonium sulphate at intervals of 2-3 weeks after transplanting the seedlings should be applied. Another dose of 200-250 kg Ammonium sulphate as surface application at the time of seed stalk emergence.

Staking

After the flower stalks are sufficiently developed, staking is necessary to keep the plants in an upright position.

Foliar spray

50 ppm NAA sprayed twice after two and four weeks of transplanting the cabbage seedlings in the field has beneficial effect on better growth and yield of cabbage varieties. The favourable temperature range for flowering and seed setting is 12.5 – 18.5^0c.

Roguing

The first roguing is done at the time of handling the mature heads. All off type plants, diseased or undesirable types are removed at this stage. Second roguing is done before the heads start bursting the loose-leaves poorly heading plants and those having a long stem and heavy frame, most by rogued out at this stage, subsequent roguing for off types, diseased plants affected by phyllody, black-leg, black rot, soft rot or leaf spot should be done from time to time as required.

Field Standards

Factors	**Foundation stage**	**Certified stage**	**Remarks**
Off-type	1.00	0.50	
Other crop plants	-	-	
Objectionable weed plants	-	-	
Diseased plants	0.10 *	0.50*	* At and after flowering and maturity stage

Pest and disease management

Use of insecticides during flowering affects the insect pollinators and will result in poor seed set. A single soil application of granulated Phorate, Dimethoate @ 18 Kg/ha during early February for control of sucking pests (Aphids) is advisable. In cabbage the major disease is "Damping – off'. Thin sowing and drenching with 150 g of Bavistin in 100 litres of water will control the disease.

Plant protection

Pests

Cut worms

Apply chlorpyriphos 2 ml/lit in the collar region during evening hours for the control of common cutworm - *Agrotis segetum*.

Aphids

The incidence is severe during autumn season. Installation of yellow sticky trap at 12 no/ha to monitor "macropterous" adults. Spray neem oil 3 % or dimethoate 2 ml/lit with 0.5 ml Teepol/lit.

Diamond backmoth

1. Growing mustard as intercrop as 20:1 ratio to attract diamond back moths for oviposition. To avoid the dispersal of the larvae, periodical spraying of mustard crop with insecticide is necessary.
2. Installation of pheromone traps at 12/ha.
3. Spraying of cartap hydrochloride 1 g/lit or *Bacillus thuringiensis* 2 g/lit at primordial stage (ETL 2 larvae/plant)
4. Spraying of NSKE 5 % after primordial stage.
5. Release of parasite *Diadegma semiclausum* at 50,000/ha, 60 days after planting.

Diseases

Club root

Seed treatment at 10 g/ kg of seeds or soil application @ 2.5 kg/ha or seedling dip in solution of 5g/ litre with *Pseudomonas fluorescens*. Dipping the seedlings in Carbendazim solution (1 – 2 g/lit) for 2 minutes. Drench the soil around the seedlings in the main field with Carbendazim @ 1 g/lit of water. Follow crop rotation. Crucifers should be avoided for three years.

Leaf spots

Spraying of Mancozeb at 2 g/lit or Carbendazim 1 g/lit.

Leaf Blight

Spraying of Mancozeb @ 2.5 g/ litre.

Ring spot

Spraying of Mancozeb 2 g/lit or Carbendzim 1 g/lit or Copper oxychloride 2.5 g/lit.

Downy mildew

Spray combination of Metalaxyl + Mancozeb 2 g/lit 3 sprays at 10 days interval.

Black rot

Dipping the seeds in 100 ppm Streptocycline for 30 minutes. Two sprays with 2 g/lit Copper oxychloride + Streptomycin 100 ppm after planting and head formation.

Harvesting and processing

The harvesting may be done in two lots. Generally the early matured plants are harvested first, when the pods turn into brown colour. After harvesting it is piled up for curing. After 4 to 5 days it is turned up side down and allowed for further curing for 4 to 5 days. Then the pods are threshed with pliable sticks and shifted with hand sifters. Then the seeds are dried to 7% moisture content, cleaned and treated with Bavistin @ 2 g/ Kg of seed.

Fig. 1. Cabbage pods

Designated diseases

Black leg, Black rot and Soft rot.

Seed Yield

The average seed yield varies from 500 to 650 kgs per hectare.

Seed standards

Factors	Foundation	Certified
Pure seed (minimum)	98%	98%
Inert matter (maximum)	2%	2%
Other crop seed (maximum) (no./kg)	5/kg	10/kg
Total weed seed (maximum) (no./kg)	5/kg	10/kg
Germination(minimum)	70%	70%
Moisture (maximum) (normal container)	7%	7%
For VP Container(maximum)	5%	5%

Cauliflower (*Brassica oleracea* var. Botrytis)

Botany

Cauliflower is highly cross-pollinated crop due to self-incompatibility. Flower is protogynous in nature. Stigma remains receptive 5 days before and 4 days after opening of the flower. The time taken from pollination to fertilization is 24-48 hours depending upon the temperature. The optimum temperature for fertilization and seed development is 12° C - 18° C. Bees are the major pollinators.

Method of seed production: There are two methods of seed production

1. In situ method (seed to seed method)
2. Transplanting method (Head to seed method)

For seed production, seed to seed method is recommended since the head to seed method in India has not been very successful. In seed to seed method (In situ method) the crop is allowed to over winter and produce seed in the original position, where they are first planted in the seedling stage.

Stages of seed production: Breeder seed→ Foundation seed→Certified seed

Varieties

Early: Early Kunwari, Pusa Katki, Early Patna, Pusa Deepali, Pusa Early Synthetic, Pant Gobhi3, Improved Japanese.

Mid season: Pant Shubhra, Pusa Synthetic, Pusa Shubhra, Pusa Aghani, Selection 235S, Hisar No.1, Pusa Himjyoti.

Late: Snowball-16, Pusa Snow ball-1, Pusa Snowball-2, PSK-1, Pusa hybrid -2

Hybrids: Pusa synthetic, Pusa hybrid 1 and 2

Season

In the hills, the last week of August is the optimum sowing time. The seed is sown in a nursery and transplanting should be completed by the end of September. For early varieties (in plains) best season for sowing is the last week of May and transplanting should be completed during first week of July. In hills, sowing should be adjusted that the plants put up the maximum leafy growth by 15th December when the temperature goes down and plants become dormant for which last week of August is optimum and transplanting should be completed by the end of September. The mean temperature of 6.5 to 11° C during February to March is very conducive to curd formation.

Land requirement

In the hills, select field on which the same kind of crop or any other cole crop was not grown in the pervious two years, unless the crop within the previous two years, was field inspected by the certification agency and found not to contain seed born diseases infection beyond the maximum permissible limit.

Isolation requirement

Cauliflower is mainly a cross pollinated crop. Pollination is chiefly done by bees. The seed field must be separated from fields of other varieties at least by 1600 m for foundation class and 1000 m for certified class seed production.

Seed rate

375 to 400 g /ha.

Nursery

Seeds may be sown on raised nursery beds 15-20 cm height in rows with 10 cm spacing. Twenty five nursery beds of 2 to 2.65 m x 1 to 1.25 m size are enough for one hectare. Thin sowing should be done to avoid damping - off. Three tonnes of FYM should be applied to nursery bed. DAP spray at 10 to 15 days after germination is important. Apply lime @ 5 t/ha before one month to nursery field and apply Borax and Sodium molybdate @ 4 kg/ha before sowing.

Transplanting

Transplant the seedlings at 35-40 days old preferably at evening time with the spacing of 60 x 45 cm (for early varieties in plains) or 90 x 60 cm for late variety and irrigate immediately after transplanting.

Main field manuring

The field should be prepared to fine tilth by deep ploughing and three to four harrowing followed by levelling. Cauliflower crop requires heavy manuring. Apply 50-60 tons of FYM/ha at the time of land preparation.

Foliar application

NAA @ 40 ppm sprayed at 30 days after curd initiation was superior in increasing the yield and quality of seed.

Roguing

Minimum of four inspections are required viz., pre-marketable stage, initiation of curd stage, curd formed stage and flowering stage. Roguing should be done based on the curd size, shape and colour, when fully developed. Off type plants with poor curd formation and plants affect by designated diseases like black leg, black rot, soft rot, leaf spot and phyllody should be removed during roguing.

First roguing is done after curd formation. Plants forming loose ricey, fuzzy and buttons are rejected. Blind, deformed and diseased plants are also rejected. Second roguing is done after bolting but before flowering, plants with peripheral and uniform bolting are kept for seed production. Early and late bolters are also rejected.

Field standard

Contaminants	**Maximum permitted (%)**	
	Foundation	**Certified**
Off types *	0.10	0.20
Plants affected by seed borne diseases **	0.10	0.50
Plants affected by phyllody **	0.1	0.5

Pest and disease management

Use of insecticides during flowering affects the insect pollinators and will result in poor seed set. A single soil application of granulated Phorate, Dimethoate @ 18 Kg/ha during early February for control of sucking pests (Aphids) is advisable. In cauliflower the major disease in "Damping – off". Thin showing and drenching with 150 g of Bavistin in 100 liters of water will control the disease.

Plant protection

Pests

Cut Worms: Set up of light trap in summer months. Spray chlorpyriphos 2 ml/lit in the collar region during evening hours.

Aphids: The incidence is severe during autumn season. Installation of yellow sticky trap at 12 no/ha to monitor Macropterous adults (winged adult) is necessary. Spraying of neem oil 3 % or dimethoate 2 ml/lit with 0.5 ml Teepol/lit.

Diamond backmoth

1. Growing mustard as intercrop at 20:1 ratio.
2. Installation of pheromone traps at 12 No/ha.
3. Spraying of cartap hydrochloride 1 g/lit or *Bacillus thuringiensis* 1g/lit at primordial stage (ETL 2 larvae/plant)
4. Spraying of NSKE 5 % after primordial stage.
5. Release of larval parasite *Diadegma semiclausum* (Ichneumonidae: Hymenoptera) at 50,000/ha, 60 days after planting.

Diseases

Club root: Seed treatment at 10 g/ kg of seeds or soil application @ 2.5 kg/ha or seedling dip in solution of 5g/ litre with *Pseudomonas fluorescens*. Dipping the seedlings in Carbendazim solution (1 – 2 g/lit) for two minutes. Drench the soil around the seedlings in the main field with Carbendazim @ 1 g/lit. Follow crop rotation. Crucifers should be avoided for three years.

Leaf Spot: Spraying of Mancozeb at 2 g/lit or Carbendazim 1 g/lit.

Leaf Blight: Spray of Mancozeb @ 2.5 g/ litre.

Blanching: Blanching refers to covering of curds. A perfect curd of flower is pure white. It is necessary to exclude sunlight to obtain this. The common practice is to bring the outer leaves up over the curd and tie them with a twine or rubber band. By using a different coloured twine each day. It is easy at the time of harvest to select those tied earlier.

Physiological disorders

Browning or brown rot

This is caused by Boron deficiency. It appears as water soaked areas and later changes into rusty brown. Spray one kg of Borax in 500 lit of water 30 days after planting.

Whip tail

This result from the deficiency of Molybdenum. It is more pronounced in acidic soil. The leaf blades do not develop properly. In severe cases only the midrib develops and it can be corrected by spraying 100 g of Sodium molybdate in 500 lit of water 30 days after planting.

Buttoning

The term buttoning is applied to the development of small curds or buttons. The plants do not develop normally and leaves remain small and do not cover the developing curds. Deficiency of Nitrogen and planting the early varieties in late season may cause these symptoms. Avoid transplanting aged seedlings.

Blindness

Blind-cauliflower plants are those without terminal buds. The leaves are large, thick, leathery and dark green. It is due to the prevalence of low temperature when the plants are young or due to damage to the terminal bud during handling the plants or due to injury by pests.

Scooping

Scooping central portion of curd when it is fully formed helps in the early emergence of flower stalks in hills. Scooping is normally not required for seed production in plains. Scooping curd pruning and half curd removal were effective in increasing the seed yield. However, scooping of curd was best compared to other methods.

Harvesting and processing:

The ripened fruit is called siliqua. Harvesting may be done in two lots. Heavy bearing may topple the plants, hence staking may be done wherever necessary. Wind belts can also be erected if needed. Generally the early matured plants are harvested first, when the siliqua

turn in to brown colour. Delayed harvest results into seed shattering and bird damage. Hence, 2-3 harvestings are required. About 50 days are needed for pod maturity after fertilization. Seeds of early types are ready for harvesting in December - January and in February- March for North Indian Plains. However, snowball types are ready for harvesting by June. As harvesting is done when bottom siliqua turn brown followed by yellowing of the top siliqua, curing is necessary for ripening the late maturing siliqua. After harvesting, plants are piled up for curing. After 4 to 5 days it is turned up side down and for further curing for 4 to 5 days. The siliqua are threshed with pliable sticks and cleaned. Then the seeds are dried to 7% moisture content, cleaned and treated with Bavistin @ 2 g / Kg of seed.

Seed yield of Indian cauliflower may very between 500-600 kg/ha and snowball from 300- 500 kg/ha.

Designated diseases: Black leg, Black rot and Soft rot

Seed standards

Factors	**Foundation**	**Certified**
Pure seed (minimum)	98%	98%
Inert matter (maximum)	2%	2%
Other crop seed (maximum) (no./kg)	5/kg	10/kg
Total weed seed (maximum) (no./kg)	5/kg	10/kg
Germination (minimum)	65%	65%
Moisture (maximum) (normal container)	7%	7%
For VP Container(maximum)	5%	5%

Hybrid seed production in Cauliflower

1.Manual emasculation and pollination

Initially the method was adopted for producing F1 hybrids. Since much labour is involved, which results in lesser quantity of seed and escalades production cost. Hence, it is not practicable on commercial scale.

2. Hand pollination without emasculation

Where male sterility is available, the process of emasculation is eliminated. Male sterility is the absence of non-function of pollen in platns, which can be used for commercial hybrid seed production.

In cole crops, male sterility is controlled plants by a single recessive gene ms which is mutated from the fertile gene Ms. Male sterile plants are female fertile but their flowers and anthers are slightly smaller than those of male fertile one.

3.Cytoplasmic male sterility

Cytoplasmic male sterility has not apparently been found in cauliflower, but it has been introduced from several sources. Pearson crossed *Brassica oleracea* with *Brassica nigra* and derived male sterile material. This character was bred into broccoli and later into cauliflower.

Free insect pollination

Free insect pollination is feasible to produce F1 hybrids under natural conditions. But this can only be used when self incompatible lines are available.

Self Incompatibility

It is genetically controlled physiological hinderance to self-fruitfulness or self fertilization. Cauliflower, broccoli and other Brassica vegetables posses homomorphic sporophytic incompatability controlled by one locus with multiple alleles. The sporophytic system, which operates in these crops, are utilized in making single, double and triple cross hybrids for commercial seed production. Production of hybrid seed involves.

1. Selection of parents development of homozygous self-incompatible lines by inbreeding and their maintenance.
2. Making diallel or top crosses using these incompatible lines
3. Testing of F1 hybrids in replicated trials along with parents and check cultivars
4. Production of F1 hybrid seed of the recommended F1 hybrid on the basis of trial using self- incompatible under local conditions.

Questions

1. After flower stalks formation to keep the plants in up right position is called as Staking (True/False)

Ans:True

2. Golden Acre is a variety of

a. Cauliflower b. Cabbage

Ans:b

3. One of the following does not cross with Cauliflower

a .Radish b. Mustard c. Chinese Cabbage

Ans:a

4. The fruit of mustard family is called Pod (True/False)

Ans:True

5. Whip tail is due the deficiency of molybdenum (True/False)

Ans:True

6. The ripened fruit of cauliflower is called Siliqua (True/False)

Ans:True

7. Cabbage requires 1600m metres of isolation to produce foundation class of seeds (True/False)

Ans:True

8. Head to seed method of seed production is suitable for nucleus seed production of cauliflower (True/False)

Ans:True

9. Over wintering is essential for flowering in

a. Bhendi b. Chilli c. Chow-chow d. Cauliflower

Ans:d

10. Ideal temperature for bolting in cabbage is

a. 10-15^{0}C b. 4-7^{0}C c. 3-5^{0}C d. None

Ans:a

Lecture No. 12

Seed production in carrot, radish and beetroot

Carrot (*Dauccus carota* L.)

Botany

Cross pollination is due to protandrous flowers. Anthesis takes place in the morning hours. The stigma becomes receptive on the fifth day after flower open and remains active for 8 days, but better fruit sets are from pollination on 6 to 11 days after flower opening. The inflorescence is a compound umbel.

Fig. 1. Inflorescence of carrot

Flowering

The individual carrot flowers, in common with most other species in *Umbelliferae*, are borne on terminal branches in compound umbels. There is a distinct order of flowering, which relates to umbel position. The first umbel to flower is the primary (sometimes referred to as the 'king' umbel) that is terminal to the main stalk. Branches from the main stalk from secondary umbels, and subsequent branches from these form tertiary umbels. Quaternary branches and umbels may also be formed.

Pollination and Pollinating Insects

Individual carrot flowers are normally protandrous and much crosspollination occurs between plants in a seed crop. However because of the extended flowering period resulting from several successive umbels per plant and the succession of flowers on individual umbels, the possibility of self-pollination always remains.

Occurrence of pollinating honeybees, efficient pollinators are frequently scarce on carrot crops because other crops species were flowering in the vicinity at the same time. Several insect genera in *Dymenoptera, Diptera* & *Coleoptera* are extremely important pollinators of carrot seed crops, in the absence of bees.An adequate presence of pollinating insects improves both seed yield and seed quality. Where natural insect pollinator populations are low placing honeybee colonies would be advantageous.

Seed production

The seed production is taken in the hills for European types and in the plains for Asiatic types. European types require high chilling of 4-7° C for a period of about 2 months. The summer and low rainfall of hills especially during flowering and seed setting stages are beneficial.

Method of seed production

1. Seed to seed (In situ method), 2. Root to seed (Transplanting of cut root)

Stages of seed production Breeder seed → Foundation seed → Certified seed

Varieties

Ooty 1, Pusa kesar, Zeno, Panvers, American beauty, Imperator

Hybrids

Pusa hybrid-1

Season

The ideal season for sowing to take up seed production is July-August

Land requirement

There are no specific requirements, but the land should be free of volunteer plants.

Isolation requirement

The minimum isolation distance required for carrot seed production is at least 1000 m for foundation and 800 m for certified seed production. Because of the high possibility of cross pollination, isolation distances for commercial seed crops should be 1000 m. For nucleus seed the distance should be at least 1600 m. In areas that specialize in carrot seed production the different cultivars within the same type can be zoned; this minimizes cross pollination between the different types. Cultivated carrots cross pollinate very readily with the wild carrot and this must be taken into account when

choosing sites for seed production. Contamination of seed crops by wild carrot pollen is a major reason for genetic deterioration of seed stocks in some areas.

Seed production methods

There are two methods of seed production.

Seed to seed method:

The crop is sown as per climatic conditions of the area. For temperate varieties in Himachal Pradesh sowing is done in the month of October and November. Crop is left in the field for flowering and seedling. The roots cannot be inspected (or) rogued.

Seed rate

2-3 kg/ha. Row spacing of 50-90 cm are used with a sowing rate of 2-3 kg per hectare. Soaking seeds in water for 72 h with a change of water every 24 h leached off the inhibitors will improve germination.

Root to seed method

This system is similar to raising carrot crop for fresh roots as far as timings are concerned but the plants (steckling) are raised in beds and transplanted in the spring. Depending on local customs and winter conditions and stecklings are either left in situ during winter or lifted in the late autumn and stored until replanting in the spring.

The transplanted steckling rows are 75 cm apart with 30 cm between plants. The seed. Raising stecklings that are later transplanted from their beds offer the opportunity for roguing plants with undesirable root or foliage characters while lifting and planting.

Roguing

Minimum of 3 field inspections should be done at 20-30 days after sowing, when roots are lifted and replanted and flowering stages. Roguing should be done based on the root colour, shape, skin colour, flesh colour of the root and bolting characters and removed.

Field standards

Contaminants	Minimum distance (meters)			
	Mother root production stage foundation certified		Seed production stage Foundation certified	
Field of other varieties	5	5	1000	800
Fields of the same variety not conforming to vareital purity requirements for certification	5	5	1000	800

Seed to seed production

Very little if any roguing can be done when the crop is grown on without lifting. But plants bolting early and those with a typical foliage characters should be removed. If the crop is lifted and replanted it is rogued as described below for root to seed, but very little confirmation of root type can be done.

Root to seed production

During the first year growing season. a) Remove plants displaying typical foliage, remove plants bolting in the root development stage. b) After the roots have been lifted inspect for trueness to type, according to root shape, colour and size, discard roots showing poor colour, green shoulder, incorrect colour, off coloured shoulders (purple, green), split or fanged roots or those with rough surfaces.

Hybrid seed production in carrot

The production of hybrid seed by hand emasculation and pollination is not possible commercially as the flowers are very small and single pollination gives only one or two seeds. In carrot, the inflorescence is compound umbel.

Sufficient buds in the female parent at peak stage of flowering are emasculated and the remaining young ones are removed. Then a cloth / paper bag is placed over the umbel of male parent and shaken to dislodge the pollen onto the sides of the bag. This bag is then used to enclose the emasculated umbel of the female parent. Apart from this, daily for a few days in the morning, the male umbel is gently rubbed over the female to ensure cross pollination. Sometimes when the pollen parent possesses some dominant marker gene with the help of which the hybrids can be distinguished in the seedling stage, it is not necessary to emasculate the flowers.

Hybrid seed production

In the heterosis breeding programme 3 lines are used, namely the male sterile line (A), male fertile sister line (B) and the pollinator line (C) that is male fertile has a good combining ability with the male sterile line. The male sterile and pollinator lines are grown in alternate rows of 4:1 or 8:2 and the hybrid seed is harvested from female line only.

Manuring

First season: A light does of 20-25 tons of FYM per ha should be applied before field preparation.

Nitrogen - 75 kg/ha (35 kg basal + 35 kg top dressing)

Phosphorus - 50 kg/ha (basal)

Potash - 50 kg/ha (basal)

Second season (During transplanting)

Farm yard manure -10 to 15 tons /ha

Nitrogen - 50 kg (25 kg at pre-bolting + 25 kg before flowering)

Phosphorus - 50 kg (basal)

Supplementary pollination

Since the honey bees are important pollinating agents. It is advisable to place beehives in the large seed fields or near by the field to increase the pollination. It is necessary when the temperature is below 15°C. Spraying of 150 ppm NAA at bolting stage also improved the seed setting percentage.

Pest and disease management

The major pests in carrot are Carrot Weevil, Spotted leaf hopper and rust fly. These can be controlled by spraying Malathion 5% dust or Carbaril @ 5 kg/ha.

Nematode: Application of neem cake @ 1 ton/ha at planting to control root knot nematode, *Meloidogyne* spp.

Diseases

Leaf spot: Spraying of Mancozeb at 2 g/lit.

Harvesting and processing

The crop matures unevenly. Seeds are harvested when the secondary umbels (heads) are fully matured (brown) and the tertiary umbels are beginning to turn brown. Hence 2 to 3 picking may often be necessary. After drying seed heads are threshed, cleaned and rubbed by hand to remove the bristles. The seeds are dried to 8% moisture content and treated with Bavistin @ 2 g per kg of seed.

Size grading of seeds with BSS 12 wire mesh sieve or density grading at 0.5 inches of water pressure found to be optimum to upgrade carrot seeds.

Fig. 2. Removal of bristles in carrot seed

Seed standards: (Variety & Hybrid)

Factors	Foundation	Certified
Pure seed (minimum)	95%	95%
Inert matter (maximum)	5%	5%
Other crop seed (maximum) (no./kg)	5/kg	10/kg
Total weed seed (maximum) (no./kg)	5/kg	10/kg
Germination(minimum)	60%	60%
Moisture (maximum) (normal container)	8%	8%
For VP Container(maximum)	7%	7%

Radish *(Raphanus sativus*)

Botany

Radish is cross pollinated crop. Anthesis occurs during 9.00-10.00 hr. Anther dehiscence is between 9.00 and 10 hr. Pollen fertility is maximum on the day of anthesis. Stigma is receptive at the time of anthesis and lasts till 4 days after anthesis.

Method of seed production

1. Seed to seed method - for varieties which do not stand transplanting (In-situ method) 2. Root to seed method (Transplanting method)

Stages of seed production

Breeder seed → Foundation seed → Certified seed

Varieties: CO- 1

Temperate varieties (Chinese type)

Produce seed in the hills by over wintering. These varieties flower very late in the plains

Temperate varieties

White icicle, Rapid red, Woods, Long frame, French break fast, which produce seed in the plains also, but behave just like winter varieties for seed production in plains.

Tropical varieties

Pusa Reshmi, Pusa Chetki, Japanese white, these produce seed freely in the plains.

Season

For hills - September-October and Plains - April-June.

Seed production systems

Both "root to seed" & "seed to seed" systems are used. The 'root to seed' is used for the biennial types especially in Europe and temperate regions. The roots are lifted in the late autumn, the tops taken off and the radishes are stored, usually in clamps, during the winter. It is also the method used for stock seed production of the annual types but in this case the material is replanted immediately after selection. In some areas of the world, especially in Asia, up to half of each steckling's root is removed before replanting. In seed production of the Japanese White cultivar steckling planting results in a higher seed yield.

The 'seed to seed' system is used for final multiplication stages where inspections of the mature root are not considered necessary and is normally used only spring sown seed crops unless the cultivars has a vernalisation requirement.

Roguing stages (seed to seed method)

1. At market maturity stage of radish, **root:** relative size, shape, coloured, proportions of each colour on bi-coloured cultivars, solidity.
2. At stem elongation, removed early bolting plants and off types according to stem colour. Remove wild radish types. Check that the remaining plants are true to type for foliage and stem characters.
3. At flower bud and very early at start of anthesis flower colour. Plants with off colour flowers are rogued.

Land requirement

Select seed fields on which the same kind of crop was not grown within previous two years, unless the crop with in the previous two years were field inspected by the certification agency and found not to contain any seed borne diseases beyond the maximum permissible levels.

Isolation requirement

Radish is cross pollinated crop by insects. Hence, seed fields must be isolated from other varieties of radish field at least by 1600 m for foundation and 1000 m for certified seed production.

Seed rate

4 to 6 kg per hectare. The roots are produced in one hectare is sufficient for transplanting in 2.5 hectares.

Sowing

It is advisable to sow the seeds on ridges formed at 45 cm apart, in lines as thin sowing. This helps in better root development and drainage. When the seedlings are 10 to 15 days old, thin out the seedlings to a distance of 7 to 8 cm with in the rows.

Manuring

First season

A light does of 20-25 tons of FYM per ha should be applied before field preparation.

Nitrogen - 75 kg/ha (35 kg basal + 35 kg top dressing)

Phosphorus - 50 kg/ha (basal)

Potash - 50 kg/ha (basal)

Second season (During transplanting)

Farm yard manure -10 to 15 tons /ha

Nitrogen - 50 kg (25 kg at pre-bolting + 25 kg before flowering)

Phosphorus - 50 kg (basal)

Supplementary pollination

Since the honey bees are important pollinating agents. It is advisable to place beehives in the large seed fields or near by the field to increase the pollination. It is necessary when the temperature is below 15°C.

Spraying of 150 ppm NAA at bolting stage in Japanese white radish recorded the highest seed yield per hectare (Sharma, 1995).

Roguing

Minimum of three field inspections should be done at 20-30 days after sowing, when roots are lifted and replanted and during flowering stages. Roguing should be done based on root character, flower character and the undesirable and diseased plants are to be removed.

Field standards

Factor	Maximum permitted (%)	
	Foundation	Certified
Off types (maximum)	0.10	0.50
Plants affected by seed borne disease	0.10	0.50
Roots not confirming to varietal characteristics	0.10	0.20

Pest and disease management

At the time of flowering, indiscriminate use of insecticides may result in lowering the bee population, pollination and seed set. Use of insecticides during flowering affects the insect pollinators and will result in poor seed set. A single soil application of granulated Phorate 10G, Dimethoate @ 18 Kg/ha during early February for control of sucking pests (Aphids) is advisable. In radish the major disease is "Damping - off". Thin sowing and drenching with 150 g of Bavistin in 100 liters of water will control the disease. White rust disease can be controlled by spraying of Mancozeb 2 g/lit or copper oxychloride 2 g/lit.

Harvesting and processing

The entire plants are cut when the plants are fully matured and the siliqua turns brown colour. Thorough drying of siliqua is must for easy separation of seeds. The seeds are separated by beating with pliable sticks. The seeds should be dried to 6% moisture content, cleaned and treated with Bavistin @ 2g per kg of seed.

Designated diseases

Black rot (*Xanthomonas campestris pv. Campestris*)

Black leg (*Leptbsphaeria maculans*)

Seed standards

Factor	Foundation	Certified
Pure seed (minimum)	98%	98%
Inert matter (maximum)	2%	2%
Other crop seed (maximum) (no./kg)	5/kg	10/kg
Total weed seed (maximum) (no./kg)	10/kg	10/kg
Germination (minimum)	70%	70%
Moisture (maximum) (normal container)	6%	6%
For VP Container(maximum)	5%	5%

Beetroot (*Beta vulgaris*)

Beet is a hardy and temperate crop. Beets are best adapted to well drained fairly deep friable sandy loams or loams.

Seed production

As with other biennial root crops, both seed-to-seed and root-to-seed methods can be followed in producing beet seed. Since the interior flesh colour is important, the root-to-seed method is followed greatly. The seed-to-seed method has certain limitations for its use as described under other root crops.

Seed-to-seed method

This method is also known as *in-situ* or over-wintering method. It is much simpler than root-to-seed method because the roots are allowed to over-winter in the field where they were grown earlier and thus time and cost of labour is saved. The only drawback is the lack of thorough roguing. The stock seed used for seed-to-seed plantings should be taken from a crop which represents trueness-to-type and freedom from rogues of all kinds. The use of this method should be restricted to the production of only certified seed (market seed) as on the grower's field negligible off-types do not matter much.

Root-to-seed method

This is the specialized technique of quality seed production where the roots / stecklings of beet are grown first year in the same way as for market crop and in second year the selected roots are replanted in the well prepared field for the seed crop. This is the most satisfactory method of stock seed production and also followed in breeders' seed and foundation seed production. When the roots reach full size by the end of the growing season, they are either replanted immediately or stored in trenches depending upon the severity of winter (amount of snowfall). In areas of heavy snowfall like Kalpa (Himachal Pradesh), stecklings uprooted in November-December are stored in shallow trenches up to March by the time snow melts. The stecklings receive the necessary chilling during their storage in the trenches. The stecklings should be larger in size as smaller ones get shriveled and dried in the storage. The depth of the trench should not be more than 45-60 cm otherwise the stecklings in the lower layer of storage pit get overheated and will be devoid of adequate thermal induction although they are well protected from freezing. In Kullu and Srinagar, where the snowfall is light the roots are planted immediately after lifting. The merits and demerits of this method remain the same as with other root crops.

Land preparation

The soil should be thoroughly prepared by ploughing the land about 4-5 weeks before sowing. Ploughing in June in temperate region before the rainy season starts, helps to take care of weeds and ease the preparation of field in July / August when rains actually start.

Manures and fertilizers

Apply well rotten farmyard manure 10-15 tones / ha at least 4-6 weeks before sowing the seed. At the field preparation, 50 kg N, 50 kg P_2O_5 and 100 kg K_2O should be incorporated thoroughly into the soil in the ratio of 1:1:2. Another dose of N 50 kg / ha is applied before initiation of root development. If the seed is to be produced by *in situ* method apply 10 tonnes farmyard manure, 50 kg P_2O_5 and 50 kg K_2O at the field preparation. Apply about 100 kg N in 2 equal split doses, first after 40 days when the new leaves start developing and the second at bolting of the crop. In the crop raised for steckling production, borax @ 20-25 kg/ha is helpful to prevent canker and internal breakdown as black spot or dry rot and the development of good quality roots. In poor growth, 4-5 weekly sprays of 1-2% urea in the replanted crops are helpful to push up the growth.

Spacing

For beet seed production, moderate-sized stecklings having a diameter of 5-7 cm are more preferable to either smaller or larger ones. For raising of stecklings, 45 cm x 10 cm and for replanting stecklings 45 cm x 45 cm of 60 cm x 45 cm spacings are most suited.

Seed rate

For *in-situ* method of seed production, seed rate of 5-6 kg/ha is sufficient. For raising stecklings, seed rate of 10-12 kg / ha is used and this will provide sufficient stecklings under better management to replant 7-8 ha of seed crop.

Sowing time and replanting

The optimum time for sowing is the second fortnight to July in Kullu and Srinagar where the snowfall is comparatively low and root-to-seed or *in situ* method is followed. Time of sowing influences size, shape and colour of foliage, and texture. The root develops good colour, texture and quality under cool weather conditions. Under high

warm weather, zoning is caused which is marked by the appearance of alternating light and dark red concentric circles in the root. Roots developed at a relatively high temperature had poor colour and the roots become coarse with woody flesh, while those planted in cooler months had excellent colour and quality. Hence, early sowings should be discouraged for seed crop. Transplanting of mature best stecklings like other root crops, should be done in November or early December after which the temperature drops considerably. Late planting results in the development of small seed-stalks with less number of branches and flowers.

Bolting, flowering and seed-setting

Beet has only temperate types which bolt and produce seed only in response to low temperature. Sometimes premature bolting is there in the crop grown for stecklings. There can be two causes responsible for it: (a) seed produced in areas having long winters and short summer with good rainfall get vernalized during later stages of ripening. The stecklings raised from this seed go to bolting before attaining maturity: (b) if the temperature goes low (4.4^0 – 10^0C) for 15 days or more in the early stages of crop growth, some percentage of bolting is likely to occur in the field. This is particularly true in the case of the crop grown later in the season (October-November) in the plains of North India, which is vernalized during winter before reaching maturity.

Transformation from vegetative to reproductive phase takes place only when the plants after root formation are exposed to low temperature of 4.4^0 – 10^0C for 60-90 days, depending on the variety. Crop is allowed to over winter either in the field or in the trenches depending on the extent of snowfall. At lower temperatures induction period is reduced to some extent. Unless the chilling requirement is complete, a rise in temperature beyond 21^0C nullifies the effect of earlier cold period and causes reversion of reproductive processes to the vegetative phase. This is called devernalization. As this reversion is irreversible, such plants cannot be vernalized again and remain in the vegetative stage. Plants are conditioned for production of flower-stalks by low temperature treatment but the elongation of seed-stalks actually takes place under long photoperiods.

Plant protection

Pests

Leaf miner and flea beetle

- Spray malathion 50 EC 2 ml/lit.

Diseases

Cercospora leaf spot

- Spray Mancozeb at 2 g/lit.

Rhizoctonia root rot

- Spot drenching with Carbendazim at 1 g/lit.

Harvesting

Ripened seeds sometimes shatter easily but if harvesting is done early in the morning when it is sufficiently moist the problem of shattering can be prevented. As ripening is uneven, 2 to 3 harvestings manually are often necessary. To prevent losses in shattering, the seed crop should be harvested when two-thirds of the seed on a branch are being ripened i.e. changing in colour to light brown.

Seed yield

On an average 800 – 1,000 kg / ha seed yield can be obtained.

Field standards

Factor	Foundation	Certified
Off types	0.10%	0.20%
Roots of other varieties not conforming to varietal characteristics	0.10%	0.20%

Seed standards

Factor	Foundation	Certified
Pure seed (minimum)	96%	96%
Inert matter (maximum)	4%	4%
Other crop seed (maximum) (no./kg)	5/kg	10/kg
Total weed seed (maximum) (no./kg)	5/kg	10/kg
Germination (minimum)	60%	60%
Moisture (maximum) (normal container)	9%	9%
For VP Container(maximum)	8%	8%

Questions

1. How do call carrot fruit?

   Ans: schizocarp

2. IMSCS for purity as well as germination are low: Are they related?

   Ans: protandrous

3. What is the fruit of beet root called?

   Ans:siliqua

4. Why is Borax help to improve crop growth?

   Ans: by preventing block rot incidence

5. Steckling means planting material (True/False)

   Ans: True

6. Cross pollination in carrot is due to protandrous flowers (True/False)

   Ans: protandrous flowers

7. Stages of roguing are 3 stages (True/False)

   Ans: True

8. Minimum germination requirement for carrot 60% (True/False)

   Ans: by preventing block rot incidence

9. Seeds of carrot are called

   a. Schizocarp b. Mericarp c. Pod d. Umbel

   Ans: b

10. Beta vulgaris is a

    a. Monogerm seed b. Multi germ seed

    c. Viviparous seeds d. a & b

    Ans: d

11. Siliqua of radish is

    a) Dehisent b) Non dehisent c) dehisent when dry d) Non dehiscent when wet

    Ans: d

Lecture No.13

Seed production in coriander, fennel and fenugreek

Coriander (*Coriandrum sativum)*

Botany

The inflorescence is compound umbel. Flowering starts with the primary umbel. In every umbel the peripheral umbellets and in every umbellet the peripheral flowers are the first ones to flower. Flowers are protandrous, small, white or pink in compound terminal umbels, fruits-schizocarp, globular, yellow-brown, ribbed, 2 seeds, ripe seeds are aromatic. Time of anthesis is 5.30-7.00 h. Duration of pollen fertility up to 14 h after anthesis stigma receptivity is 12 h before to 6-7 h after anthesis.

Fig. 1. Compound umbel

Stages of seed production: Breeder seed → Foundation seed → Certified seed

Varieties : CO1, CO2, CO3, Gujarat Coriander -1, Gujarat Coriander-2, Rajendra Swati, Rcr- 47, Swathi, Sadhana.

Season: In Tamil Nadu, as an irrigated crop, coriander is raised in June-July and September-October. In the first season, it matures early before the end of August-September. In the second season the crop matures late with an extended growth phase during January- February. The growth and the yield of second season crop are found to be better than the first season crop.

Land requirement: Land to be used for seed production of coriander should be free from volunteer plants.

Isolation requirement: Foundation seed – 200 m; Certified seed – 100m

Seed rate: Irrigated condition - 10-15 kg/ha

Rainfed condition - 25-30 kg/ha

Seed treatment: Coriander fruit contains two seeds which are fully capable of germination. Therefore, it is highly essential to divide fruit into halves (mericarps) by rubbing on rough floor with a wooden roller holding by hands at both the ends. This operation not only reduce 50 per cent seed requirement (both halves) but only enhance early and high percentage of germination.

Sowing: For irrigated crop, sowing is generally done in rows spaced at 30 to 40 cm apart with 15 cm between hills. Soil depth should not exceed 3.0 cm. Three to five seeds are sown in a hill and later on thinned to two plants per hill.

Seed treatment: Water soluble inhibitors are present in coriander schizocarp which prevents seed germination. Seed leaching in running water for 16 hr and then soaking in double the quantity of 100 ppm GA3 solution for 16 hr will enhanced the germination and vigour index.

Main field manuring: About 10 tonnes of farm yard manure is applied at the time of last preparation. In addition, to this, 20 kg N, 30 kg P and 20 kg K per hectare should be applied at the time of sowing for both irrigated and rainfed crop. For irrigated coriander an additional dose of 40 kg N/ha should be applied in two equal splits, first at 30 and second at 75 days of sowing.

Irrigation: First irrigation is given 3 days after sowing and thereafter at 10 to 15 days interval depending upon the soil moisture available in the soil.

After cultivation: The first hoeing and weeding are given in about 30 days. Thinning the plants is also attended simultaneously, leaving only two plants per hill. Depending upon the growth one or two more weeding are done.

Roguing: A minimum of 3 inspections shall be made during before flowering, 50% flowering and prior to harvest to verify the true nature of plant.

Field Standards

Factors	Foundation seed	Certified seed
Isolation distance (m)	10	5
No. of field inspection	2	2
Offtypes (%)	0.10	0.20

Pest and Disease Management: At the seedling stage coriander is often attacked by the leaf eating caterpillars and semi-loopers and at the flowering stage by the aphids. Spraying the crop with methyl demeton (0.05%) is recommended to control the aphids but at flowering stage the use of any insecticide would kill the bee population affecting pollination in the crop.

Powdery mildew (*Erysiphe polygoni*) is a serious disease which ruin the crop if allowed unchecked in the initial stage itself. Spraying wettable sulphur 0.25% or 0.2% solution of Karathane twice at 10 to 15 days interval is recommended. Grain mould is caused by *Helminthosporium sp, Alternaria sp., Carvularia sp* and *Fusarium sp*. It can be controlled by spraying carbendazim 0.1% 20 days after seeds set.

Plant protection

Aphid: Spraying of methyl demeton 25 EC @ 2 ml/lit or dimethoate 30 EC @ 2 ml/lit.

Diseases

Powdery mildew: Spraying of Wettable sulphur 1 kg/ha or Dinocap 250 ml/ha at the time of initial appearance of the disease. Neem seed kernel extract 5% spraying in thrice (1st spray immediately after the appearance of disease. 2nd and 3rd at 10 days interval. 3 sprays of NSKE (5%), 1st spray immediately after appearance of the disease, 2nd & 3rd at 15 days interval).

Grain mould: Spraying of Carbendazim 0.1 % (500 g/ha) 20 days after grain set.

Harvesting and processing: Harvesting has to be done when the fruits are fully ripe and start changing from green to brown colour. Delaying of the harvest should be avoided reduces shattering during harvest and splitting of the fruits in subsequent processing operations. The plants are cut or pulled and piled into small stacks in the field to wither for 2 to 3 days. The fruits are then threshed out from the plants by beating with sticks or rubbing with hands. The produce is winnowed, cleaned and dried in partial shade. After drying the produce is stored in gunny bags lined with paper. The irrigated crop yields and average 600 to 1200 kg/ha.

Coriander seeds treated with halogen mixture @ 3g/kg of seed and packed in 300 gauge polylined cloth bag stored for more than 5 months.

Seed standards

Factors	Foundation	Certified
Pure seed (minimum)	98%	98%
Inert matter (maximum)	2%	2%
Other crop seed (maximum) (no./kg)	10 /kg	20/kg
Total weed seed (maximum) (no./kg)	10/kg	20/kg
Germination(minimum)	65%	65%
Moisture (maximum) (normal container)	10%	10%
For VP Container(maximum)	8%	8%

Fenugreek (*Trigonella foenum-graecum* L.)

Botany

Fenugreek is a self pollinated and quick growing crop produces bright orange to yellow flowers. The pods are sickle shaped containing small deeply furrowed seed.

The flowers open between 6.00 and 9.00 am. The stigma becomes receptive 12 hour before and the anthers also dehisce before the flower actually opens.

Fig. 1. Fenugreek flower

Method of seed production

Stages of seed production: Breeder seed → Foundation seed → Certified seed

Varieties : CO1, Rajendra Kanti, RMT-1, Lam Sel.1, Hissar Sonali

Isolation: Foundation Seed 10 m; Certified seed 5 m

Climate and Soil: It has a wide adaptability and is successfully cultivated both in the tropics as well as temperate regions. It is tolerant to frost and freezing weather. It does well in places receiving moderate or low rainfall areas but not in heavy rainfall area. It can be grown on a wide variety of soil but clayey loam is relatively better. The optimum soil pH should be 6.0 to 7.0 for its better growth and development.

Land preparation and sowing: Land is prepared by ploughing thrice and beds of uniform size are prepared. Broadcasting the seed in the bed and raking the surface to cover the seeds is normally followed. But, line sowing is advocated in rows at 20 to 25 cm apart which facilitates the intercultural operations.

Season: Sowing in the plains is generally taken up in September to November while in the hills, it is grown from March. Approximately 20 to 25 kg of seed is required for one hectare and the seed takes about 6-8 days to complete its germination.

Manures and fertilizers: Besides 15 tones of farmyard manure, a fertilizer dose of 25 kg N, 25 Kg P_2O_5 and 50 kg K_2O per ha is recommended. Half of the N dose and the entire

quantity of P and K are applied basally and the remaining half N is applied 30 days after sowing.

Irrigation: First irrigation is given immediately after sowing and subsequent irrigation is applied at 7 to 10 days interval.

Inter cultivation: Hoeing the weeding during the early stages of plant growth is required to encourage proper growth. Thinning may be done on 20 to 30 days to keep the distance between the plants at 10 to 15 cm and to retain 1 to 2 plants per hill.

Rouging: The offtypes should be removed both at flowering and at maturity stage. The plants of *melilotus spp* should also be removed from the field prior to harvest.

Field standards

Factors	Breeder seed	Foundation seed	Certified seed
Isolation distance (m)	50	10	5
No. of field inspection	-	2	2
Offtypes (%)	-	0.10	0.20
Inseparable other crop plants (%)	-	-	-
Objectionable weed plants (%)	-	0.01	0.02
Plant / affected by designated diseases (%)	-	-	-

Harvest: Fenugreek seeds attained physiological maturity 45 days after anthesis when the seed moisture content was around 20 per cent. Harvesting should be done when the lower leaves start shedding and the pods have become yellowish. Harvesting should be done by cutting the plants with sickles. Delay in harvesting leads to shattering and lose of seeds. The harvested plants are tied in bundles and allowed to dry for 4-6 days. Threshing should be done on clean floor or tarpaulin. The seeds are separated by beating followed by winnowing or by the use of mechanical threshers.

Fig.2. Fenugreek plants with ripening fruits or pods

Seed grading: Seed grading is done with 6/64" round perforated metal sieve.

Seed yield: 1200 – 1500 kg/ha.

Plant protection: Root rot (*Rhizoctonia solani*) is a serious disease and can be controlled by soil application of Neem cake @ 150 kg/ha and seed treatment with *Trichoderma viride* @ 4g/kg and drenching with carbendazim 0.05% first at the onset of the disease and another after one month.

Seed standards

Factors	Foundation	Certified
Pure seed (minimum)	98%	98%
Inert matter (maximum)	2%	2%
Other crop seed (maximum) (no./kg)	5/kg	10/kg
Total weed seed (maximum) (no./kg)	10/kg	20/kg
Germination(minimum)	70%	70%
Moisture (maximum) (normal container)	8%	8%
For VP Container(maximum)	6%	6%

Fennel (*Foeniculum vulgare*)

Botany

Two kinds of flowers on this umbelliferous plant. The first of the tiny yellow flowers to bloom on an umbel or hermaphrodite with a few isolated staminate ones. These hermaphrodite flowers are completely protandrous. After the five stamens of a

blossom dehisce and their pollen drops off, the stigma becomes receptive and continues to be receptive for 2-4 days .The pollen remains viable for 10 hrs. Flower opening started at 6 A.M. and reached a maximum between noon and 2.00pm.

Fig. 1. Inflorescence of fennel

Variety: RF 101, RF 125, PF 35**,** CO-1, Gujarat Fennel-1

Season: Mid September to Mid October

Nursery: For transplanted crop nursery is raised in the month of June or July. The seedlings of 45-60 days are transplanted in the month of August

Seed rate:	Direct sowing	:	10-12 kg/ha
	Transplanted crop	:	3-4 kg/100m^2 in nursery is sufficient for transplanting in one hectare

Sowing: Sowing should be done in rows 45-60 cm x 20 cm or broad casting and the depth of sowing should not be more than 2 cm in case of direct sowing.

Manuring: FYM/compost at the rate of 10-15 t/ha should be applied at the time of field preparation. In addition to this 90 kg N/ha in 3 equal splits, first as basal dose with 40 kg/ha P_2O_5 at the time of sowing, second at 30 DAS and third at 60 DAS with irrigation should be applied to obtain good yield.

Weed control: Because of slow germination it faces severe weed competition. At the time of thinning i.e. 30 DAS, one hand hoeing and weeding should be done and it should be repeated twice or thrice as required.

Irrigation: It is a long duration crop or it requires more irrigations. The crop is irrigated at an interval of 15-25 days until the seed maturation.

Pest and Disease management: Fennel is free from major disease but blight, powdery mildew and stem rot disease are prevailing in some parts. Spraying of copper fungicides, fytolan, sulphur dust, and capton controls the above diseases.

Harvesting: It matures in about 170-180 days. All the umbels do not mature the same time. So plucking of umbels is done when seeds are fully developed but still green. Harvesting is completed by plucking twice or thrice at an interval of 10 days. Plucked umbels are dried in sun for 1-2 days and then in shade for 8-10 days. Longer exposure to sun changes the colour and luster of the seeds which reduces the quality.

A sieve with 1/14" x ¾" perforations was recommended for grading of fennel seed.

Yield: 900-1000 kg/ha.

Field and seed Standards

Factors	Foundation seed	Certified seed
Isolation distance (m)	10	5
No. of field inspection	2	2
Offtypes (%)	0.10	0.20

Seed standards

Factors	Foundation	Certified
Pure seed (minimum)	98%	98%
Inert matter (maximum)	2%	2%
Other crop seed (maximum) (no./kg)	5/kg	10/kg
Total weed seed (maximum) (no./kg)	10/kg	20/kg
Germination(minimum)	70%	70%
Moisture (maximum) (normal container)	8%	8%
For VP Container(maximum)	6%	6%

Questions

1. Inflorescence in coriander is Compound umbel (True/False)

   Ans: True

2. The chemical responsible for seed dormancy in Coriander is

   a. Phenol b. ABA c. CCC d. Coumarine

   Ans: d

3. Presence of mericarp is a common feature of

   a. Anacardiaceae b. Umbelliferae c. Solanaceae d. Labitae

   Ans:b

4. What is the pollination behaviour of coriander?

   Ans: cross pollination

5. How to break seed dormancy in coriander?

   Ans: leaching

6. What is the isolation requirement for coriander foundation seed crop?

   Ans: 200m

7. How many roguings are required for coriander seed production?

   Ans: three

8. What is the botanical name of fenugreek?

   Ans: *Trigonella foenum-graecum*

9. What is the isolation requirement for foundation seed crop fenugreek?

   Ans: 10 m

10. Mention fennel varieties released from TNAU?

    Ans: CO1

Lecture 14

Seed production in pepper (*Piper nigrum)*

Botany

Flowers are very minute. Monoecious or dioecious or hermophrodite forms occur in different varieties. The male flowers are very few, 1 to 19 per cent in different varieties. The fruit is a single seeded berry, which has a thin, soft pericarp surrounding the seed.

Fig. 1. Pepper plant and spikes

Pepper vines start yielding usually from the 3rd to 4th year. The vines flower in May – June. It takes 6 to 8 months from flowering to ripening stage. Turning of green fruit to red colour is symptom of maturity. The whole spikes are picked during November to February in plains and January to March in hills

Varieties

Panniyur-1, Panniyur-2 (Krishna), Panniyur-3 (Shima), Panniyur-4, Panniyur-5, Panniyur-6, Panniyur-7, Sreekara, Subhakara, Panchami, Pournami,IISR Thevam, IISR Malabar Excel, IISR Girimunda, IISR Sakthi, PLD-2

Nursery

Pepper is propagated by cuttings, raised mainly from the runner shoots. Cuttings from the lateral branches are seldom used, since in addition to reduction in the number of fruiting shoots, the vines raised from them are generally short lived and bushy in habit. However, rooted lateral branches are useful in raising pepper in pots.

Runner shoots from high yielding and healthy vines are kept coiled on wooden pegs fixed at the base of the vine to prevent the shoots from coming in contact with soil and striking roots. The runner shoots are separated from the vine in February- March and after trimming the leaves, cuttings of 2 to 3 nodes each are planted either in nursery beds or polythene bags filled with fertile soil. Cuttings from middle 1/3 of the shoots are desirable as they are high yielding. Adequate shade is to be provided and irrigated frequently. The cuttings will stricken roots and become ready for planting in May—June.

Propagation

A rapid multiplication technique has been developed by the National Research Centre for Spices, Calicut. In this method, a trench is filled with rooting medium (preferably forest soil, sand and cow dung mixture at 1:1:1). Split halves of bamboos with Septa with 8 to 10 cm diameter and 1.25 to 1.50 m length are fixed at 45^0 angles on a strong support. The bamboos can be arranged touching one another. Rooted cuttings are planted in the trench at the rate of one cutting each for one bamboo. The lower portions of the bamboo are filled with a rooting medium (coir dust and cattle manure mixture 1:12) and the growing vine is tied to the bamboo in such a way as to keep the nodes pressed into the rooting medium. The tying could be done with dried banana sheath fiber. The vines are irrigated regularly. As the vines grownup, filling up the bamboo with rooting medium and tying each node, pressing it down to the rooting medium are to be continued regularly. For rapid growth, each vine is fed at 15 days interval with 0.25 litre of nutrient solution prepared by dissolving urea (1kg), super phosphate (0.75 kg), muriate of potash (0.5 kg) and magnesium sulphate (0.25 kg) in 250 liters of water.

When the vine reaches the top in about 3 to 4 months, the terminal bud is nipped off and the vine is crushed at about three nodes above the base in order to activate the axillary buds. After about 10 days each vine is cut at the crushed point and removed from the rooting medium and each node is separated. Such cuttings with the bunch of roots intact are planted in polybags filled with pot mixture and kept in a cool humid place. Care should be taken to keep the axil above the soil. The bud starts developing in about 3 weeks when the polybags can be moved and kept in semi shade. Subsequent harvesting can be had at every 2-2½ month's time. The advantages of this method are

1) Multiplication is rapid (1:40).

2) The root system is well developed and

3) A better field establishment and more vigorous growth as a result of better roots system.

Land

Well drained level land and hill slopes are suitable for growing pepper. When grown on a sloppy land, the slopes facing south should be avoided and the lower half of north and north eastern slopes are preferred for planting, so that the vines are not subjected to the scorching effect of the sun during summer.

System of cultivation

Pepper is grown as monocrop as well as a mixed crop. Large scale cultivation of pepper as monocrop is done on hill slopes by clearing jungle lands and planting standards for the vines to climb on. As a mixed crop, it is grown with arecanut, coconut, mango, jack etc. where these trees serve as standards for the pepper vines. Peeper is also a suitable intercrop in coffee estates where the shade trees serve as good standards for them.

Planting

Pepper cuttings are generally planted with the onset of the southwest monsoon. Planting can also bed done during the northeast monsoon wherever it is regular and well distributed when pepper is grown as pure crop, pits of 0.5 m cube are dug at a spacing of 2.5 x 2.5 m and *Erythrina* stem cuttings of 2 m length or its two year old seedlings are planted on receipt of early monsoon showers. Certain other trees like Silver Oak, *Ailanthus excelsa* and *Garuga pinnata* are also used. With the onset of regular rains, 2 or 3 rooted cuttings are planted around the base of the standard nearly 30 cm away. But in the case of coconut and arecanut which have a thick intercoiled root net close to the trunk, pepper cuttings are to be planted 100 to 120 cm away from the tree trunk which are about 8 to 9 m high. Initially, the vines may be allowed to climb on a stick or pole about 2 m tall which is tied to the trunk in a slanting position. After one year, when the vine has attained sufficient length it may be separated from the temporary stake and the lower leaves may be nipped off. A narrow trench of 15 cm deep and wide should be prepared from the base of the vine to the base of the tree trunk. The vine may be placed in the trench in such a way that the growing tips are tied to the trunk while the other parts of

vine are covered with the soil. A small ridge is formed over the trench which should not be disturbed while doing intercultural operations to the palm.

Cultural practices

As the cuttings grow, the shoots are tied to the standards as often as required. The young vines should be protected from hot sun during summer months by providing them with artificial shade. Regulation of shade by lopping the branches of standards is necessary not only for providing optimum light to the vines buy also for enabling the standards to grow straight. Adequate mulch with green leaf, saw dust or coir dust or organic matter should be given towards the end of northeast monsoon. The base of the vines should not be disturbed to avoid root damage.

During the second year, practically the same cultural practices are repeated. However, lopping of the standards should be done carefully from the fourth year onwards, not only to regulate the height of the standards, but also to shade the pepper vines optimally. Excessive shading during flowering and fruiting encourages pest infestation. Pruning the top of the vine after it has reached the required height i.e. 6 m is normally practiced when it is trained on standards like silver oak, coconut, arecanut for convenience of picking.

From the fourth year usually two diggings are given, one during May-June and the other towards the end of southwest monsoon in October- November. Growing cover crop like *Calapogonium mucanoides, Moimosa invisa* are also recommended under west coast conditions.

Manuring

Judicious and regular manuring is necessary to get good yield. About 10 kg of well rotten cattle manure or compost is given in April-May. Fertilizers to supply 100 g N, 40 g P_2O_5 and 140 g K_2O per standard for vines of three years and above may be applied annually in two split doses in April-May and August- September. During the first year of planting, 1/3 of the above dose and in the second year 2/3 of the dose may be given. Manures are applied around the vines at a distance of 30 cm and forked into the soil. Lime may be applied at the rate of 500 g per standard during April in alternate years.

Harvesting and curing

Pepper vines start yielding usually from the 3rd to 4th year. The vines flower in May – June. It takes 6 to 8 months from flowering to ripening stage. Turning of green fruit to red colour is symptom of maturity. The whole spikes are picked, when one or two berries on the spike turn bright or red during November to February in plains and January to March in hills.

Berries are separated from the spikes by rubbing them between the hands or trampling them under the feet or spikes with fully ripe berries are filled in gunny bags and steeped in flowing water for about 7 days. Outer rind of the berries is then removed by rubbing them with hands in a bucket of water and further cleaning the seeds with fresh water. The cleaned seeds are dried for 3 to 4 days. The seeds which are now dull white in colour are further cleaned by winnowing and polishing them by rubbing with a cloth. The recovery of white pepper is about 25 percent of rip berries while that of black pepper is about 33 percent.

Pepper seeds can be stored up to one year at 20-30^{0}C with periodical sun drying.

Yield

One hectare plantation of 7 to 8 years old gives about 800 to 1000 kg of black pepper.

Plant protection

The important pests are beetles,top shoot borer, thrips which can be controlled by spraying of any insecticides such as Endosulfan (0.05%), Monocrotophos (0.05%) or chlorpyriphos 2 ml/lit or dichlorvos 76 WSC 1 ml/lit or phosphomidan 40 SL @ 2 ml/lit three rounds at monthly intervals starting from new flush formation

The important disease is quick wilt or foot rot, this disease can be controlled by application of *Trichoderma viride* @ 20 g/vine along with FYM or Bordeaux mixture 1% or Metalaxyl-Mancozeb @ 2 g/lit or spraying with 1% Bordeaux mixture and 0.25% Ridomil /MZ. Slow decline or slow wilt disease controlled by treating the planting pit with phorate @ 15 g or carbofuron @ 50 g.

Questions

1. Type of fruit in pepper is called as berry (True/False)

Ans: True

2. Harvestable maturity of pepper is red coloured fruits (True/False)

Ans: True

3. National Research Centre for Spices is located at Calicut (True/False)

Ans: True

4. Pepper seeds can be stored with a minimum germination for period of one year (True/False)

Ans: True

5. The advantage of propagation through rapid multiplication technique ratio is 1:40 (True/False)

Ans: True

Lecture No. 15

Seed production in potato

1. POTATO (*Solanum tuberosum*)

Potato has special seed production problems as the quality characteristics of seed potatoes are influenced by a number of factors and important amongst them are the diseases and pests namely, viruses, fungi, bacteria and nematodes. Once the seed tuber is infected by the pathogens, especially viruses which enter through the plant system, the plant growth therefore declines and the yield reduces progressively. It is therefore, important that seed stocks should not only be genetically pure but also should be in right physiological condition and disease free at the time of planting. Seed production technology developed for seed potato production, thus aims at producing disease free, genetically pure seed. There are now two independent channels of seed production for hills and plains.

Fig. 1.Flower bud of potato

Hill seed: The seed produced in hills (2500 metres above sea level) at suitable locations is called 'Hill Seed'.

Plain seed: The seed produced in plains at suitable locations is called 'plain seed'. Northern plains have emerged as an important source of potato seed production. The low aphid plains seed is in right physiological condition at the planting time and yields higher than the traditional hill grown seed.

Once healthy seed potatoes are introduced into the system of growing them during low Aphid period accompanied by a systematic insecticide application, roguing

and removal of haulms before the aphids attain critical number and the re-growth is checked, the health standards for the seed crop could be maintained for a number of generations. This system of seed potato production has been designated as 'Seed Plot Technique'.

Stages of seed production

For seed multiplication and certification purposes following stages are recognized. BS - FS I - FS II - CS I – CS II.

CS II: This is done in case of those varieties which have a low rate of multiplication and in years of shortage of seeds.

Land requirements

A crop of seed potato shall not be eligible for certification if grown on land infested with wart and/or cyst forming nematodes; or brown rot or non-cyst forming nematodes within the previous three years; and common scab. Preference should be given to two to three years crop rotation.

Isolation requirements

A minimum isolation distance of 5 m for foundation and certified seed class should be provided all around a seed field to separate it from fields of other varieties, and fields of the same variety not conforming to varietal purity and health requirements for certification.

Time of Sowing

The sowing should be done from 20th September (when rainfall is low) or 25th September up to 15th October. Delayed plantings will result in poor yields.

Seed rate

Seed rate depends upon tuber size. Twenty five to 30 qtls of seed potato per hectare will be sufficient if the usual sized tubers (4 to 6 cm) are used.

All size of tubers like large, medium and small may be utilized as seed, but the medium size (25 – 55 mm or 25-75 g) often called as seed size performs better than other size grades as seed material.

Fertilization

125:80:100 kg NPK with 25t FYM/ha. Apply all phosphorus, potash and half of the nitrogen at the time of sowing. The remaining half of nitrogen should be applied

about thirty five days after sowing, or when the plants are about to 30 cm height. For best results, the fertilizers should be placed either 5 cm below the tubers or on the sides.

Method of sowing

Whole tubers should be used for planting. Tubers should be under sprouting (sprouts 0.5 to 1 cm long) for quick emergence. After 15th October when the temperature goes down, cut tubers can also be used for planting. Care must be taken that each piece to be used for planting has two or three emerging eyes and weighs at least 40 gm. By this practice the seed rate is reduced considerably. Plant the tubers 3 to 4 cm deep in the soil having adequate moisture. Row to row spacing at 60 cm and tuber to tuber spacing at 15 to 20 cm is recommended.

Irrigation

Potato requires light and frequent irrigation. First irrigation should follow immediately after emergence. Subsequent irrigations should be given at proper intervals. Restrict the irrigation after the crop has tuber raised well. Withhold irrigation by the third week of December i.e., ten to fifteen days before cutting of haulms.

Interculture

Keep the field free from weeds. At least one earthing up is a must. It should be done when plants attains the height of 15 cm.

Haulm cutting

The practice of haulm cutting is adopted as a precautionary measure to avoid chances of viral disease transmission through the vectors like aphids. The haulms must be cut by the end of December, or at the latest by the first week of January before the aphid population reaches the critical stage (20 aphids per hundred compound leaves). No re-growth should be allowed.

Roguing: Very careful roguing is required for producing a high quality crop of seed potato. The roguing is to be done at the following stages.

First roguing: First roguing should be done 25 days after sowing to remove: a) All virus affected plants and b) All plants apparently belonging to other varieties and which can be identified from foliage.

Second roguing: It should be done when the crop is fully grown. This would be about 50 to 60 days after sowing. At this time tubers are formed and therefore, while roguing,

not only the upper portion of plant, but all the tubers belonging to the plant should be removed carefully. Also at this stage the virus affected plant as well as off type, should be removed.

Third roguing: This is the third and final roguing and should be done just before cutting the foliage. Foliage should not be cut unless this roguing has been completed. At this stage, all virus affected plant and off type plants, along with their tubers have to be very carefully removed.

Harvesting

a. The crop is ready for harvest ten to fifteen days after haulm cutting when the skin of tuber has hardened. Premature harvesting causes handling problems, as the soft skin gets easily peeled of and further such tubers cannot withstand long transportation and storage.
b. At the time of potato digging, the moisture in soil should be optimum for obtaining clean tubers.
c. The harvesting of seed potatoes can be done by any of the equipment available in the market for this purpose. Every effort should be made to avoid cuts, bruises, etc. After harvesting, tubers should not be left exposed to the hot sun for a prolonged period (not more than an hour). It should be immediately lifted and carried to an airy shed and kept in piles (height 1 m, width 3 m) for 7 to 10 days so that the superficial moisture evaporates and further hardening of skin is achieved. If sheds are not available, piles may be made in field and covered with dry haulms.

Sorting and Grading

When the potatoes are properly cured, grading should be done. A single grade from 3.0 to 5.5 cm is being made at present for `Plain Seed' by hand grading. While grading, the shape, colour, depth of eyes, etc. of tubers should be critically examined and off types discarded. In addition to off types, the tubers with cuts, bruises, cracks or otherwise mechanically damaged or showing visible symptoms of late blight, dry rot, charcoal rot, wet rot, scab, black scruf, etc. should invariably be removed.

Seed standards

Size of seed tuber: 4-6cm x 2.5 to 3.5cm in diameter; weight: 20-40g

Packing

After sorting and grading the seed potatoes should be put in clean jute-hessian bags (50 kg size) and the bags appropriately labeled.

Storage

Soon after packing, the seed potatoes should be moved to the end use areas for cold storage. If the ambient temperatures are above 32°C, the seed potato should first be kept in pre-cooling chambers, or in a cool place for preconditioning, and then stored in cold storage at temperatures from 2.2 to 3.3° C and 75 to 80 % relative humidity. Periodic inspection of seed stocks in cold storage is necessary, to ensure that stocks are keeping good. Turning of bags during rainy season helps in improving aeration.

Potato is traditionally grown vegetatively through seed tubers. This results in continuous accumulation and increase of various tuber borne diseases in seed tubers and consequent reduction in crop yields. To overcome these problems a new potato production technology making use of True Potato Seed (TPS) as planting material for raising the crop has been developed. TPS can serve as a cheap and highly productive planting material for raising commercial potato crop, especially in areas where good quality seed tubers at reasonable prices and in adequate quantities are not available.

The major advantages of this technology over the traditional seed tuber technology are as follows:

1. Unlike the seed potato production which is confined to northern India only, the TPS can be produced in all potato growing regions.
2. The crop raised through TPS is almost disease free as most of the diseases get filtered out during TPS production.
3. The TPS being very small, can be stored and transported easily, whereas the seed tubers are bulky hence the storage and transport are expensive.
4. TPS provides a low cost potato production technology where only about 50 g TPS is required for sowing in about 375 m^2 area for producing seedling tubers enough for planting one hectare next year. About 150 g TPS/ha is required if the commercial crop is to be raised in the first year itself by transplanting seedlings in field.

The TPS technology involves two major steps *viz.,*

(a) Production of hybrid seeds and

(b) Its used as planting material for raising the commercial crop.

Two high yielding TPS hybrids *viz.,* TPS C-3 and HPS 1/13 have been recommended for commercial use.

Hybrids and their parents

TPS C-3	**:**	JTH/C.107 X JEX/A 680-16 (Female x Male)
HPS 1/13	**:**	MF.1 x TPS-13 (Female x Male)

Production of Hybrid TPS

The hybrid TPS can be produced both in the hills, where the crop is grown during long summer days and also in the plains where the crop is grown in winters. Whereas, in the hills the crop flowers natural and hybridization for seed production can be done easily; in the plains, however, additional light has to be provided to induce flowering in the crop. In northern plains, where the winters are severe, the parental lines need to be planted either about 15-20 days before optimum time of the planting of the crop, or the planting is delayed till the second week of November so that the flowering time does not coincide with the severe winter period. Delayed planting of parental lines should not be done in frost prone areas.

Following steps are involved in the production of hybrid True Potato Seed (TPS)

1. If the TPS parents are planted in the plains, there is generally need to provide extra light for about 5 hours at the end of the day to prolong the day length and get proper flowering. Arrangements can be made for providing light from 150 W sodium vapour lamp (one for about every 100 sq.m). Light arrangement is not required if the parents are planted (in April/May) in the northern hills during summer crop season.
2. Plant male and female parental lines (TPS-13 as male and MF-1 as female for producing hybrid TIPS HIPS V13, and JEX/A 680-16 as male and JTH/C-107 as female for producing hybrid TPS of C-2) in two separate but adjacent blocks. The

area required for planting male block is generally kept at about 1/4 to 1/6 of the female block, depending on pollen producing ability of the male parent.

3. Plant the male block about a week before planting female block during the main crop season in the plains. Follow the spacing of 60 x 20.cm.
4. In the female block, prepare beds of three rows each. For this, draw 3 rows at 50 cm inter-row distance leaving 80 cm walking space between two adjacent beds. Plant tubers at 15 cm intra-row distance.
5. Use about 30 g size seed tubers or the seed pieces for planting female block. After germination, trim the plants in female block to retain a single stem per plant.
6. Follow all other cultural and plant protection practices for potato crop.
7. In the plains, after the germination is complete, switch on the light in hybridization block in the evening before sunset for a period of 5 hours every day. This will facilitate rapid plant growth and flowering in the parental material.

Hybridization

When the parental material comes to flowering, follow the steps given below to produce hybrid TPS

i. Trim the flower bunches in the female plants to retain only 6-8 large size buds per bunch. Very small buds, old flowers and berries if any, should be removed from the bunches and prepared for pollination next day.
ii. Collect flowers from the male parent in the evening preceding the day of pollination. Only just opened flowers with anthers that are about to shed pollen or the large size buds, which would open next day, should be collected.
iii. Spread flowers of the male parent on a sheet of paper placed on the table at room temperature and use them for extracting pollen next morning.
iv. Extract the pollen in a small dish by shaking anthers using electric buzzer or manually.
v. Pollinate the flowers of the female parent by dipping the stigma in pollen or applying pollen to the stigma using a brush. Do the first pollination between 8-10 AM and re-pollinate the flowers at the same time next day. Continue the process of

pollination till the flowering period of the crop is over. Usually there are two flushes of flowers during the crop period.

vi. Store the left over pollen in small vials, keep the vials in desiccators and place the desiccators in refrigerator at 6-10° C for the use of next day, if necessary. It is advisable to use fresh pollen for pollination every day.

vii. Provide support (use sticks) to the stems of female plants.

viii. After berries are formed, the berry bunches should be covered with thin muslin cloth bags of about 8 x 12 cm size.

Seed extraction and storage

i. Collect well developed berries about 50-55 days after pollination, keep them in trays and allow them to ripen at room temperature for a period of about 2 weeks.

ii. Mash the soft ripe berries.

iii. After mashing the berries, separate out the TPS with a high pressure water source. Treat the seed and pulp mass with 10% hydrochloric acid (HCI) with continuous stirring for 20 minutes. Wash the seeds with water at least 3-4 times to ensure complete removal of HCl.

iv. Immediately after washing, surface disinfect the seeds by soaking in 0.05% solution of Sodium hypochlorite for 10 minutes and again wash with clean water to ensure that there is no sodium hypochlorite solution on seed.

v. Spread the seed in a thin layer on muslin cloth stretched over a wooden frame and keep the frames in a well ventilated room preferably under fan for 24 hrs, in shade. TPS can be safely dried in any type of low moisture environment i.e. forced air oven, fan etc. Temperatures above 30^0C should be avoided during the initial seed drying period. Thereafter, seeds can be safely dried under temperatures not exceeding $40^0\text{C} \pm 5^0\text{C}$.

vi. Expose the shade dried seeds to warm sun for about ½ hr to reduce the moisture content.

vii. Keep the seeds in a moisture proof container along with silica gel bags and store them at low temperatures. The seeds may be kept in polythene

lined aluminum foil covers or double polythene bags or tin cans, sealed and stored in desiccators kept in refrigerator at 6-10^{0}C or even at room temperature during the winters.

Plant protection

Pests

Nematodes: Growing potato year after year in the same field should be avoided. Crop rotation with vegetables and green manure may be followed. Application of carbofuran 3 G (1.0 kg a.i.) 33 kg/ha in furrows while seeding has to be done. For cyst nematode resistant variety Kufri Swarna, application of half dose of the above nematicide is enough.

Biological control of nematodes: Applicaton of *Pseudomonas fluorescens* at 10 kg/ha.

Aphids: Spray of methyl demeton 25 EC or dimethoate 30 EC 2 ml/lit.

Cut worms

1. Installation of light trap during summer to attract adult moths.

2. Soil drenching at collar region of the plants in evening hours with chlorpyriphos or endosulfan 2ml/lit a day after planting.

White grub

1. Summer ploughing to expose the pupae and adults.

2. Quinalphos 5 D at 25 kg/ha 10 days after first summer rains.

3. In endemic areas application of phorate 10 G at 25 kg/ha during autumn season (August - October) is recommended.

Potato tuber moth

2. Installation of pheromone traps at 20 No/ha.

3. Earth up at 60 days after planting to avoid potato tuber moth egg laying in the exposed tubers.

4. Foliar spraying of NSKE 5 % or quinalphos 20 EC 2 ml/lit (ETL 5 % leaf damage).

5. Seed tubers treated with quinalphos @ 1 kg/100 kg of tubers.

Diseases

Late blight: Spraying of Mancozeb 2 g/lit or Chlorothalonil 2 g/lit on 45, 60 and 75 days after planting. Growing of late blight resistant varieties like Kufri Jyothi, Kufri Malar and Kufri Thangam.

Brown rot: Proper drainage facilities are important. Affected plants are removed and destroyed.

Early blight: Spraying of Mancozeb 2 g/lit or Chlorothalonil 2 g/lit at 45, 60 and 75 days after planting.

Virus diseases: Virus free potato seeds should be used. Virus affected plants are rogued regularly. The aphid vectors are controlled by spraying of Dimethoate or Methyl demeton 2 ml/ha.

Questions

1. Match the following

Tuber	-	2-3 years rotation 4
Light	-	Harvest 3
Haulm cutting	-	Stem 1
Disease free	-	True seed 2

2. International Research Centre for Potato is located in

   a. Cali, Columbia b. Manila, Philippines

   c. Limer, Peru d. Elbaton, Mexico

   Ans: a

3. Seed multiplication ratio for potato is

   a. 1:4 b. 1:8 c. 1:12 d. 1:16

   Ans: a

4. Best suited season for planting TPS

   a. April-May b. May – June

   c. June – July d. July – August

   Ans: a

Lecture No. 15

Seed production in potato

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Potato has special seed production problems as the quality characteristics of seed potatoes are influenced by a number of factors and important amongst them are the diseases and pests namely, viruses, fungi, bacteria and nematodes. Once the seed tuber is infected by the pathogens, especially viruses which enter through the plant system, the plant growth therefore declines and the yield reduces progressively. It is therefore, important that seed stocks should not only be genetically pure but also should be in right physiological condition and disease free at the time of planting. Seed production technology developed for seed potato production, thus aims at producing disease free, genetically pure seed. There are now two independent channels of seed production for hills and plains.

Fig. 1.Flower bud of potato

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Plain seed: The seed produced in plains at suitable locations is called 'plain seed'. Northern plains have emerged as an important source of potato seed production. The low aphid plains seed is in right physiological condition at the planting time and yields higher than the traditional hill grown seed.

Once healthy seed potatoes are introduced into the system of growing them during low Aphid period accompanied by a systematic insecticide application, roguing

and removal of haulms before the aphids attain critical number and the re-growth is checked, the health standards for the seed crop could be maintained for a number of generations. This system of seed potato production has been designated as 'Seed Plot Technique'.

Stages of seed production

For seed multiplication and certification purposes following stages are recognized. BS - FS I - FS II - CS I – CS II.

CS II: This is done in case of those varieties which have a low rate of multiplication and in years of shortage of seeds.

Land requirements

A crop of seed potato shall not be eligible for certification if grown on land infested with wart and/or cyst forming nematodes; or brown rot or non-cyst forming nematodes within the previous three years; and common scab. Preference should be given to two to three years crop rotation.

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A minimum isolation distance of 5 m for foundation and certified seed class should be provided all around a seed field to separate it from fields of other varieties, and fields of the same variety not conforming to varietal purity and health requirements for certification.

Time of Sowing

The sowing should be done from 20th September (when rainfall is low) or 25th September up to 15th October. Delayed plantings will result in poor yields.

Seed rate

Seed rate depends upon tuber size. Twenty five to 30 qtls of seed potato per hectare will be sufficient if the usual sized tubers (4 to 6 cm) are used.

All size of tubers like large, medium and small may be utilized as seed, but the medium size (25 – 55 mm or 25-75 g) often called as seed size performs better than other size grades as seed material.

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Method of sowing

Whole tubers should be used for planting. Tubers should be under sprouting (sprouts 0.5 to 1 cm long) for quick emergence. After 15th October when the temperature goes down, cut tubers can also be used for planting. Care must be taken that each piece to be used for planting has two or three emerging eyes and weighs at least 40 gm. By this practice the seed rate is reduced considerably. Plant the tubers 3 to 4 cm deep in the soil having adequate moisture. Row to row spacing at 60 cm and tuber to tuber spacing at 15 to 20 cm is recommended.

Irrigation

Potato requires light and frequent irrigation. First irrigation should follow immediately after emergence. Subsequent irrigations should be given at proper intervals. Restrict the irrigation after the crop has tuber raised well. Withhold irrigation by the third week of December i.e., ten to fifteen days before cutting of haulms.

Interculture

Keep the field free from weeds. At least one earthing up is a must. It should be done when plants attains the height of 15 cm.

Haulm cutting

The practice of haulm cutting is adopted as a precautionary measure to avoid chances of viral disease transmission through the vectors like aphids. The haulms must be cut by the end of December, or at the latest by the first week of January before the aphid population reaches the critical stage (20 aphids per hundred compound leaves). No re-growth should be allowed.

Roguing: Very careful roguing is required for producing a high quality crop of seed potato. The roguing is to be done at the following stages.

First roguing: First roguing should be done 25 days after sowing to remove: a) All virus affected plants and b) All plants apparently belonging to other varieties and which can be identified from foliage.

Second roguing: It should be done when the crop is fully grown. This would be about 50 to 60 days after sowing. At this time tubers are formed and therefore, while roguing,

not only the upper portion of plant, but all the tubers belonging to the plant should be removed carefully. Also at this stage the virus affected plant as well as off type, should be removed.

Third roguing: This is the third and final roguing and should be done just before cutting the foliage. Foliage should not be cut unless this roguing has been completed. At this stage, all virus affected plant and off type plants, along with their tubers have to be very carefully removed.

Harvesting

a. The crop is ready for harvest ten to fifteen days after haulm cutting when the skin of tuber has hardened. Premature harvesting causes handling problems, as the soft skin gets easily peeled of and further such tubers cannot withstand long transportation and storage.
b. At the time of potato digging, the moisture in soil should be optimum for obtaining clean tubers.
c. The harvesting of seed potatoes can be done by any of the equipment available in the market for this purpose. Every effort should be made to avoid cuts, bruises, etc. After harvesting, tubers should not be left exposed to the hot sun for a prolonged period (not more than an hour). It should be immediately lifted and carried to an airy shed and kept in piles (height 1 m, width 3 m) for 7 to 10 days so that the superficial moisture evaporates and further hardening of skin is achieved. If sheds are not available, piles may be made in field and covered with dry haulms.

Sorting and Grading

When the potatoes are properly cured, grading should be done. A single grade from 3.0 to 5.5 cm is being made at present for `Plain Seed' by hand grading. While grading, the shape, colour, depth of eyes, etc. of tubers should be critically examined and off types discarded. In addition to off types, the tubers with cuts, bruises, cracks or otherwise mechanically damaged or showing visible symptoms of late blight, dry rot, charcoal rot, wet rot, scab, black scruf, etc. should invariably be removed.

Seed standards

Size of seed tuber: 4-6cm x 2.5 to 3.5cm in diameter; weight: 20-40g

Packing

After sorting and grading the seed potatoes should be put in clean jute-hessian bags (50 kg size) and the bags appropriately labeled.

Storage

Soon after packing, the seed potatoes should be moved to the end use areas for cold storage. If the ambient temperatures are above 32°C, the seed potato should first be kept in pre-cooling chambers, or in a cool place for preconditioning, and then stored in cold storage at temperatures from 2.2 to 3.3° C and 75 to 80 % relative humidity. Periodic inspection of seed stocks in cold storage is necessary, to ensure that stocks are keeping good. Turning of bags during rainy season helps in improving aeration.

Potato is traditionally grown vegetatively through seed tubers. This results in continuous accumulation and increase of various tuber borne diseases in seed tubers and consequent reduction in crop yields. To overcome these problems a new potato production technology making use of True Potato Seed (TPS) as planting material for raising the crop has been developed. TPS can serve as a cheap and highly productive planting material for raising commercial potato crop, especially in areas where good quality seed tubers at reasonable prices and in adequate quantities are not available.

The major advantages of this technology over the traditional seed tuber technology are as follows:

1. Unlike the seed potato production which is confined to northern India only, the TPS can be produced in all potato growing regions.
2. The crop raised through TPS is almost disease free as most of the diseases get filtered out during TPS production.
3. The TPS being very small, can be stored and transported easily, whereas the seed tubers are bulky hence the storage and transport are expensive.
4. TPS provides a low cost potato production technology where only about 50 g TPS is required for sowing in about 375 m^2 area for producing seedling tubers enough for planting one hectare next year. About 150 g TPS/ha is required if the commercial crop is to be raised in the first year itself by transplanting seedlings in field.

The TPS technology involves two major steps *viz.,*

(a) Production of hybrid seeds and

(b) Its used as planting material for raising the commercial crop.

Two high yielding TPS hybrids *viz.,* TPS C-3 and HPS 1/13 have been recommended for commercial use.

Hybrids and their parents

TPS C-3	**:**	JTH/C.107 X JEX/A 680-16 (Female x Male)
HPS 1/13	**:**	MF.1 x TPS-13 (Female x Male)

Production of Hybrid TPS

The hybrid TPS can be produced both in the hills, where the crop is grown during long summer days and also in the plains where the crop is grown in winters. Whereas, in the hills the crop flowers natural and hybridization for seed production can be done easily; in the plains, however, additional light has to be provided to induce flowering in the crop. In northern plains, where the winters are severe, the parental lines need to be planted either about 15-20 days before optimum time of the planting of the crop, or the planting is delayed till the second week of November so that the flowering time does not coincide with the severe winter period. Delayed planting of parental lines should not be done in frost prone areas.

Following steps are involved in the production of hybrid True Potato Seed (TPS)

1. If the TPS parents are planted in the plains, there is generally need to provide extra light for about 5 hours at the end of the day to prolong the day length and get proper flowering. Arrangements can be made for providing light from 150 W sodium vapour lamp (one for about every 100 sq.m). Light arrangement is not required if the parents are planted (in April/May) in the northern hills during summer crop season.
2. Plant male and female parental lines (TPS-13 as male and MF-1 as female for producing hybrid TIPS HIPS V13, and JEX/A 680-16 as male and JTH/C-107 as female for producing hybrid TPS of C-2) in two separate but adjacent blocks. The

area required for planting male block is generally kept at about 1/4 to 1/6 of the female block, depending on pollen producing ability of the male parent.

3. Plant the male block about a week before planting female block during the main crop season in the plains. Follow the spacing of 60 x 20.cm.
4. In the female block, prepare beds of three rows each. For this, draw 3 rows at 50 cm inter-row distance leaving 80 cm walking space between two adjacent beds. Plant tubers at 15 cm intra-row distance.
5. Use about 30 g size seed tubers or the seed pieces for planting female block. After germination, trim the plants in female block to retain a single stem per plant.
6. Follow all other cultural and plant protection practices for potato crop.
7. In the plains, after the germination is complete, switch on the light in hybridization block in the evening before sunset for a period of 5 hours every day. This will facilitate rapid plant growth and flowering in the parental material.

Hybridization

When the parental material comes to flowering, follow the steps given below to produce hybrid TPS

i. Trim the flower bunches in the female plants to retain only 6-8 large size buds per bunch. Very small buds, old flowers and berries if any, should be removed from the bunches and prepared for pollination next day.
ii. Collect flowers from the male parent in the evening preceding the day of pollination. Only just opened flowers with anthers that are about to shed pollen or the large size buds, which would open next day, should be collected.
iii. Spread flowers of the male parent on a sheet of paper placed on the table at room temperature and use them for extracting pollen next morning.
iv. Extract the pollen in a small dish by shaking anthers using electric buzzer or manually.
v. Pollinate the flowers of the female parent by dipping the stigma in pollen or applying pollen to the stigma using a brush. Do the first pollination between 8-10 AM and re-pollinate the flowers at the same time next day. Continue the process of

pollination till the flowering period of the crop is over. Usually there are two flushes of flowers during the crop period.

vi. Store the left over pollen in small vials, keep the vials in desiccators and place the desiccators in refrigerator at 6-10° C for the use of next day, if necessary. It is advisable to use fresh pollen for pollination every day.

vii. Provide support (use sticks) to the stems of female plants.

viii. After berries are formed, the berry bunches should be covered with thin muslin cloth bags of about 8 x 12 cm size.

Seed extraction and storage

i. Collect well developed berries about 50-55 days after pollination, keep them in trays and allow them to ripen at room temperature for a period of about 2 weeks.

ii. Mash the soft ripe berries.

iii. After mashing the berries, separate out the TPS with a high pressure water source. Treat the seed and pulp mass with 10% hydrochloric acid (HCI) with continuous stirring for 20 minutes. Wash the seeds with water at least 3-4 times to ensure complete removal of HCl.

iv. Immediately after washing, surface disinfect the seeds by soaking in 0.05% solution of Sodium hypochlorite for 10 minutes and again wash with clean water to ensure that there is no sodium hypochlorite solution on seed.

v. Spread the seed in a thin layer on muslin cloth stretched over a wooden frame and keep the frames in a well ventilated room preferably under fan for 24 hrs, in shade. TPS can be safely dried in any type of low moisture environment i.e. forced air oven, fan etc. Temperatures above 30^0C should be avoided during the initial seed drying period. Thereafter, seeds can be safely dried under temperatures not exceeding $40^0\text{C} \pm 5^0\text{C}$.

vi. Expose the shade dried seeds to warm sun for about ½ hr to reduce the moisture content.

vii. Keep the seeds in a moisture proof container along with silica gel bags and store them at low temperatures. The seeds may be kept in polythene

lined aluminum foil covers or double polythene bags or tin cans, sealed and stored in desiccators kept in refrigerator at 6-10^{0}C or even at room temperature during the winters.

Plant protection

Pests

Nematodes: Growing potato year after year in the same field should be avoided. Crop rotation with vegetables and green manure may be followed. Application of carbofuran 3 G (1.0 kg a.i.) 33 kg/ha in furrows while seeding has to be done. For cyst nematode resistant variety Kufri Swarna, application of half dose of the above nematicide is enough.

Biological control of nematodes: Applicaton of *Pseudomonas fluorescens* at 10 kg/ha.

Aphids: Spray of methyl demeton 25 EC or dimethoate 30 EC 2 ml/lit.

Cut worms

1. Installation of light trap during summer to attract adult moths.

2. Soil drenching at collar region of the plants in evening hours with chlorpyriphos or endosulfan 2ml/lit a day after planting.

White grub

1. Summer ploughing to expose the pupae and adults.

2. Quinalphos 5 D at 25 kg/ha 10 days after first summer rains.

3. In endemic areas application of phorate 10 G at 25 kg/ha during autumn season (August - October) is recommended.

Potato tuber moth

2. Installation of pheromone traps at 20 No/ha.

3. Earth up at 60 days after planting to avoid potato tuber moth egg laying in the exposed tubers.

4. Foliar spraying of NSKE 5 % or quinalphos 20 EC 2 ml/lit (ETL 5 % leaf damage).

5. Seed tubers treated with quinalphos @ 1 kg/100 kg of tubers.

Diseases

Late blight: Spraying of Mancozeb 2 g/lit or Chlorothalonil 2 g/lit on 45, 60 and 75 days after planting. Growing of late blight resistant varieties like Kufri Jyothi, Kufri Malar and Kufri Thangam.

Brown rot: Proper drainage facilities are important. Affected plants are removed and destroyed.

Early blight: Spraying of Mancozeb 2 g/lit or Chlorothalonil 2 g/lit at 45, 60 and 75 days after planting.

Virus diseases: Virus free potato seeds should be used. Virus affected plants are rogued regularly. The aphid vectors are controlled by spraying of Dimethoate or Methyl demeton 2 ml/ha.

Questions

1. Match the following

Tuber	-	2-3 years rotation 4
Light	-	Harvest 3
Haulm cutting	-	Stem 1
Disease free	-	True seed 2

2. International Research Centre for Potato is located in

   a. Cali, Columbia b. Manila, Philippines

   c. Limer, Peru d. Elbaton, Mexico

   Ans: a

3. Seed multiplication ratio for potato is

   a. 1:4 b. 1:8 c. 1:12 d. 1:16

   Ans: a

4. Best suited season for planting TPS

   a. April-May b. May – June

   c. June – July d. July – August

   Ans: a

Lecture No.18

Seed production technology in turmeric and ginger

Turmeric (*Curcuma longa* L)

Botany

It is an herbaceous perennial with a thick under ground rhizome giving rise to primary and secondary rhizomes called fingers. The leaves are broad with long leaf stalks. The flowers are borne on separated peduncle arising directly from the rhizome. There are four important species of Curcuma. They are 1) *Curcuma longa*, the widely cultivated type 2) *C. aromatica*, the Cochin turmeric or kasturi manjal 3) *C. angustifolia,* East Indian Arrow root having plenty of starch in its rhizome and 4) *C. amada,* mango ginger, which has the taste and flavour of raw mango.

Floral biology

The anthesis starts from 7 a.m. and continued up to 9 a.m. The maximum number of flowers (72%) opened before 8 a.m.

Fig.1. Flowers of turmeric

Varieties

CO-1, CO-2, BSR-1, BSR-2, Suguna, Suvarna, Sudharashana, Krishana, Sugundham, Roma, Suroma, Rajendra Sonia, Ranga, Rasmi

Preparation of land

The land is prepared with the receipt of early monsoon. Soil is brought to a fine tilth by giving about four deep sloughing. Weeds, stubbles, roots etc. are removed. Immediately after the receipt of pre monsoon showers, beds of 1 to 1.5 m width, 15 cm

height and of convenient length are prepared with a spacing of 40 to 50 cm between beds. Planting is also done by forming ridges and furrows.

Planting

Kerala and other West Coast areas where the rainfall is sufficiently early crop can be planted during April-May with the receipt of pre monsoon showers. In Andhra Pradesh and Tamil Nadu, sowing is done during May-June or July-August. Since turmeric is a shade loving plant, castor or *Sesbania grandiflora* may be raised along the border lines in the field.

Seed materials

Whole or split mother rhizomes weighing 35 to 44 g are used for planting. Well developed healthy and disease free rhizomes are to be selected. Rhizomes are treated with 0.3% Dithane M-45 and 0.5% malathion for 30 minutes before sowing. Two system of planting viz., flat beds and ridges and furrows methods are adopted in India. Small pits are made with a hand hoe in the beds in rows with a spacing 25 x 30 cm and covered with soil or dry powdered cattle manure. The optimum spacing in furrows and ridges is about 45 to 60 cm between the rows and 25 cm between the plants. A seed rate of 2500 kg of rhizomes is recommended to plant one hectare.

Manures and manuring

Farm yard manure @ 10 t/ha is applied as basal dressing. The other NPK recommendation followed for Tamil Nadu (Irrigated condition).

Manure	(kg/ha)
Neem cake	200-basal
N	225 kg each at basal, 30,60,90 and 120 days after planting *i.e.*, 125 kg N
P_2O_2	60 kg as basal
K_2O	60 kg as basal
$FeSO_4$	30 kg basal

Mulching

The crop is to be mulched immediately after planting with green leaves or banana psuedostem or sugarcane trash at the rate of 12 to 15 tonnes per hectare. It may be

repeated for second time after 50 days with the same quantity of green leaves after weeding and application of fertilizers.

After cultivation and growing as intercrop

Weeding may be done thrice at 60, 120 and 150 days after planting depending upon weed intensity. It can be grown as an intercrop in coconut and arecanut plantations. It can also be raised as a mixed crop with chillies, colocasia, onion, brinjal and cereals like maize, ragi etc. In some places, double inter cropping viz., Fenugreek + Onion in Turmeric field is followed. Depending on the soil types, irrigated crop require 15 to 20 irrigations in heavy soils and 35 to 40 in light soils. Moisture stress affects the growth and development of the plant especially during the rhizome bulking stage.

Harvesting

Depending upon the variety, the crop becomes ready for harvest in seven to nine months. Usually it extends from January-March. Early varieties mature in 7 to 8 months, medium varieties in 8 to 9 months and late varieties after 9 months.

The land is ploughed and the rhizomes are gathered by hand picking or the clumps are carefully lifted with a spade. Harvested rhizomes are cleaned of mud and other extraneous matter adhering to them. The average yield per hectare is 20 to 25 tonnes of green seed turmeric rhizomes. Curing of turmeric by sodium bicarbonate method registered the highest recovery of processed rhizome than conventional cow dung method.

Post harvest handling

Cleaning and Sorting

Just after harvesting, rhizomes are cleaned for adhering soil and roots. Harvested produce may be left over for 24 hours or so and then collected and cleaned. The rhizomes which are not fit for seed purposes, should be taken out (they are very small or very large, injured, bruised, cuts, deformed etc).

Separation

Fingers are separated from the mother rhizomes; both are suitable for seed purposes. The most effective treatment for storage is 100 gauge poly bags with 3% ventilation which exhibited 91.9 % sprouting in the field.

Plant protection

Pre planting treatment

The seed rhizomes are dipped in carbendazim 1 g/lit and phosalone 35 EC 2 ml/lit or monocrotophos 36 WSC 1.5 ml/lit for controlling rhizome rot and scales.

Pests

Thrips

Spraying of dimethoate 30 EC or methyl demeton 25 EC 2 ml/litre.

Rhizome scale

Application of well rotten sheep manure @ 10 t/ha in two splits (one basally and other at earthing up) or Poultry manure in 2 splits followed by drenching dimethoate 30 EC 2 ml/lit or phosalone 35 EC 2 ml/lit or application of Carbofuran 3 G @ 1.5 kg a.i./ha. Seed rhizomes dipped in phosalone 35 EC 2ml/lit or monocrotophos 36 WSC 1.5 ml/lit and then stored.

Nematode

Application of Carbofuran 4 kg a.i./ha twice on the third and fifth month after planting the rhizomes.

Diseases

Rhizome rot

Drenching with Bordeaux mixture 1 % or Copper oxychloride 0.25 %. Seed treatment of rhizomes with 0.3% Copper oxychloride for 30 min before storage is recommended.

Leaf spot

Spraying of Carbendazim 500 g/ha or Mancozeb 1 kg/ha or Copper oxychloride 1.25 kg/ha.

Ginger (*Zingiber officinale)*

Ginger is one of the earliest known oriental spices and is being cultivated in India both as a fresh vegetable and as a dried spice since time immemorial. Ginger is obtained from the rhizomes of *Zingiber officinale*.

Floral biology

From bud initiation to full bloom takes about 20 to 25 days and 23-28 days were required to complete flowering. Flowering sequence in ginger is acropetal

In ginger, flowering started in October and continued until early December and the peak period being in November. The flowers started to open about 3 am and anthesis occurred simultaneously.

Fruit is seldom produced, is an oblong thin walled, three-valved capsule but is rarely produced. Seeds are glabrous, small, black, arillate and perispermous.

Important cultivars

The indigenous varieties are; Maran, Kuruppampadi, Ernad Wynad local Thingpuri, Jorhat, Tinladium, Burdwan, Suprabha, Suruchi, Surari, Tura, Tuni, Malli, and Varada,

Soil

Ginger thrives best in well drained soils like sandy or clay loam, red loam or lateritic loam. A friable loam, rich in humus is ideal. However being an exhaustive crop, soil should be rich in fertility. Soil of pH 6 – 7.0 is preferred.

Climate

Ginger grows best in warm and humid climate. It is mainly cultivated in the tropics from sea level to an attitude of 1500m, both under rainfed and irrigated conditions. For successful cultivation of the crop a moderate rainfall at the sowing time till the rhizomes sprout, fairly heavy and well distributed showers during the growing period, and dry weather with a temperature of 28 to 35^{o}C for about a month before harvesting are necessary. Prevalence of high humidity throughout the crop period is desirable.

Season

The time of planting is important since the soil must be moist and not dry out since once the setts are sown and, in general, the earlier in the season the crop is planted the higher the yield, especially with rain grown crops.

Planting starts after the commencement of south-west monsoon mostly between March-June. However, ginger can be planted any time during the year in green where irrigation facilities are assured.

Seed rate

1500-1800 kg ha^{-1} and it varies from region to region.

Optimum size of planting material

In vegetatively propagated crop mostly the size and weight of the propagule require extra ordinary care for the success of the crop. The review of the researchers conducted on the characteristics of rhizome for better yield revealed that the seed weight is the primary criteria for selection of the mother rhizome. The rhizomes with weight of 15 to 150 grams or are 3-5 cm or 4-5 buds / rhizomes are recommended for better crop establishment and higher yield.

Rhizome treatment

Seed rhizome should be treated with 200 ppm ethephon for 15 minutes to increase the number of root and shoot per seed rhizome. Water soaking for 10 min. at $51^{o}C$ followed with pre-plant soaking of rhizomes in 750 ppm ethephon for increased number of shoot and resultant rhizome yield.

In Australia also rhizome treatment with etherl is recommended for increased root and shoots growth they also insist in India, the gamma radiation with rhizome reduced the root, shoot growth and rhizome yield.

Spacing

Ginger should be planted on raised beds and spacing to be given is 9" x 9" (or) 6" x 6" spacing is optimum.

Manures and fertilizers

In ginger rhizome production has been found to increase by fertilizer management, either with organic, inorganic or biofertilizers. Application of need cake @ 2t ha^{-1} and cattle manure @ 25-30 t ha^{-1} for improving the rhizome yield is recommended.

The combination of NPK levels of different doses were also evaluated worldwide and a fertilizer recommendation ranges from 40 to 225 kg for N, 40 to 90 kg for P and 40 to 180 kg for K depending on the place of production.

Mulching

Application of green leaf at 20,000 pounds per acre as mulch will enhance the yield.

Irrigation

Water requirement of ginger is 1320-1520 mm during complete crop cycle. In areas receiving less rainfall, the crop needs regular irrigation. Irrigations are given at intervals of 10 days with a total to 16-18 irrigations. Germination stage, rhizome initiation stage and rhizome development stage are critical for irrigation.

Foliar application

Foliar spray at 45 and 75 days after planting with Zn 0.3%, Fe 0.2% and B 0.2% alone or in combination increased yield.

Special operation

Earthing up

Soil stirring and earthing up are essential special operation as it helps in enlargement of daughter rhizomes, provides adequate aeration for roots and protects the rhizome from scale insects. Earthing up is mostly combined with weeding and mulching.

Physiological disorders

Deficiency	Symptom
Iron	Chlorosis

Maturation

Rhizomes are left to mature and develop their full aroma, flavour and pungency when required for oil. Time to harvest thus varies with locality and cultivar and is based mainly on local experience.

However, rhizomes can be harvested on the 180th DAP for obtaining mild ginger with good crisp texture.

Ginger can be harvested between 8-9 months after planting depending upon the variety, agro climate condition and its usage. If the rhizomes are used for vegetable purpose for preparation of ginger preserve, candy, soft drinks, pickles and alcoholic beverages harvesting should be done at 4-5 months. If it is used for dried ginger and preparation of ginger oil oleoresin, harvesting is to be done between 8 and 10 months.

Plant protection - Pests

Shoot borer

Spraying of dimethoate 30 EC 2 ml/lit or phosphamidon 40 SL 2 ml/lit.

Leaf roller

Spraying of carbaryl 50 WP 2 g/ha or quinalphos 25 EC 2 ml/lit.

Diseases

Soft rot (*Pythium* sp.)

Lack of drainage and continued dampness expose the plants to infection.

The disease spreads through the seed rhizomes and soil. In the field drenching the bed with 2.5 g/lit of Copper oxychloride or 1% Bordeaux mixture or Metalaxylmancozeb 4 g/lit. The seed rhizomes treatment with Mancozeb or Copper oxychloride 3 g/lit or 200ppm Streptocycline for 30 minutes before storage is recommended.

Leaf spot

Spraying with 1 % Bordeaux mixture or Copper oxychloride 0.25%.

Harvesting

Harvesting is usually manual, plants being carefully lifted from the soil to prevent damage.

Yield

Average yield of green varies from 15 to 25 t/ha.

Storage

Harvested rhizomes treated with CCC at 250-1250 ppm and stored with or without saw dust inhibited shoot growth during storage. After storage the rhizomes are soaked for 24 h in 50%. Coconut water is used to break dormancy (Hasanah ad Satyastuti, 1989).

Dipping ginger rhizome in imazalil of 0.8 g ai / lit gave good control of storage fungi and smoking ginger seed rhizomes once or twice before storage by spreading them on the floor resulted in a higher yield of subsequent crop than the storage of non-smoked seed in pits.

Storing of ginger seed rhizomes in 100 gauge white polythene bags (WPB) with 3% ventilation covered by dry sand was found to be more effective method of storage.

Field Standards

	FS	**CS**
Minimum isolation distance	10	5
Off types (%) max. permitted	Nil	0.5

Seed Standards

The rhizome should be clean, healthy from healthy field's plants, bold firm and conform to the varietal characteristics.

Not conforming to varietal characteristics, it should not exceed 0.10% for foundation seed, 0.2% for certified seeds.

Cut, bruised, diseased, injured rhizomes or those damaged by maggots shall not exceed more than 0.2% by weight.

Maximum tolerance limit of rhizomes showing visible symptoms caused by diseases like rhizome rot, ginger yellow and ginger maggot – FS – None, CS – None.

Questions

1. *Curcuma amada* is a species having flavour of raw mango is called as Mango ginger (True/False)
   Ans: True

2. Why is turmeric not propagated through seed?
   Ans: Flowers are sterile

3. Why are turmeric flowers found at the base of the plant?
   Ans: **The flowers are borne on separated peduncle arising directly from the rhizome**

4. Mention widely cultivated type of turmeric in Tamil Nadu?
   Ans: *Curcuma longa*

5. How is high genetic purity achieved even with 5 m ID in turmeric?
   Ans: Due to vegetative propagation

6. For planting of turmeric, which is preferred - Finger or mother rhizome?
   Ans: Mother rhizome

7. Mention chemical which is used for rhizome treatment of turmeric?
   Ans: 0.3% Dithane M-45

8. What is the physiological disorder in ginger?
   Ans: Chlorosis

9. What is the maximum isolation required for foundation seed crop of ginger?
   Ans: 10m

10. Is the foliar application is necessary for ginger seed production?
    Ans: Yes

Lecture No.19

Physiological and harvestable maturity for seeds

Seeds are ready for harvest after the attainment of physiological maturation.

1. Physiological maturation

It is the stage of accumulation of maximum dry matter within the seeds. The moisture content of the seed at this stage will be in decreasing order (25-30%) and is expressed with maximum dry weigh of seed, germination and vigour potential. The physiological maturation is represented for individual seed and this maturation will not be the same for the population, due to differential flowering habit

2. Harvestable maturation

The stage of attainment of physiological maturity by 80 per cent of the population is considered as the harvestable maturity. The moisture content of the seed at this stage will be lesser than the physiological maturation stage (18-20%). Generally the seed crop is harvested at harvestable maturity stage for getting high quality seed.

Harvesting

In general, the crop harvested at harvestable maturity will have the greater seed yield. In crops the maturation will not be always be uniform but there will be mingling of matured, immatured and over matured based on the time of anthesis and fertilization. Hence optimum time of harvest for a given seed crop is necessary as beyond the point losses will be greater than the potential seed yield. Hot dry weather conditions greatly accelerate the rate of natural seed drying on the plant. Seed moisture can form the most important indication of a crop's fitness for harvesting.

Vegetable seed crops are divided in to three groups depending on the state of seed at harvest time.

a. **Dry seed**

The seed is usually dried on the plant before harvesting e.g. okra, brassicas, lettuce, peas, beans, beet and onion.

b. Fleshy fruits

The ripened fruits are picked from the plants and dried first. The dried fruits are then opened later to remove the dried seeds, e,g. chillies, ribbed gourds and bottle gourd.

c. Wet fleshy fruits

In fruits containing a high level of moisture, the seed has a gelatinous or mucilaginous coating adhering to it. This has to be removed after seed extraction by a fermentation process or treatment with dilute acids. Such fruits are harvested when they mature and ripen. (e.g. tomato ,brinjal. cucumbers and pumpkins).

Crop	Maturity indices	Remarks
Dried Seeds		
Amaranthus	yellowish browning of inflorescence	Prone to shattering
Onion	Seeds become black on ripening in silver colored capsules.10% heads exposed black seeds.	Prone to shattering
Carrot	Second and 3rd order head turn brown	Shattering on delayed harvest
Radish	Pods become brown and parchment like	Do not shatter easily
Turnip	Plants turn to brown parchment colour	Prone to shattering
Coriander	Plants turn to light yellow or brown in colour	Prone to shattering
Peas	Pods become parchment like	Do not shatter easily
Beans	Earliest pods dry & parchment like and remaining have turned yellow	Over maturity leads to shattering and cotyledon cracking
Wet fleshly fruits		
Brinjal	Fruit turn to straw yellow colour	Wet seed extraction (fermentation, acid, alkali)

Tomato	Skin colour turn to red and the fruits are softened	
Cucumber	Fruit become yellowish brown in colour, and stalk adjacent to the fruit withers for confirming actual seed maturity.	Seed extraction - scooping, (acid, alkali, fermentation))
Watermelon	Tendrils wither on fruit bearing shoot. Skin colour of the fruit resting on the soil is pale yellow and gives dull sound on thumping.	
Squash, Pumpkin	Rind becomes hard & its colour changes from green to yellow/ orange or golden yellow to straw colour	
True potato seed (TPS)	Berries of potato becomes green to straw coloured and soft	
Bitter gourd	Fruit pulp and seed becomes red and light brown respectively	Seeds are separated manually and washed
Fruits dried before extraction		
Chillies	Green colour changes to red or yellow	Dry method of seed extraction
Bottle and Sponge gourd	Rind becomes hard and colour changes to light brown or yellow	
Vegetatively propagated materials		
Colacasia	Drying and dieing of petiole and leaves	Skin becomes tough, uproot
Zinger	Drying and falling down of pseudo-stem turning brown	Select healthy, disease free rhizomes
Turmeric	Drying and falling down of stem turning brown	Select healthy, disease free rhizomes
Garlic	The stem get dry and change in colour from green to brown	
Seed potato	Haulms get dry, droop down turn dark brown in colour	Delay leads to spoilage of seed tubes.

Method of Harvesting

The harvesting of seed or fruits is done manually or mechanically, depending upon the scale of production, cost and availability of skilled labour and or of suitable harvesting machines.

1. Hand picking

Seeds of some crops such as solanaceous fruits (brinjal, pepper, tomato), cucurbits and sweet corn are conveniently harvested by picking fruits by hand. The small seeded fruits or seed heads of vegetable crops like onion, carrot, okra or chilli can be cut with a knife or secatures. Often it is preferable to cut off the whole plant with a matchet or sickle, as in the case of lettuce, chicory, brassicas, radish and peas. The legumes are, however, usually harvested by pulling up the whole plant and then threshed to recover the seed (e.g. peas and beans). Although hand harvesting methods are labour intensive, they allow plants to be harvested individually or even at several stages of crop growth. Manual harvesting provides more protection and the maximum potential seed yield per unit area, when compared with the mechanical harvesting. In plants requiring after ripening, the larger the plant part are cut and removed with the ripening seed results in higher seed yield (e.g. the small seeded vegetable crops like lettuce and brassicas.)

2. Mechanical harvesting

Vegetable seed crop may be harvested by employing a suitable mechanical harvester, especially in the large scale commercial seed producing farms where the manual labour is costly. In the mechanical harvesting, cutting and threshing operations may be carried out by two separate machines or both the operations may be performed by a single combined machine. The cutting operations can be mechanized, using mowing-windrowing machines, which are most conveniently used for crops like peas, beans, spinach, carrot and brassicas.

Questions

Match the following

1. Identify the Harvestable maturity symptoms

1. Bhendi	-	Fruits yellow to orange
2. Snake gourd	-	Red colour fruits
3. Moringa	-	Seeds turn into black colour.
4. Chillies	-	Seeds colour turn to black
5. Coriander	-	Hairline crack
6. Onion	-	Plants turns light yellow or brown

Answer key

1. Bhendi	-	Hairline crack
2. Snake gourd	-	Fruits yellow to orange
3. Moringa	-	Seeds turn into black colour.
4. Chillies	-	Red colour fruits
5. Coriander	-	Plants turns light yellow or brown
6. Onion	-	Seeds colour turn to black

Lecture No.20

THRESHING AND SEED EXTRACTION METHODS

Carefully harvested produces are to be carefully threshed / extracted to remove the seeds from fruit / panicle / pod. Removal of seeds from dry fruits is known as threshing while that of wet fruits is known as extraction

A. Threshing / Extraction

Threshing involves beating or rubbing the plant material to detach the seed from its pod or fruit. The detached seed is then winnowed to remove chaff, straw and other light material from the seed.

Traditional threshing methods

Seed has to be extracted from dry seed heads (e.g. onion, lettuce, brassicas), dried fruits (chilli, pepper and gourds) or from fleshy fruits like tomato, cucumbers and melons in which the seeds are wet at the time of extraction. Threshing may be carried out by flailing, beating or rolling the seed containing material to separate it from other plant debris or straw. It may be performed manually, with animals or mechanically. Hand threshing is simplest and can be a cheaper method if sufficient labour is available. Seeds may be hand rubbed, beaten against a solid wall or on the ground with sickel or flail. Thickness or depth or the plant material being threshed should be sufficient to avoid damage to the seeds.

1. Mechanical threshing

Various types of threshing machines with adjustable cylinder speeds are available for extraction of vegetable seeds. The cylinder clearance, concave mesh size, airflow rate and screen size greatly influence the efficiency of these machines. Every care must be taken to avoid damage to the seed during mechanical threshing, by properly adjusting the speed of the beaters, the width of the gap between the beaters and the concave, the airflow and the sieve sizes.

Hand threshing for dry seed separation

Common method mostly performed by women labour. Relatively cheap, easy and make use of surplus local labour. Usually adopted for threshing high value vegetable seeds. Hand threshing may be done in the following ways.

a. **Rubbing** – Rubbing seeds materials with a pressure in an open-ended trough line with ribbed rubber (bamboo contained). This method is quite suitable for pod materials such as brassicas and radish.

b. **Beating –** the seed materials is beaten with the help of wooden pliable sticks repeatedly with a tolerable force as the seeds are separated but not broken.

c. **Flailing** – specially designed instruments are used for separating the seeds from the plants. e.g. Sweet corn.

d. **Rolling –** seed materials is rolled on threshing floor or tarpaulin repeatedly and seeds are easily separated.

e. Walked on – the seed material is spread on the threshing floor and children or other persons are asked to walk on the seeds materials till the seeds are separated. Seeds which have been hand threshed are usually still mixed with the plant debris and further separation is done by winnowing or sieving.

Seed extraction from wet or flashy fruits:

The selected fruits are harvested for seed in the same way that is picked for the market. The seeds extraction from wet / flash fruits can be done by the following methods.

1. Manual method
2. Fermentation method
3. Mechanical method
4. Chemical method

5. Juice and seed extraction method

1. Manual Method

(a) Maceration e.g., watermelon, (b) Crushing e.g., brinjal, (c) Scraping e.g., cucumber (d) Separated e.g., muskmelon, (e) Scooping e.g., pumpkins and (f) Extraction e.g., squashes.

1.1. Dry Extraction

Dry extraction is done either manually or mechanically. Manual extraction is by beating with pliable bamboo stick or by beating against a hard surface. Threshers (LCT) are used for mechanical extraction. In this method care should be taken to avoid mechanical injury.

1.2. Wet Extraction

It is normally practiced in fleshy fruits of vegetables like tomato, brinjal, bittergourd, snakegourd and ashgourd. Among these, extraction is easier in brinjal and ashgourd as the fleshy pulp's interference is less. Seeds are separated with pulp and are washed with adequate water and for removing the sliminess; seeds are washed with 0.1% HCI for 2-3 minutes. In chillies, dry extraction using curry powder grinder is preferable than soaking in water and squeezing off the fruit rind. In tomato seed extraction is done either by fermentation method or acid method. Alkali method (Na_2CO_3) and citric acid method are also available but are not practiced widely.

3. Fermentation Method

Fruits with pulp and seed are squeezed and kept as such for 24-48 hours. The seeds will settle down. Decayed pulp and immatured seed will float. The settled seeds are washed with more of water. The seeds are shade dried and then sun dried before using. Care should be taken to avoid germination of seed during fermentation. The seeds will be dull in colour.

4. Chemical method

i. Alkali method

This method is relatively safe and can be used for small quantities of seed in cooler temperate areas where the fermentation method is not used. The pulp containing the extracted tomato seed is mixed with an equal volume of a ten per cent solution of sodium carbonate (washing soda). The mixture is left for up to 48 hours at room temperature and after washed out in a sieve and subsequently dried. This method is not suitable for commercial seed production as sodium carbonate tends to darken the testa of the seed.

ii. Acid method

Acid method is often favoured by large commercial seed producers as it produces a very bright clean seed. Addition of 30ml of hydrochloric acid per litre of seed and pulp mixture, stirred properly and left for half an hour then the seeds are washed thoroughly with water, sieved and dried. The benefits of this method are (i) seed extraction and drying is done on the same day, (ii) higher seed recovery, (iii) the problems of low and high temperatures are avoided, (iv) discoloured seed resulting from fermentation is entirely avoided and (v) remove external seed borne pathogens.

B. Grading

The threshed produces are precleaned either manually or mechanically and are graded using different but optimum sieve of specified sizes. This grading brings homogeneity in the lot which aids in obtaining uniformity among the population in the subsequent sowing.

Sieve size recommened for different crops

Crop	Sieve size (Perforated round metal sieve)
Tomato	- 5/64
Chillies	-5/64

Brinjal	- 5/64
Bhendi	- 10/64
Gourds	-16/64
Onion	- 5/64

In some crops weight grading is used for upgrading

Crop	**Weight grading technique**
Bhendi	Water floatation technique
Marigold	Floatation technique with acetone

Questions

1. Identify the threshing methods

a. Maceration - Brinjal

b. Crushing - Watermelon

c. Scraping - Squashes

d. Separated - Pumpkin

e. Scooping - Muskmelon

f. Extraction - Cucumber

Answers

a. Maceration - Watermelon

b. Crushing - Brinjal

c. Scraping - Cucumber

d. Separated - Muskmelon

e. Scooping - Pumpkin

f. Extraction - Squashes

Lecture No.21

Drying principles and methods

Seed Drying means …

Removal or elimination of moisture from the seed to the required level is called drying. Drying of seeds is done by following methods:

1. Sun drying(Natural Drying)
2. Forced air drying (Mechanical drying)
3. Use of desiccants (Chemical) for drying

1. Natural Drying (or) Sun drying

Here the seeds are uniformly spread over clean dried yard and allowed for drying to the required moisture level. The seeds should not be dried under hot sun during 12.00 noon to 2.00 pm as it causes damage to seeds by UV rays. This method depends on weather conditions, which are unpredictable one.

Advantages

- Easy process
- Cheap method
- Requires no additional equipment
- Does not require any expenditure on electricity or fuel

Disadvantages

- More chance for mechanical admixture
- Seed loss is more while drying due to insects, birds and animals.
- Takes long time for drying.
- Uneven drying.
- High weather risk and damage due to sudden rain or heavy wind.

2. Mechanical drying (or) artificial drying

Forced air is used for seed drying by the following three means.

a. Natural air drying: Natural air is blown upon the seeds using suitable air blower for drying. Continuous drying is possible in this method. In modern seed godowns provisions are made to forcible circulation of air with the help of electric blower or fan**.** If

the outer air is comparatively dry, this method is followed. So it is possible only during dry months.

b. Drying with supplemental heat: Small quantity of heat is applied to raise the air temperature to 10-20^0 F for reducing the relative humidity of air used for drying. In this, drying is performed quickly due to use of dry air, but continuous drying for long period affects seed quality.

c. Heated air Drying: The air is heated considerably as much as by 100^0 F (40^0 C) and used for drying the seeds. Very quickly the seeds get dried. The seeds should not be continuously dried as it causes damage to seed. High moisture seeds should be dried by this method.

Advantages

- Quick method
- Perfect drying is possible even under unfavourable weather condition.
- Seed loss is minimized.

Disadvantages

- Requires specialized equipment and machine, which is costly.
- Care should be taken while drying the seed using hot air, as it causes damage to the seed.
- Tempering is to be followed while drying the seed in this method.

TYPES OF DRIER

- Metal bin drier
- Vegetable seed drier
- Batch drier

Here the seeds are placed in a metal bin and the heated air is blown in to the bin through the perforations made at the bottom of the bin. In this uniform drying of all layer is not possible for which decide the thickness of the seed layer to be taken to the bin and also have to stir the seed manually or mechanically at regular intervals.

Vegetable seed drier

In this drier, the seeds are separated over the bottom screen seed trays which are kept inside chamber or cabin. The heated air is passed to dry the seed. The heat is

generated by electrical source and the air is passed through trays. Here uniform drying is possible.

Batch-Drier

In bin batch dryers, the seed is placed in a (usually round) bin, and ambient or slightly heated air is blown through it by a fan. The maximum thickness of the seed layer in the bin depends on the initial moisture content, the type of seed, the air temperature and RH and fan horse power. To obtain a uniform airflow through the seeds, a full perforated floor is required.

A layer of seed 0.8 to1.0 m at 20% moisture can be dried to 14% within 24 hrs without affecting germination at 30-35^{0}C and 50-60%RH air at a rate of 5-8m^3 per minute per m^3 of seed.

After the seed in a bin has reached the acceptable average moisture content, a moisture gradient will remain from the top to the bottom of the seed. The surface layer will have a moisture content above the average and the bottom layer of the bin will be lower than average. Thus, proper mixing of the seeds is essential before further storage or packaging. This can be addressed by installing one or more grain stirrers to mix the entire content of a bin for 3-12 hours.

Wagon Batch- Dryer

A seed transport wagon can be transformed into a wagon batch-dryer by equipping it with a plenum, a perforated floor, and a fan/heater unit coupled with a canvas transition to the wagon. The drying principles of a wagon batch dryer and a bin batch dryer are similar. Wagon batch dryers are most frequently used for drying fragile seeds such as large-seeded legumes (eg. field or garden beans and peanuts). The recommended air flow rate for the ambient –air wagon drying of a 1.5m layer of peanut seeds is 0.25m^3 of air per m^2 of floor area.

3. Use of seed desiccants (Chemical drying)

In this method silica gel or fused calcium chloride ($CaCl_2$) is used to absorb the moisture from the seed and its surrounding environment.

Silica gel is of two types, as

i) Indicator type

ii) Non-indicator type

- Active ingredient in Silica gel is Lithium chloride, which is responsible for drying process. Silica gel can absorb moisture upto 15 per cent of its weight. So to get very low moisture content we can use this, which is not possible in mechanical driers.

- Indicator type will be blue in colour and on absorbing moisture, this turns to pink colour. So we can remove this and reuse after dehydration. Non – indicator type will be white in colour and remains same (white) even after absorption of moisture content. So there is no indication in this type. But this can also be reused after dehydration.

- Calcium chloride is used for most of the vegetable and flower seeds of breeding material. Here the quantity needed is more. It can absorb 10 per cent of its weight.

- The method is suitable for drying small quantities of seeds only. It is a sophisticated and costlier method.

Advantages

- Less time consuming
- Drying rate is uniform

Disadvantages

- It cannot be used in large scale
- A skilled person is required to monitor the operation

The rate of drying the seed depends upon the following factors:

- The moisture content of the seed
- The existing relative humidity and temperature of the environment
- Depth of spread of seeds
- Rate of air blow
- Drying temperature
- Size and capacity of the drier and
- Kind of seeds

Tempering

When the heated air is used for drying, moisture content in the surface layer of the seed is removed at a faster rate, while the moisture present inside tends to reach outside slowly to maintain the equilibrium. On continuous drying a pressure gradient is developed inside the seed due to difference in moisture content between the dried outer

layer and drying inner layer of the seed. This results in the damage of seeds by formation of hair like cracks in the seed. Hence tempering is to be followed. It refers to the discontinuation of drying operation for a specified period to allow the moisture present in the interior of the seed to migrate all over the exterior portion uniformly.

Questions

1. The temperature limit for heated air drying is

   a. 110^{o}F b. 65^{o}F c. 87 ^{o}F d. 168^{o}F

   Ans: a

2. Mention the name of seed desiccants used for seed drying

   a. Silica gel b. KNO_3 c. KH_2PO_4 d. $CaCO_3$

   Ans: d

3. Which is orthodox type of seed?

   a. Mango b. Jack c. citrus d. tomato

   Ans: d

4. Quick drying of seeds is possible in this method

   a. Natural air drying b. Drying with supplemental heat

   c. Heated air Drying d. None

   Ans: c

5. Calcium chloride absorbs moisture ……..% of its weight

   a. 10 b.15 c.20 d. 25

   Ans: a

Lecture No. 22

Seed processing

Seed processing is a vital part of the total technology involved in making available high quality seed. It assures the end users, seeds of high quality with minimum adulteration. In Agriculture, the term seed processing includes cleaning, drying, seed treatment, packaging and storage. Seed processing may be understood to 'comprise all the operations after harvest that aim at maximizing seed viability, vigour and health.

Purposes of seed processing

To lower the cost of further processes likes storage including transport. This is achieved by reducing the bulk of the seed lot by cleaning debris and by removing empty or fractured seed (pre cleaning)

1. To increase the longevity of seeds; by drying seeds to safe moisture content and treating with protective chemicals
2. To reduce the variability in vigour by invigorating the seeds and removing the low vigour seeds
3. To improve the uniformity in seed shape or size by grading or by pelleting.

Principles and objectives

The quality of seed is improved during processing in two ways

1. Separation of other tree seeds or inert matter and
2. Upgrading or the elimination of poor quality seeds.

The ultimate goal of seed processing is to obtain the maximum percentage of pure seed with maximum germination potential.

The threshed produce is heterogeneous in nature. Processing brings homogeneity in the produce. This homogeneity helps in obtaining uniformity in the field. Processing of seeds is carried out in approved (By Director of Seed Certification) seed processing plants.

Seed processing is to narrow down the level of heterogeneity of the seed lot by using suitable processing methods. The heterogeneity occurs in a seed lot due to following reasons:

Causes for heterogeneity

- Variability in soil for fertility, physical, chemical and biological properties
- Variability in management practices (irrigation, application of nutrients etc.)
- Variability in ability of the seedling for utilizing the inputs
- Variability in pest and disease infestation
- Position of pod or fruit in a plant or the position of seed in a pod.

This heterogeneity can be narrowed down in the processing of seeds by eliminating the undersized, shriveled, immature, ill filled seeds using appropriate sieve size. The germinability and vigour of the seed lot can be upgraded by grading the seeds according to size, specific gravity, length and density of the seeds. The inherent qualities such as germinability and vigour are exemplified by certain physical characteristics of the seed *i.e*., large size, a denser seed, optimum length etc., So, if grading is done to obtain a particular range of size, shape, length and density of the seeds, the quality of the lot is upgraded.

Requirement in seed processing

1. There should be complete separation.
2. There should be minimum seed loss.
3. Upgrading should be possible for any particular quality.
4. There should be have more efficiency.
5. It should have only minimum requirement.

Types of materials removed during seed processing

1. Inert materials
2. Common weed seeds

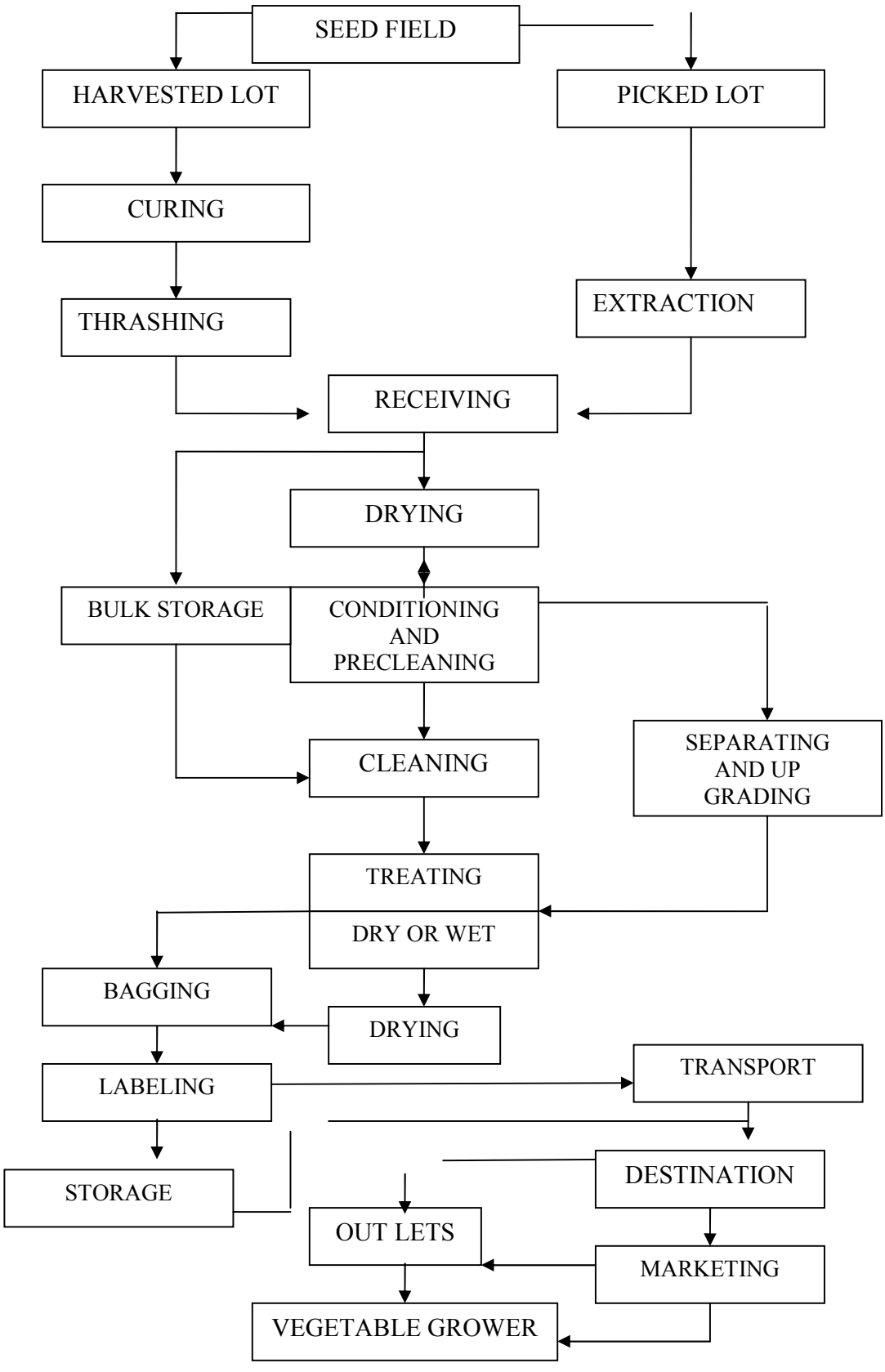
3. Noxious weed seeds
4. Deteriorated seeds
5. Damaged seeds
6. Other crop seeds
7. Other variety seeds
8. Off-size seeds

Sequence of operation in seed processing

1. Sequences of operations are based on characteristics of seed such as shape, size, weight, length, surface structure, colour and moisture content. Because each crop seed possesses individually seed structure. Therefore, sequence of operation will be applied proper equipments. However, sequences of operation in seed processing are drying, receiving, pre-cleaning, conditioning, cleaning, separating or upgrading, treating (Drying), weighting, bagging and storage or shipping.

The Sequence flow of seed lot in a processing plant is as below

Flow chart of seed processes



Questions

1. During processing care should be taken to avoid
   a. Mechanical damage b. heat damage
   b. Frost damage d. thrashing injury
   Ans: a

2. Wet extraction is the common practice of extraction in
   a. chillies b. bhendi
   c. onion d. bitter gourd
   Ans: d

3. The book on 'Seed Processing' was written by
   a. B.M. Modi b. N.P.Neema
   c. Gregg d. S.S. Atwal
   Ans: c

4. Purpose of seed processing is
   a. To increase the longevity of seeds
   b. To reduce the variability in vigour
   c. To improve the uniformity in seed
   d. All
   Ans: d

Lecture No. 23

Grading and upgrading equipments

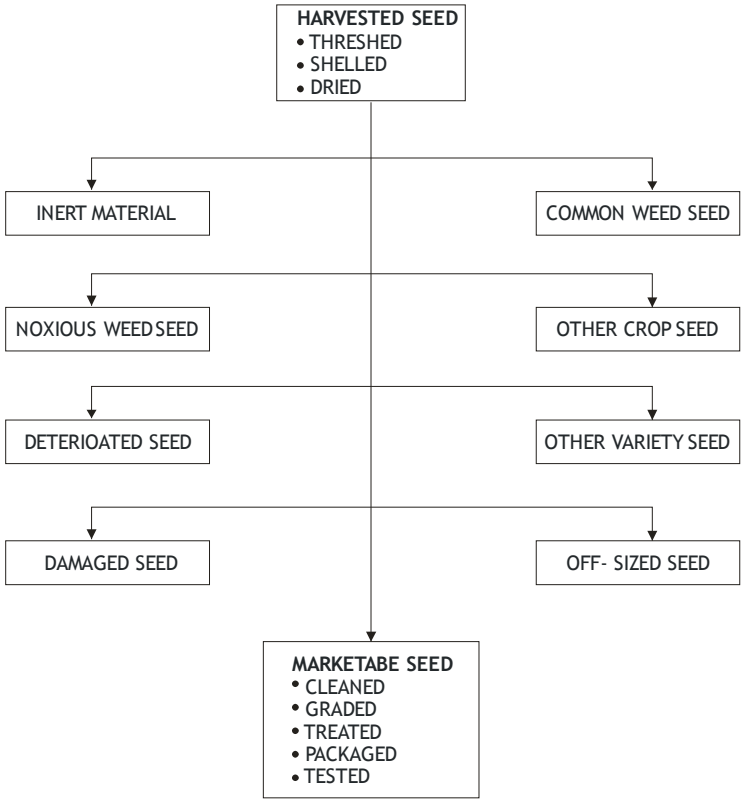
Sound seeds may be distinguished from inert matter, sterile and empty seeds by size and shape, specific gravity, colour and surface texture. Processing has well been mechanized and based on the physical characters of seed, separate machines are available for grading and upgrading, and these machines can be used either singly or in combination.

Physical characteristics of seed and the processing equipments available for grading

1	Size	:	Based on size it can be separated with air screen cleaner cum grader
2.	Length	:	Disc or indented cylinder separator
3.	Weight	:	Specific gravity separator
4.	Shape	:	Spiral separator or draper separator for round and flat seeds
5.	Surface texture	:	Rough from smooth surface seed-dodder mill
6.	Colour	:	Electronic colour separator
7.	Electrical conductivity	:	Seed differing in their ability to conduct electrical charge can be separated with electronic separator

Materials separated during processing

The second stage of cleaning is carried out with air blasts and vibrating screens and is applicable to all kinds of seeds. It is essentially the same as scalping but more refined. It is performed mostly by one machine known as air-screen cleaner.



Principles and mechanism of grading and upgrading equipments

1. Air screen cleaner

This is the most important machine of every cleaning plant. It uses screens and aspiration (air blow) for two separations (Fig.1). A coarse upper screen removes larger material, a lower fine screen stops the seeds and lets through fine matter and then the seed fraction passes through a transverse or nearly vertical air stream which can separate light impurities such as empty or partly filled seeds, husks and glumes from the seed. In most cases a number of sieves with different sized perforations are used and the cleaning is a process of gradually shifting out smaller particles. Factors which determine the quality and quantity of seed cleaned include (i) size of the perforations, (ii) the precision of the perforation, (iii) the angle at which the sieves operate, (iv) the amplitude and speed of movement of the sieves and (v) correct cleaning and maintenance of the equipment.

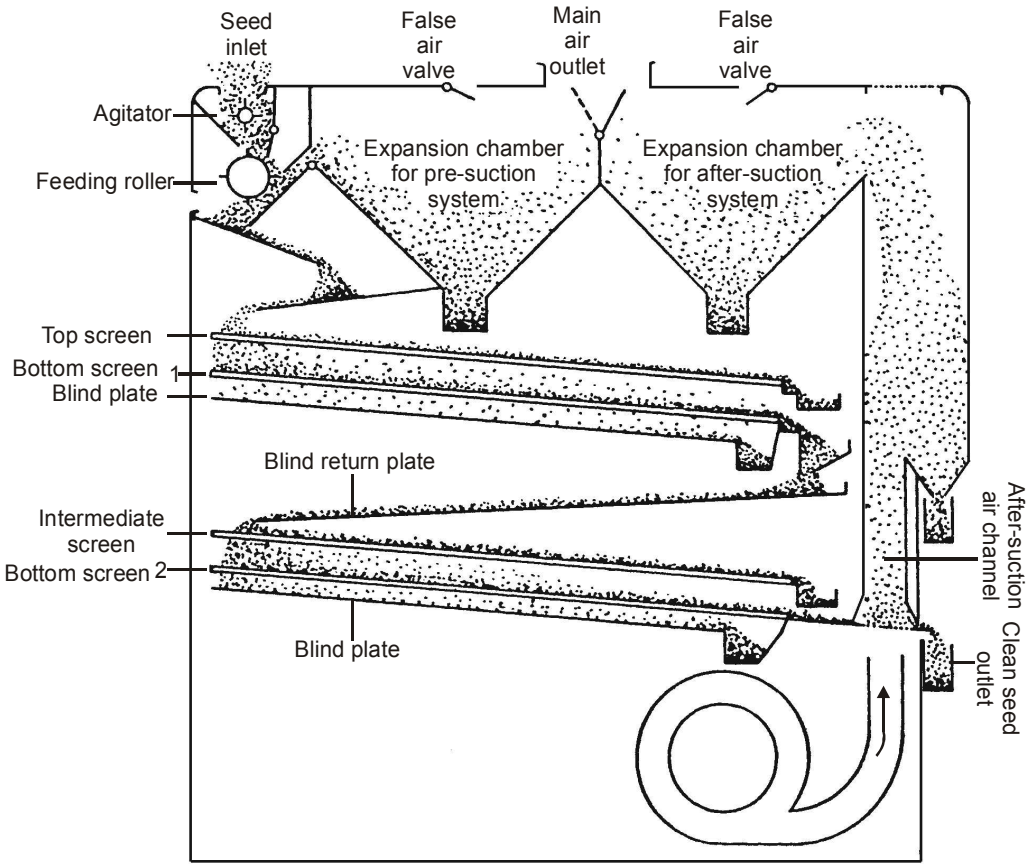


Fig. 1. Working principle of the air screen cleaner

Upgrading

Seed lots require further cleaning treatment to remove adulterants that are similar to pure seed in size and shape, to be separated by air screen cleaner. Removal of seeds larger or smaller than required size (sizing) and removal of cracked, damaged or otherwise defective seeds (grading) is accomplished in this final stage of processing.

1. Specific gravity separation

This method makes use of a combination of weight and surface characteristics of the seed to be separated. The principle of floatation is employed here. A mixture of seeds is fed onto the lower end of a sloping perforated table. Air is forced up through the porous deck surface and the bed of seeds by a fan, which stratifies the seeds in layers according to density with the lightest seeds and particles of inert matter at the top and the heaviest at the bottom. An oscillating movement of the table causes the seeds to move at

different rates across the deck. The lightest seeds float down under gravity and are discharged at the lower end, while the heaviest ones are kicked up the slope by contact with the oscillating deck and are discharged at the upper end. This machine separates seeds of the same density but of different size and seeds of the same size but of different densities (Fig.2 & 3).

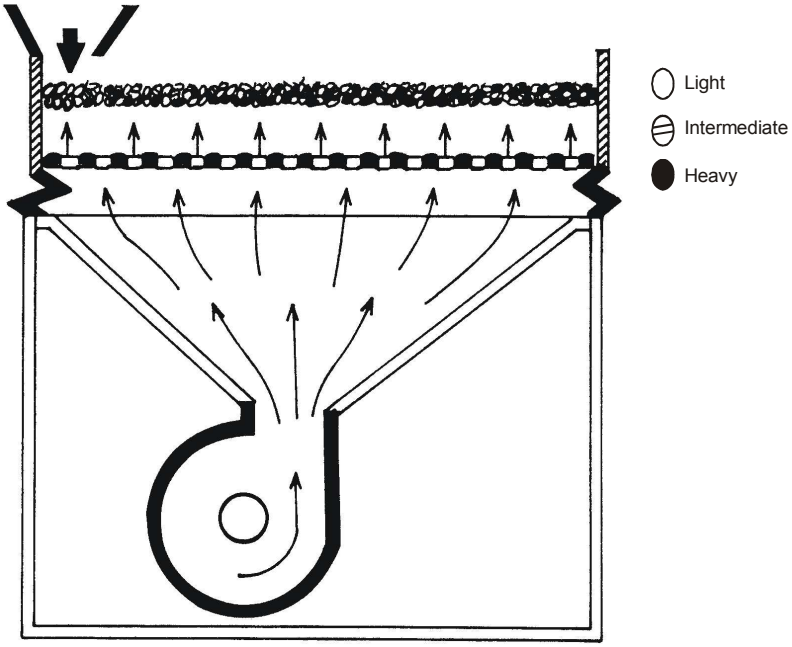


Fig.2. Working principle of the specific gravity separator

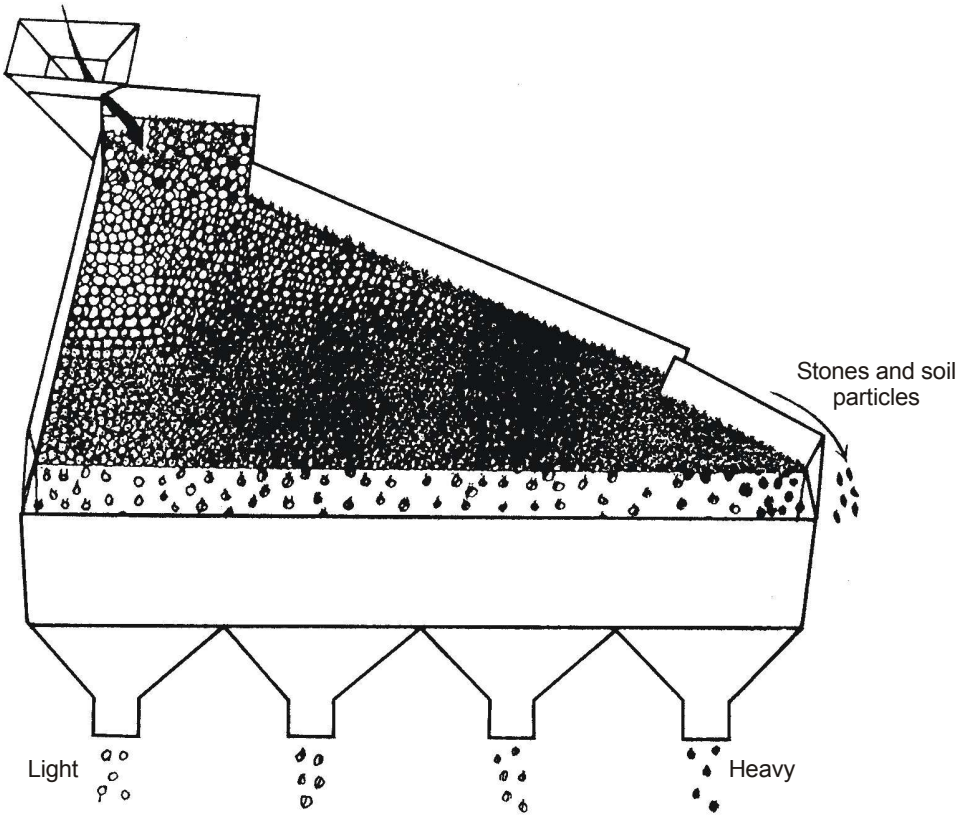
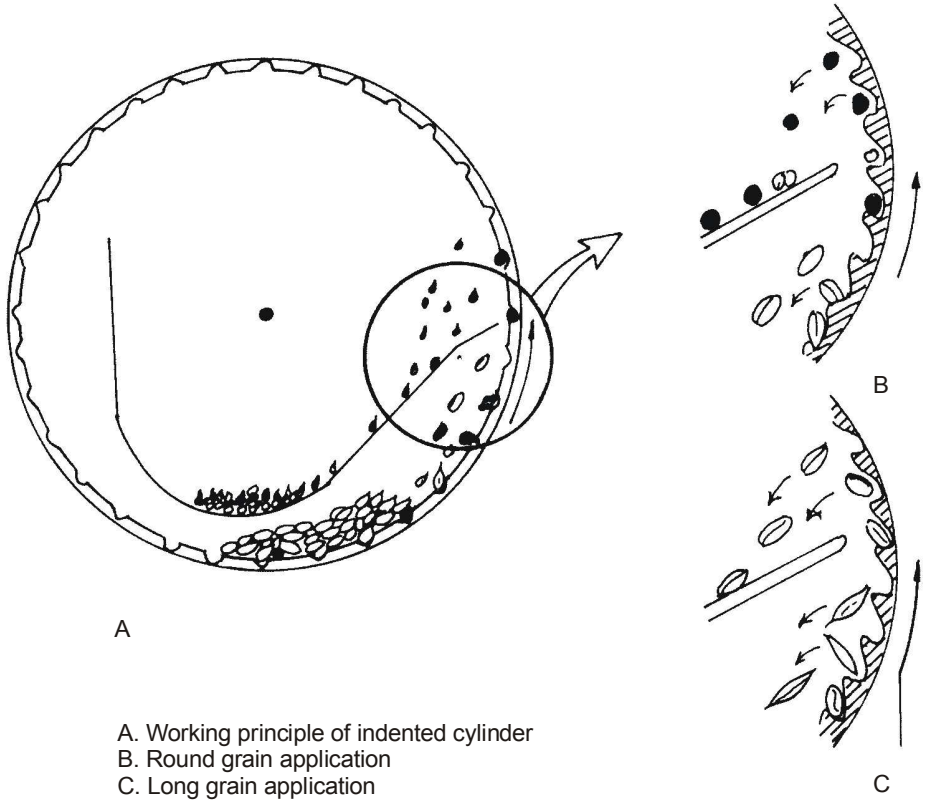


Fig.3. A specific gravity separator with triangular deck showing the different fractions: one light, two intermediate and one heavy fraction. The fifth side outer is used when soil clods are present.

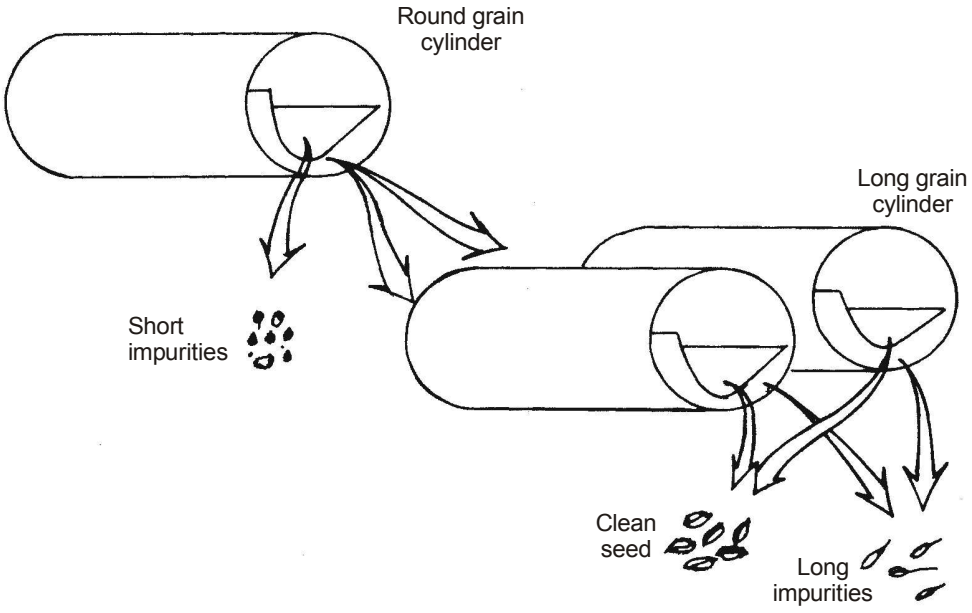
2. Indented cylinder

This helps to separate seeds according to the length. The equipment consists of a slightly inclined horizontal rotating cylinder and a movable separating trough. The inside surface has small closely spaced hemispherical indentations. Small seeds are pressed into the indents by centrifugal force and can be removed. The larger seeds flows in the centre of the cylinder and is discharged by gravity (Fig.4 & 5).



A. Working principle of indented cylinder
B. Round grain application
C. Long grain application

Fig. 4: Working principle of indented cylinder- b: round grain application c: long grain application.



The flow of seeds over the standard arrangement of one round grain and two long grain cylinders.

Fig. 5: The flow of seeds over the standard arrangement of one round – grain and two long-grain cylinders.

3. Magnetic Separator

The magnetic separator separates seed according to its surface texture or related seed characteristics. First, seed is treated with iron filings, which adhere to rough surface alone. The treated seed lot is passed over a revolving magnetic drum and separated from smooth, uncoated seed. It may help to add varied amounts of water while mixing seed and powder, depending on the seed type. At any rate, the effectiveness of magnetic separation depends on the components of the seed lot and on the powder and water used in the treating operation. The greater the difference between surface textures of the seed lot's components, more effective will be the separation.

4. Colour Separator

The colour separator is used to separate discoloured seed, greatly of lower quality. Separation based on colour is necessary because the density and dimensions of discoloured seed are the same as those of sound seed, so other machines are not effective for separation. Electronic colour separation uses photocells to compare the seed colour with "background" which are selected to reflect the same light as the good seed. Seed that differs in colour is detected by the photo cells, which generate an electric impulse. The impulse activates an air jet to blow away the discoloured seed.

5. Friction Cleaning

The air-screen combinations cannot remove debris that has a size and density similar to the seeds. However, if the debris has a different surface texture, it may be possible to remove by friction cleaning. Any object rolling or sliding over a sloping surface encounters a certain friction depending on the texture of itself and that of the sloping surface. Separation is made on a velvet cloth or rubber belt with variable inclination, which ensures that the slope necessary for the run off of the seed is different from the slope necessary for run -off of the debris. The belt continuously moves upwards and removes the debris while the seeds roll down the slope. (Fig. 6)

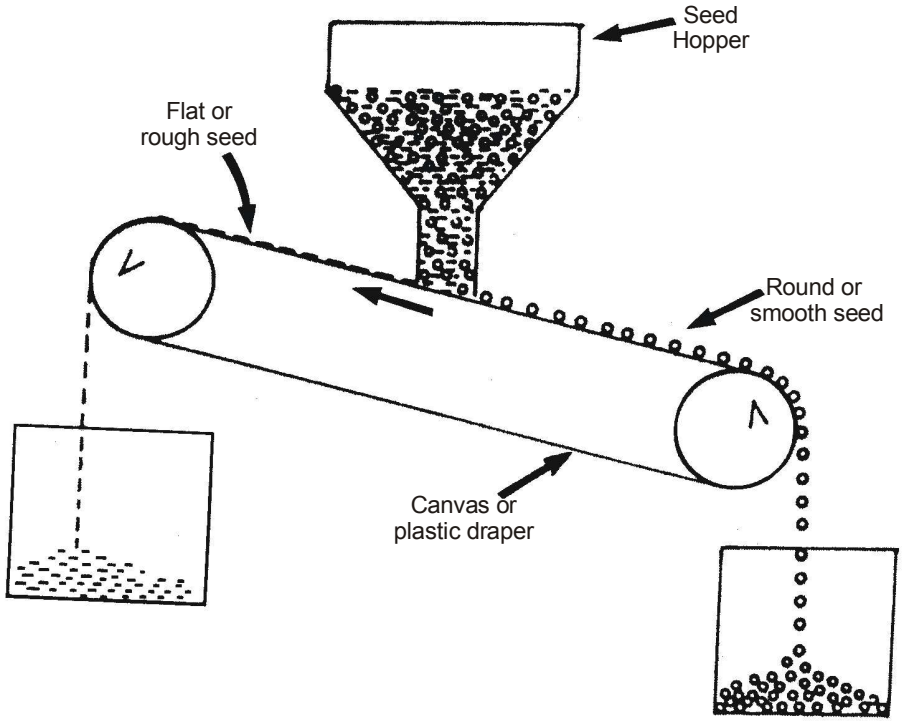
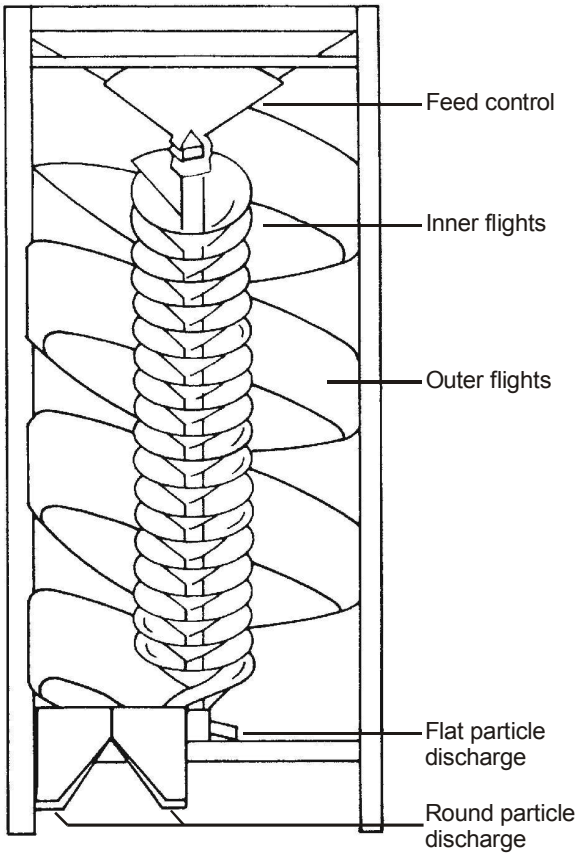


Fig. 6. Working principle of friction cleaner

6. Spiral Separator

The separator, which classifies seed according to its shape and rolling ability, consists of sheet metal strips fitted around a central axis in the form of a spiral. The unit resembles an open screw conveyor standing in a vertical position. The seed is introduced at the top of the inner spiral. Round seeds roll faster down the incline than flat or irregularly shaped seeds, which tend to slide or tumble. The orbit of round seed increases with speed on its flight around the axis, until it rolls over the edge of the inner flight into the outer flight where it is collected separately. The slower moving seed does not build up enough speed to escape from the inner flight. Most spirals have multiple inner flights arranged one above the other to increase the capacity (Fig.7).



Diagrammatic representation of a spiral separator.

Fig. 7. Working principle of spiral separator

7. Liquid flotation

Cleaning by flotation depends on the principle that the density of the seed of a given species is specific both for filled and ill filled seed. In this method, liquids with a density or specific gravity between that of the full and empty seed are used. The specific gravity of the liquids used is such that the full seed sinks and the empty seed and light debris float.

The following factors to be taken in to consideration when designing a seed – cleaning plant:

1. Handling and cleaning of the seeds should be possible without mixing or damaging seed with a minimum of equipment, personnel and time.
2. Seed separators, elevators, conveyors and storage bins should be arranged so that seeds can flow continuously from beginning to end, yet be flexible enough to bypass a machine or return part for recleaning.

3. other factors to be considered are kinds of crop seeds to be cleaned, nature of contaminants and weed seeds, volume of seed to be handled, method of handling, type of conveying system and location of shipping and receiving facilities

Cleaning usually requires a succession of operations, which can be regarded as proceeding in three stages

1. Conditioning or pre-cleaning,
2. Basic cleaning and
3. Separation and grading.

Questions

1. In seed production, mechanical admixtures in a seed lot affect the

   a. Physical purity b. Genetic purity

   c. Keeping quality of the seed d. Physiological quality

   Ans:b

2. Process of removal of all undesirable material from raw seed produce

   a. Drying b. Packaging c. Processing d. Seed treatment

   Ans: c

3. Specific gravity separator upgrade the seeds according to their

   a. weight b. length c. surface texture d. colour

   Ans:a

4. Indent cylinder separator, separates the seeds based on

   a. shape b. breadth c. colour d. length

   Ans:d

5. Basic grading is separation of seeds based on

   a. size b. shape c. surface texture c. colour

   Ans: a

.

Lecture No. 24

Seed certification

Seed certification is a legally sanctioned, scientifically and systematically designed process to secure, maintain, multiply and make available to farmers, seeds of superior plant varieties, so grown to ensure genetic purity, physical quality, high germinability and freedom from pest and diseases.

In India, the launching of seed production programmes for hybrids of maize, sorghum and pearl millet is early 1960s sowed the seed for seed industry. National Seeds Corporation (1963) was the first official seed certification agency even before enactment of The Seeds Act. Statutory support for quality control of seed and regulation of growing seed industry was provided by The Seeds Act (1966). The Seed Review Team (1967) critically examined the situation and recommended the formation of the Seed Certification Agency as an autonomous body. An amendment of the Seed Act (1972) provided for the establishment of a Central Seed Certification Board to advice the Governments on matters relating to certification and to co-ordinate the functioning of the State Seed Certification Agencies. The certification agencies are registered as autonomous bodies under the Societies Registration Act. The Seed Certification Agency of Tamil Nadu was established in the year 1979.

Phases of seed certification

1. Receipt and scrutiny of application
2. Verification of seed source
3. Field inspection to verify field standards
4. Post harvest seed inspection
5. Seed testing to verify seed standards
6. Issue of certificate , tagging , labeling and sealing

Seed certification procedures

Application for Registration as certified seed production

The person interested should register with the concerned Assistant Director of Seed Certification by remitting Rs 25/- per crop, per season.

Sowing Report

The seed producer shall apply to the Assistant Director of Seed Certification concerned. Separate sowing reports are required for different crop varieties, different classes, different stages and if the seed farm fields are separated by more than 50 m and sowing dates differ by more than 7 days and if the seed farm area exceeds 10 ha.

Registration of sowing report

The Assistant Director of Seed Certification scrutinizes and registers the seed farm and assigns a Seed Certification Number for each sowing report.

Verification of Seed Source

Verification of seed source is made by scrutiny of documents such as certification tags, sale bill of the producer to seed grower, purchase bills etc., and by enquiries during field inspection.

Field Inspection

The primary objective of conducting field inspection is to verify those factors, which can result in irreversible damage to seed quality by causing genetic and physical contamination.

The objective of field inspection is to verify the following factors:

1. Cropping history
2. Seed source
3. Unit of seed certification
4. Isolation distance
5. Genetic and physical contaminants
6. Border rows

1. Cropping history of seed field

The seeds left scattered in the field from the last crop may cause genetic or physical contamination of the seed crop by volunteer plants. Hence in the previous year or season the same crop of lower standard should not have been grown. The volunteer plants should be destroyed by irrigation and subsequent ploughing, just before sowing or planting.

2. Seed source

Source of seed of the seed crop should be approved and should satisfy the specific requirement of purity. It is verified by checking the certification tag of the source seed used for sowing.

3. Unit of seed certification

One unit shall consist of 10 hectares of seed farm if (i) seed fields are separated by not more than 50 meters (ii) planting dates do not differ by more than 7 days (iii) seed crop is of same variety and class.

4. Isolation distance

It should be provided to separate the seed crop from all possible sources of contamination during the growing period. Sources of contamination may be (i) cross pollination from different cultivars or (ii) transmission of designated diseases (iii) mechanical admixture from adjacent crop during harvest.

5. Physical and genetic contaminants

Proper roguing of physical and genetic contaminants must have been performed so as to conform to the prescribed minimum seed certification standards. In hybrid seed production field, border rows are used to provide enough pollen and it absorbs foreign pollen thus avoiding contamination of main seed crop. Besides, the planting ratio between male and female parent is also confirmed. Roguing space should also be verified wherever applicable. Necessary guidance should be given to farmers at each stage of field inspection.

6. Border rows

In hybrid seed production field, border rows are used to provide enough pollen and it absorbs foreign pollen thus avoiding contamination of main seed crop. Besides, the planting ratio between male and female parents is also confirmed. Roguing space should also be verified where ever applicable.

Stages and number of field inspection

The stages and number of field inspections required depends on the breeding system of the seed crop.

Table1. Stages of field inspection for sexually propagated crops**.**

Crop	Vegetative	Flowering	Post flowering	Pre harvest
Self pollinated varieties	-	✓	-	✓
Cross pollinated varieties	✓	✓	-	✓
Hybrids	✓	✓	✓	✓

Table 2.General factors to be observed

Vegetative stage	Seed source, cropping history, isolation distance, seed production practices
Flowering stage	Isolation distance, off-types, rogues, objectionable weeds, seed borne diseases, other crop plants.
Post flowering and pre-harvest stage	Isolation distance, off-types, rogues, objectionable weeds, seed borne diseases, other crop plants.
Harvest stage	Isolation distance, off-types, rogues, objectionable weeds,

Stages of crop inspection for vegetatively propagated crops

Potato	-	Sprouting, seedling lifting and replanting, tuberisation, tube hardening, haulm cutting stages
Cauliflower	-	Curd formation, bolting
Knol khol	-	Knob formation, bolting
Cabbage	-	Head formation

Field counts

It is impossible to examine all the plants in the seed farm. All the characters of the plant may not exhibit in a particular time. Hence 'random counting' is made at required stages of crop growth.

Table3. No. of field counts

Area of the field (acres)	No. of counts to be taken
<5	5
5 – 10	6
10 – 15	7
15 – 20	8
20 – 25	9

Table 4.Number of plants /heads per count

S.No.	Crop	No. plants / heads per count
1.	Bajra, barely, oats, paddy, sorghum, wheat, ragi	1000 heads
2.	Berseem, jute, lucerne, mesta, soyabean	1000 plants
3.	Beans, cluster beans, cowpea, pea, greengram, blackgram, horsegram, bengalgram, mustard, sesamum, niger, safflower, green leafy vegetables	500 plants
4.	Bhendi, brinjal, bulb crops, capsicum, chilli, cole crops, cucurbits, potato, cotton, maize, castor, groundnut, sunflower, redgram, root crops, tomato	100 plants

Processing

Processing report should accompany the seed lot. ODV should not exceed 1%.Yield should correlate with estimated yield. Seed should conform to prescribed moisture level and be brought to the processing plant in new containers within 2 months. Processing and sampling should be completed within 2 months.

Processing should be done only in approved seed processing unit after proper cleaning. Lot identity should be maintained throughout. Appropriate sieve size should be used except in cases of exigencies with approval from Assistant Director of Seed

Certification. Processed seed shall not have seed of the size lower than the lower than the aperture of the bottom screen used beyond 5 % by weight. Float test is done for paddy, the maximum float admissible is 5 %, or else adjust the air flow or feeding to perfect the processing. Stenciling on containers should be verified. Next lot number should be assigned and written legibly on the containers after processing.

Hand processing

It is allowed when the quality of seed lot is below 1000 kg in pulses and sunflower, 500 kg in sesamum under single seed certification number for tomato, chillies, brinjal etc., and groundnut, hand processing is allowed irrespective of quantity since required equipments are not available.

Assigning Lot No

The lot number will have four parts. Each part will signify and conform the following details.

MAR 04- 22- 10 - 01

MAR 04 First part	-	Month of harvest
MAR 22 Second part	-	State code
MAR 10 Third part	-	Processing plant code
MAR 01 Fourth part	-	Seed producer code

Seed Sampling and Testing

Processing and sampling should be completed within 2 months from the date of receipt in the processing unit. SCO (Seed Certification Officer) who takes the sample shall send the same to the concerned Assistant Director of Seed Certification within 24 hours of sampling with necessary details. He will be sent it to the STL with secret code number within 3 days. After analyses, STO (Seed Testing Officer) will communicate the result to the Assistant Director of Seed Certification. After decoding he will communicate the result immediately to the producer and SCO concerned.

Tagging and Labelling

After receiving the seed analytical reports from the STO the result will be checked with seed standard. After checking the tags the details may be filled up without any correction or omission. Seed will be treated with approved chemicals, bagged, weighed and stitched with tags and sealed. Tagging should be done within one month

from the date of test. For lots subjected to genetic purity tagging should be completed within 15 days from the date of receipt of results.

Sealing and grant of certificate

After receiving the seed analytical report, the producer will get the tag from the ADSC & affixes labels (producer's label) and tags **(Blue for C.S & White for F.S)** to the containers & sealed to prevent tampering and grant certificate fixing **a validity period for 9 months.** Tagging should be done within two months from the date of testing.

Validation

Before expiry of the seed lot the producer shall apply for validation if he desires to have the seed lot validated for a further period of 6 months. He shall do so after stocking the seed lot in an approved seed processing unit. The process of extension of validity is called "validation". Within 10 days from the date of receipt of orders from the Assistant Director of Seed Certification, SCO will inspect the seed lot. He will verify the correctness of the seed lots and ensure whether all the containers have tags and seals are intact. Later samples will be drawn and tested, if the lot conforms to the prescribed standards the SCO will extend the validity period by six months by stamping validation in the existing tags duly signed.

Seed certification agency

The functions of the Seed Certification Agency can be broadly classified into five categories.

1. Seed certification
2. Seed law enforcement
3. Grow out test
4. Issuing of certificate for transport of seeds
5. Training and Liaison

1. Seed certification

a. Outlines the procedure for seed certification, which includes submission of application, growing, harvesting, processing, storage and labeling of seeds.

b. Inspection of fields to ensure that minimum standards for seed source, land requirements, isolation, off types, pollen shedders, shedding tassels, objectionable weed plants, designated diseases and similar factors are maintained at all times.
c. Inspection of seed processing plants to seed that the admixtures of other kinds and varieties are not introduced.
d. Arrange of seed sampling, analysis of sample and issue of certificate in accordance with the provisions of the seed Act and Seed Rules.
e. Maintain the list of recognized breeders of seed, required records to verify the production of certified seeds.
f. Monitor the Breeder seed production plots by constituting a monitoring team.

2. Seed Law Enforcement

Seed inspectors will visit the premises of seed distribution agencies, inspect seed lots produced, take samples of seed, as per the procedure and have such samples tested to ensure that the seed conforms to the prescribed standards of certification. If found necessary seed inspectors can issue orders to stop the sale of seeds, seize the stocks and initiate prosecution.

3. Grow out test

It is a test of genetic purity. Samples are drawn both from the source seed and the seed produced and grown in the field along with the standard seed samples of respective variety. By comparison, it can be determined whether varietal purity and health of the seed produced are according to the prescribed standards.

The objective of grow-out-test is to determine the genetic purity of a given seed lot of a released cultivar and the extent to which the submitted sample conforms to the prescribed standards. Grow out tests are conducted for foundation classes I and II of variety cotton and tomato, hybrid cotton and its parents and hybrids of red gram, castor, tomato, brinjal, musk-melon, true potato seed and seeds of seedless watermelon. Grow out test will be conducted under direct supervision of the Director of Seed Certification

4. Issuance of certificate

Issuance of Form II to the seeds to be moved out of Tamil Nadu. Issuance of following certificate for export of seeds "Certified that the seeds to be exported are not wild species do not belong to foundation or breeder seeds".

5. Training and Liaison

(a) Orientation training

Training is given to the newly joined seed certification officers.

(b) Refresher training

Technical officers already positioned in the department are trained.

(c) Training to seed producers

Training is given on seed production aspects to Government, Quasi government and Private Seed Producers.

(d) Quality control training to seed dealers

Training is also given to seed dealers on the regulatory aspects of seed selling and seed legislation.

Questions

1. Colour of the foundation class of seed label is

   a. Blue b. Green c. Yellow d. White

   Ans:d

2. Class of seed production outside the preview of seed certification is

   a. Foundation b. Breeder c. Certified d. TFL

   Ans:d

3. The costliest seeds are

   a. TFL b. Certified Seed c. Foundation Seed d. Breeder Seed

   Ans:d

4. As per seed certification procedures the tag should be accompanied with
   a. Producer label b. processing report
   c. Seed test results d. Seed standards
   Ans:a

5. Indian seed certification is
   a. Compulsory b. Voluntary c. Tentative d. Statuary
   Ans:b

6. Indian seed certification rules are based on the rules proposed
   a. ISTA b. ISST c. OECD d. AOSA
   Ans:c

7. Azar blue color tag is enclosed with the seed bag of
   a. Certified seed b. Foundation seed
   c. Breeder seed d. Nucleus seed
   Ans:a

8. In certification, the number of counts to be taken from 6 to 10 acres
   a. 6 b. 7 c. 8 d.9
   Ans:a

9. The size of the certification tag is
   a. 15 x 7.5 cm b. 10 x 11 cm c. 15 x 10 cm d. 15 x 15 cm
   Ans:a

10. Hand processing is allowed for
    a. Tomato b.Bhendi c. Potato d. Onion
    Ans:a

11. Process of verifying the factors which cause irreversible damage to the genetic purity or seed health

a. Seed testing b. Field inspection c. Seed inspection d. Seed processing

Ans:b

12. Plants of the same kind growing naturally from seed that remains in the field from a previous crop

a. Pollen shedder b. Off type c. Volunteer plant d. Shedding tassels

Ans:c

Lecture No. 25

Seed testing

Seed testing is the cornerstone of all other seed technologies. It is the means by which we measure the viability and all the physical factors that regulate the use and maintenance of seeds. Everything that is done with seeds should have some test information to guide the work and ensure high quality. Seed tests tell if a crop of seeds is worth collecting, if handling procedures are correct, and how many potential seedlings are available for regeneration. Seed testing is the science of evaluating the planting value of seed. Seed quality in India is legally controlled by the Seed Act, 1966. The seed Act is enforced by Govt. of India through the Central Ministry of Agriculture and Co-operation and State Department of Agriculture. According to this Act all the seeds of notified varieties / kinds when sold to farmers must meet the minimum standard of germination, genetic purity and physical purity. The seed should be packed in a suitable container and a label has to be affixed on the container. Information about germination, physical purity, variety, date of test and name of the seed producer has to be given on the label. The germination as given on the label is valid for 9 months and after which it has to be revalidated.

Objectives

1. To determine their quality, that is, their suitability for planting.
2. To identify seed quality problems and their probable cause.
3. To determine the need for drying and processing and specific procedures that should be used.
4. To determine if seed meets established quality standards or labelling specifications.
5. To establish quality and provide a basis for price and consumer discrimination among lots in the market.

Brief history of seed testing

International

Organised seed testing started more than a hundred years ago as to avoid unscrupulous practices prevalent in the seed trade during the nineteenth century. The first lab for seed testing was established in Thrandt, in Saxony, Germany, in 1869 under the direction of Frederick Nobbe. A few years later in 1871, a seed testing laboratory was opened in Copenhagen, Denmark, under the direction of E. Moller Holst. Seed testing spread rapidly in Europe during the next twenty to thirty years. At the beginning of the twentieth century (1900) about 130 seed testing stations were operating in Europe. In the United States, the first seed testing laboratory was opened in 1876. In India, the first seed testing station was established in 1961.

International Seed Testing Association (ISTA)

As seed testing developed, it necessitates for the establishment of common methods of testing that would secure uniformity in evaluation and test results. This leads to the formation of the International Seed Testing Association in 1924.

The primary object of ISTA is to develop, adopt and publish standard procedures for sampling and testing seeds, and to promote uniform application of them for the evaluation of seeds moving in the international seed trade. In addition, it also promotes research in all aspects of seed science and technology, including sampling, testing, storing, processing and distribution, ISTA, developed the International Rules for Seed Testing based upon scientific evidence.

The ISTA Rules for testing seeds are followed by its member countries. In carrying out seed testing work. The introduction of the International Seed Analysis Certificate, widely used in the international seed trade, is another important achievement.

Association of Official Seed Analysis (AOSA)

The need for standardization of seed testing methods led to the formation of an organization in 1908, then known as Association of Official Seed Analyst of North America. The basic objectives of AOSA are to develop, adopt and publish rules for testing seeds, and to encourage research in seed technology.

Seed Testing Laboratory

The seed testing laboratory is the hub of seed quality control. Seed testing services are required from time to time to gain information regarding planting value of seed lots. To carry out these responsibilities effectively, it is necessary that seed testing laboratories are established, manned and equipped in a manner such that whatever samples are received could be analysed in the least possible time, so that the seed quality control work and the need of seed industry are effectively met.

Routine tests in STL

- Purity
- Germination
- Moisture

Types of samples received at STL

Service sample - Sample received from the farmers

Certified sample - Sample received from certification agencies or officers

Official sample - Sample received from the seed inspectors.

Seed sampling

Seed sampling is to draw a portion of seed lot that represents the entire seed lot.

Seed lot - It is a uniformly blended quantity of seed either in bag or in bulk.

Seed Size	Maximum quantity per lot
Larger than wheat and paddy	20,000 kg
Smaller than wheat and paddy	10,000 kg
Maize	40,000 kg

Method of obtaining working sample from seed lot

- Primary sample
- Composite sample
- Submitted sample

Working sample – used for actual testing is done in Seed Testing Laboratories

Sampling intensity

a. For seed lots in bags (or container of similar capacity that are uniform in size)

I.	up to 5 containers	Sample each container But never < 5 Primary sample
	6-30 "containers	Sample atleast one in every 3 containers but never > < than 5 P. S.
	31-400 "containers	Sample atleast one in every 5 containers but never < 10 P. S.
	401 or more	Sample atleast one in every 7 containers but never < 80.

II. When the seed is in small containers such as tins, cartons or packets a 100 kg weight is taken as the basic unit and small containers are combined to form sampling units not exceeding this weight e.g. 20 containers of 5 kg each. For sampling purpose each unit is regarded as one container.

b. For seeds in bulk

Up to 500kg	-	At least 5 Primary sample
501 - 3000 Kg	-	1 Primary sample for each 300 kg but not less than 5 Primary samples
3001-20,000 Kg	-	1 Primary sample for each 500 kg but not less than 10 Primary samples
20,001 and above	-	1 Primary sample for each 700 kg but not less than 40 Primary samples

Principles of sampling

Sample is obtained from seed lot by taking small portion at random from different places and combining them. From this sample smaller samples are obtained by one or more stages. In each and every stage thorough mixing and dividing is necessary.

Methods of sampling

a. Hand sampling

This is followed for sampling the non free flowing seeds or chaffy and fuzzy seeds such as cotton, tomato, grass seeds etc., In this method it is very difficult to take samples from the deeper layers or bag. To over come this, bags are emptied completely

or partly and then seed samples are taken. While removing the samples from the containers, care should be taken to close the fingers tightly so that no seeds escape.

b. Sampling with triers

By using appropriate triers, samples can be taken from bags or from bulk.

1. Bin samplers

Used for drawing samples from the lots stored in the bins.

2. Nobbe trier

The name was given after Fredrick Nobbe- father of seed testing. This trier is made in different dimensions to suit various kinds of seeds. It has a pointed tube long enough to reach the centre of the bag with an oval slot near the pointed end. The length is very small. This is suitable for sampling seeds in bag not in bulk.

3. Sleeve type triers or stick triers

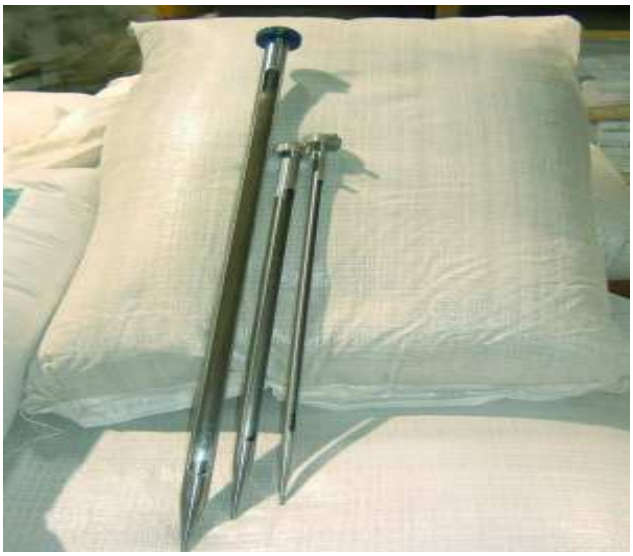
It is the most commonly used trier for sampling: There are two types *viz.,*

1. with compartments 2. Without compartments.

It consists of a hollow brass tube inside with a closely fitting outer sleeve or jacket which has a solid pointed end. Both the inner tube as well as the outer tube has been provided with openings or slots on their walls. When the inner tube is turned, the slots in the tube and the sleeve are in line. The inner tube may or may not have partitions.

This trier may be used horizontally or vertically. This is diagonally inserted at an angle of 30^0 in the closed position till it reaches the centre of the bag. Then the slots are opened by giving a half turn in clockwise direction and gently agitated with inward push and jerk, so that the seeds will fill each compartment through the openings from

different layers of the bag, then it is again closed and with drawn and emptied in a plastic bucket. This trier is used for drawing seed samples from the seed lots packed in bags or in containers.



Types of samples

1. Primary sample

Each probe or handful of sample taken either in bag or in bulk is called primary sample.

2. Composite sample

All the primary samples drawn are combined together in suitable container to form a composite sample.

3. Submitted sample

When the composite sample is properly reduced to the required size that to be submitted to the seed testing lab, it is called submitted sample. Submitted sample of requisite weight or more is obtained by repeated halving or by abstracting and subsequently combining small random portions.

4. Working sample

It is the reduced sample required weight obtained from the submitted sample on which the quantity tests are conducted in seed testing lab.

Weight of submitted sample

The minimum weights for submitted samples for various tests are as follows

1. Moisture test

100 g for those species that have to be ground and 50 g for all other species.

2. For verification of species and cultivars (genuineness of variety)

Crop	Lab only (g)	Field plot & Lab (g)
Peas, beans, maize, soybean and crop seeds of similar size	1000	2000
Barley, oats, wheat and crop seeds of similar size	500	1000
Beet root and seeds of similar size	200	500
All other genera, seed potato, sweet potato and other vegetatively propagated crops	100	250

3. For other tests like purity and count of other species

Crop	Size of seed lot (kg)	Size of submitted sample(g)	Size of working Sample for purity (g)	Sample count of other species(g)
Brinjal	20,000	1000	140	1000
Chillies	10,000	70	7	70
Bhendi	10,000	7	7	7
Tomato (variety)	10,000	100	10	100
Tomato (hybrid)	10,000	100	10	100
Cabbage	10,000	100	10	100
Cucumber, muskmelon and longmelon	1000	150	70	150
Bitter gourd	2000	1000	450	1000

The samples taken may be packed in bags, sealed and marked for identification. For moisture testing the samples should be packed separately in moisture proof polythene bag and kept in the container along with the submitted samples.

Information to accompany the sample:

Date…… Kind…… Variety ……

Class of seed…… Lot No. ……

Quantity of seed in lot (kg) ……

Tests required (1) Purity…… (2) Germination…… (3) Moisture ……

Senders Name and Address……

Mixing and dividing of seeds

The main objective of mixing and dividing of seeds is to obtain the representative homogenous seed sample for analysis by reducing the submitted sample to the desired size of working sample.

Method of mixing and dividing

1. Mechanical dividing
2. Random cups method
3. Modified halving method
4. Spoon method
5. Hand halving method

1. Mechanical method

The reduction of sample size is carried out by the mechanical dividers suitable for all seeds except for chaffy and fuzzy seeds.

Objective of mechanical dividing

- To mix the seed sample and make homogenous as far as possible
- To reduce the seed sample to the required size without any bias
- The submitted sample can be thoroughly mixed by passing it through the divider to get 2 parts and passing the whole sample second time and 3rd time if

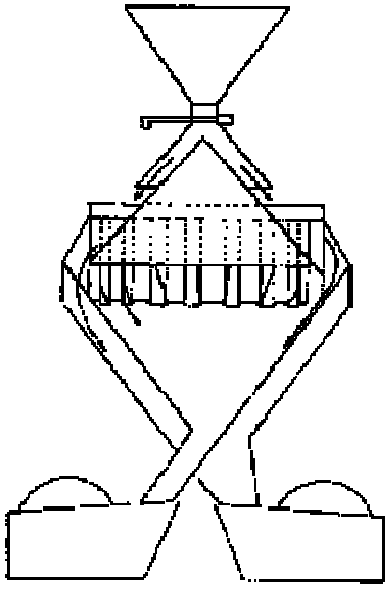
necessary to make the seeds mixed and blended so as to get homogenous seed sample when the same seeds passed through it into approximately equal parts.

- The sample is reduced to desired size by passing the seeds through the dividers repeatedly with one half remain at each occasion.

Types of mechanical dividers

a. Boerner divider

It consists of a hopper, a cone and series of baffles directing the seeds into 2 spouts. The baffles are of equal size and equally spaced and every alternate one leading to one spout. They are arranged in circle and are directed inward. A valve at the base of the hopper retains the seeds in the hopper. When the valve is opened the seeds fall by gravity over the cone where it is equally distributed and approximately equal quantity of seeds will be collected in each spout. A disadvantage of this divider is that it is difficult to check for cleanliness.



b. Soil divider

It is a sample divider built on the same principles as the Boerner divider. Here the channels are arranged in a straight row. It consists of a hopper with attached channels, a frame work to hold the hopper, two receiving pans and a pouring pan. It is suitable for large seeds and chaffy seeds.

c. Centrifugal or Gamet Divider

The principle involved is the centrifugal force which is used for mixing and dividing the seeds. The seeds fall on a shallow rubber spinner which on rotation by an electric motor, throw out the seeds by centrifugal force. The circle or the area where the seeds fall is equally divided into two parts by a stationary baffle so that approximately equal quantities of seed will fall in each spout.

2. Random cup method

This is the method suitable for seeds requiring working sample upto 10 grams provided that they are not extremely chaffy and do not bounce or roll (e.g.) *Brassica spp*.

Six to eight small cups are placed at random on a tray. After a preliminary mixing the seed is poured uniformly over the tray. The seeds that fall into the cup is taken as the working sample.

3. Modified halving method

The apparatus consists of a tray into which is fitted a grid of equal sized cubical cups open at the top and every alternate are having no bottom. After preliminary mixing the seed is pouted evenly over the grid. When the grid is lifted approximately half the sample remains on the tray. The submitted sample is successively halved in this method until a working sample size is obtained.

4. Spoon method

This is suitable for samples of single small seeded species. A tray, spatula and a spoon with a straight edge are required. After preliminary mixing the seed is poured

evenly over the tray. The tray should not be shacked there after. With the spoon in one hand, the spatula in the other and using both small portions of seed from not less than 5 random places on the tray should be removed. Sufficient portions of seed are taken to estimate a working sample of approximately but not less than the required size.

5. Hand halving method

This method is restricted to the chaffy seeds. The seed is poured evenly on to a smooth clean surface and thoroughly mixed into a mound. The mound is then divided into 1/2 and each half is mound again and halved to 4 portions. Each of the 4 portions is halved again giving 8 portions. The halved portions are arranged in rows and alternate portions are combined and retained. The process is repeated until the sample of required weight is obtained.

Questions

1. ISTA was established during

   a.1968 b. 1966 c. 1924 d. 1997

   Ans: c

2. Nobbe trier is useful in

   a. Sampling b. Dividing c. weighing d. Purity analysis

   Ans: a

3. On which samples seed testing is carried out in the seed testing laboratory?

   a. Primary samples b. Composite samples

   c. Submitted samples d. Working samples

   Ans: c

4. Seed testing is the science of evaluating seed for its

   a. planting value b. vigour c. contamination of seed lot d. health status

   Ans: a

5. The sample taken at one point in a seed lot

a. Primary sample b. Composite sample

c. Submitted sample d. Working sample

Ans: a

6. The submitted sample size for amaranthus

a. 1g b.10g c. 20g d. 100g

Ans: a

7. Seed sampling in tomato is done using

a. Stick trier b. Nobbe trier c. Spoon method d. Hand sampling

Ans: d

8. Seed testing is to be done under

a. Controlled condition b. Ambient condition

c. Cold condition d. At field condition

Ans: a

9. Boerner divider work on the principle of

a. Specific gravity b. Gravitational force

c. Other crop seed d. Damaged seed

Ans: b

10. What is the Father of Seed Testing?

a. Roberts b. M(c) Donald c. Frederick Nobbe d. R.N.Basu

Ans: c

Lecture No.26

Purity analysis and germination test for seeds

Purity analysis

The purity test is the first test to be made. Seed samples can contain impurities such as weed seeds, seeds of other crop species, detached seed structures, leaf particles and other material. The object of purity analysis is to determine the composition of the sample being tested by weight. To do this, a purity test is conducted, in which the working sample is separated into the following component parts:

i) **Pure seed** refers to the species under consideration. In addition to mature, undamaged seed, it includes, undersized, shriveled, immature and germinated seeds, provided they can be definitely identified as the species under consideration, more over it includes pieces resulting from breakage that are more than one half their original size Pure seeds includes the following:

a. Intact seeds
b. Achenes and similar fruits like caryopsis, schizocarpand mericarp with or without pedicel, perianth and whether they contain true seed unless it is apparent and when difficult to identify.
c. Pieces of seeds, achenes, mericarp and caryopsis resulting from breakage that is more than half the original size (Half seed rule). However, seeds of Leguminosae, Cruciferae and Coniferae are considered as inert matter if their seed coat is removed.
d. Clusters of Beta or pieces of such clusters with or without seeds that are retained by 200 x 300 mm sieve.
e. Florets and caryopsis of Grammae.

- Florets and one flowered spikelet's with an obvious caryopsis containing endosperm provided, also that, the caryopsis of particular genera and species have attained minimum sizes.

f. Free caryopsis

- All florets and caryopsis (except broken florets and caryopsis half or less than half the original size and in the case of *Dactylis glomerata* excluding one-fifth of the weight of multiple floret in which the sterile floret extends to or beyond the tip of the fertile floret) remaining in heavy protein after blowing at an uniform blowing speed.

With reference to specific species

Allium sp., ***Capsicum*** sp., ***Cucumis*** sp., and ***Lycopsersicon*** sp., seed with or without seed except pieces of seed more than 1/2 the original size with or without seed coat.

ii) **Other seeds** shall include seeds and seed like structures of any plant species other than that of pure seed.

iii) **Inert matter** includes seed units and all other matters and structures not defined as pure seed or other seed. It includes, seeds and seed like structures eg., achenes, caryopsis, mericarp and seeds of leguminaceae less than ½ the original size with no seed coat.

To perform purity analysis, the working sample is kept over the purity work board at the base end. A small quantity of sample is brought to the middle of the board and split into two basic components as pure seed and inert matter. The inert matter is further divided as pieces of seeds less than 1/2 the original size, stones, pieces of leaves, weed seeds, other crop seed etc. The pure seed is further divided into pure seed and other distinct variety (ODV) etc. The pure seed and inert matter are weighed upto three decimals and percentage worked out. The weed seed, OCS, ODV are counted and reported as number per kg.

Instruments

1. Seed blower

It is used to remove the light weighted inert matter from the seeds. Working sample is kept at the lower portion of the tube and the required uniform upward flow of air is regulated upto prescribed period of time. Lighter matter is separated from the sample by air flow and settle down in the partition provided in the tube of the blower. The tube is removed and inert matter is collected.

2. Diapanascope

The purity work board is provided with light source in the background which facilitates easy separation of different component. It also helps better distinguishing of red pericarp from white pericarp and short bold grains long slender grains from medium types.

The percentage by weight of each of the component parts shall be calculated to one decimal place. Percentage must be based on the sum of the weight of the components not on the original weight of the working sample, but the sum of the weights of the components must be compared with the original weight as a check against loss of material or other error. The result shall be reported to one decimal place and the percentage of all components must total 100. Components of less than 0.05% shall be reported as Trace. If the purity is less than the standard retirement the certification department will reject the seed.

Seed germination test

Principle

Germination tests shall be conducted with a pure seed fraction. A minimum of 400 seeds are required in four replicates of 100 seeds each or 8 replicates of 50 seeds each or 16 replicates of 25 seeds each depending on the size of seed and size of containers of substrate. The test is conducted under favourable conditions of moisture, temperature, suitable substratum and light if necessary. No pretreatment to the seed is given except for those recommended by ISTA.

Materials required

A. Substratum

The substratum serves as moisture reservoir and provides a surface or medium for which the seeds can germinate and the seedlings grow. The commonly used substrata are sand, paper and soil.

I. Sand

a. Size of sand particle

Sand particles should not be too large or too small. The sand particles should pass thorough 0.80 mm sieve and retained by 0.05 mm sieve.

b. Toxicity

Sand should not have any toxic material or any pathogen. If there is presence of any pathogen, found, then the sand should be sterilized in an autoclave.

c. Germination Tray

When we use the sand, germination trays are used to carry out the test. The normal size of the tray is 22.5 x 22.5 x 4 cm. They tray may either zinc or stainless steel.

B. Method of seed placement

1. Seeds in sand(s)

Seeds are planted in a uniform layer of moist sand and then covered to a depth of 1 cm to 2 cm with sand.

2. Top of sand (TS)

Seeds are pressed into the surface of the sand

C. Spacing

We must give equal spacing on all sides to facilitate normal growth of seedling and to avoid entangling of seed and spread of disease. Spacing should be 1-5 times the width or diameter of the seed.

D. Water

The amount of water to be added to the sand will depend on size of the seed. For cereals, except maize, the sand can be moistened to 50% of its water holding capacity. For large seeded legumes and maize sand is moistened to 60% water holding capacity.

II. Paper

Most widely used paper substrates are filter paper, blotter or towel (kraft paper). It should be have capillary movement of water, at vertical direction (30 mm rise / min.). It should be free from toxic substances and free from fungi or bacteria. It should \ hold sufficient moisture during the period of test. The texture should be such that the roots of germinating seedlings will grow on and not into the paper.

A. Methods

a. Top of Paper (TP)

Seeds are placed on one or more layers of moist filter paper or blotter paper in petridishes. These petridishes are covered with lid and placed inside the germination cabinet. This is suitable of those seeds which require light.

a. **Between paper (BP)**

The seeds are placed between two layers of paper

b. Roll towel method

The seeds are placed between two layers of paper and rolled in towels. The rolled towels are placed in a water source and kept in germinator or germination room.

c. Inclined plate method

Germination on glass plate with germination paper and kept at an angle of 45^0C.

III. SOIL

Should be non-caking, free from large particles. It must be free from weed seeds, bacteria, fungi, nematode and other toxic substances. Soil is not recommended for reuse.

B. TEMPERATURE

Normally most of the seeds germinate between 20-30^0 C.

C. LIGHT

Light requirement seeds should provided with light eg. Lettuce

Germination requirements for different crops

Crop	Substratum	Temp ^{0} C	First count (Days)	Final count (days)	Pre - treatment
Brinjal	TP,BP	20-30	7	14	EthreI (25 ppm) 48 hrs.
Tomato	TP,BP	20-30	5	14	
Chillies	TP,BP	20-30	7	14	(Hot water 85° C 1 min)
Bhendi	BP,S	20-30	4	21	
Onion	TP,BP	15-20	6	21	KN03
Carrot	TP,BP	20-30	7	14	KN03
Radish	TP,BP	20-30	4	10	Pre chill
Cabbage					Pre chill
Cauliflower	TP	20-30	5	10	Pre chill, KN03
Ash gourd	S	30-35	5	14	light
Biter gourd	BP,S	20-30	4	14	
Bottle gourd	BP,S '	20-30	4	14	-

TP- Top paper, BP-Between paper, S-Sand method

Germination apparatus

1. Germination Cabinet / Germinator

This is called chamber where in temperature and relative humidity is controlled. We can maintain the required temperature

2. Room germinator

It works with same principle of germinator. This is a modified chamber of larger one and the worker can enter into it and evaluate the seedlings. Provisions are made to maintain the temperature and relative humidity. This is used widely in practice.

3. Counting Board

This is used for accurate counting and spacing of seeds. This consists of 2 plates. The basal one is stationary and top one is movable. Both top and basal plates are having uniform number of holes viz., 50/100, when the plates are in different position. After taking the sample, the top plate is pulled in such a way that the holes are in one line so that the fixed number of seeds falls on the substratum.

4. Vacuum Counter

Consists of a head, pipe and wall. There are plates of 50 or 100 holes which can be fitted to the head. When vacuum is created the plate absorbs seeds and once the vacuum is released the seeds fall on the substrate.

5. Impression Board

Made of plastic / wood with 50 or 100 holes/pins. Here the knobs are arranged in equal length and space. By giving impression on the sand it makes uniform depth and spacing for seed.

D. Seedling Evaluation

ISTA classified the seedlings into different categories based on the development of essential structures

CATEGORIES OF SEEDLINGS

1. Normal seedlings
2. Abnormal seedlings
3. Hard seeds
4. Fresh ungerminated seeds
5. Dead seeds

1. Normal seedlings

Seedlings which show the capacity for continued development into normal plant when grown in favorable conditions of soil, water and temperature.

Characters of normal seedling

1. A well developed root system with primary root except in certain species of graminae which normally producing seminal root or secondary root
2. A well developed shoot axis consists of elongated hypocotyls in seedlings of epigeal germination.
3. A well developed epicotyls in seedlings of hypogeal germination.
4. One cotyledons in monocots and two in dicots
5. A well developed coleoptile in graminae containing a green leaf
6. A well developed plumule in dicots
7. Seedlings with following slight defects are also taken as normal seedlings. Primary root with limited damage but well developed seminal root system in leguminaceae (Pisum), graminae (maize), cucurbitaceae (cucumis) and malvaceae (cotton)
8. Seedlings with limited damage or decay to essential structures but no damage to conducting tissue
9. Seedlings which are decayed by pathogen but it is clearly evident that the parent seed is not the source of infection.

II. Abnormal Seedlings

Seedlings which do not show the capacity for continued development into normal plant when grown in favorable conditions of soil, water and temperature.

Types of abnormal seedling

A. Damaged seedlings

Seedlings with any one of the essential structures missing or badly damaged so that the balanced growth is not expected. Seedlings with no cotyledons, with splits, cracks and lesions or essential structures and without primary root.

B. Deformed seedlings

Weak or unbalanced development of essential structures such as spirally twisted or stunted plumule or hypocotyls or epicoptyl, swollen shoot, stunted roots etc.

C. Decayed seedlings

Seedlings with any one of the essential structures showing diseased or decayed symptoms as a result of primary infection from the seed which prevents the development of the seedlings.

III. Hard seeds

Seeds which do not absorb moisture till the end of the test period and remain hard (e.g.) seeds of leguminaceae and malvaceae

IV. Fresh ungerminated seeds

Seeds which are neither hard nor have germinated but remain firm and apparently viable at the end of the test period.

V. Dead seeds

Seeds at the end of the test period are neither hard nor fresh or have produced any part of a seedling. Often dead seeds collapse and milky paste comes out when pressed at the end of the test.

Retesting

If the results of a test are considered unsatisfactory it shall not be reported and a second test shall be made by the same method or by alternative method under the following circumstances.

1. Replicates performance is out of tolerance.
2. Results being inaccurate due to wrong evaluating of seedlings or counting or errors in test conditions.

3. Dormancy persistence or phytotoxicity or spread of fungi or bacteria. The average of the two tests shall be reported.

Use of tolerances

The result of a germination test can be relied upon only if the difference between the highest and the lowest replicates is within accepted tolerances.

To decide if two test results of the same sample are compatible again the tolerance table is used.

Reporting results

The results of the germination test is calculated as the average of 4 x 100 seed replicates. It is expressed as percentage by number of normal seedlings. The percentage is calculated to the nearest whole number. The percentage of abnormal seedlings, hard, fresh and dead seeds is calculated in the same way. These should be entered on the analysis of certificate under appropriate space. If the result is nil for any of these categories it shall be reported as '0'.

Seed standards for germination

S.No.	Crop	Class of seed	
		Foundation Seed	**Certified seed**
1.	Brinjal	70	70
2.	Chillies	60	60
3.	Bhendi	65	65
4.	Tomato	70	70
5.	Cabbage	70	70
6.	Cauliflower	65	65
7.	Carrot	60	60
8.	Radish	70	70

9.	Beet root	60	60

Questions

1. Number of seeds to be tested for assessing germination percentage as per ISTA is

   a.100 b. 400 c.200 d.240

   Ans: b

2. Germination test results are to be reported in

   a. One decimal places b. Whole number c. Two decimals d. Three decimals

   Ans: b

3. Soil dividers are used for

   a. Mixing b. Dividing c. Sampling d. a & b

   Ans: d

4. In purity analysis wings is considered as

   a. Pure seed b. Inert matter c. Other crop seed d. Damaged seed

   Ans: b

5. The pure seed fraction recommended for brinjal is

   a. 97% b. 98% c. 99% d. 96%

   Ans: b

6. As per ISTA the germination test has to be conducted with

   a. Pure seed fraction b. Whole submitted sample

   c. Whole working sample d. Submitted sample

   Ans: a

7. The light intensity required for germination of non-dormant seed in lux

   a. 150 b. 450 c. 250 d. 350

   Ans: c

8. To provide alternate temperature in a germination test, the high temperature is to be followed for

a. 8hr b. 10hr c. 9hr d. 12hr

Ans: a

9. The light intensity which favours the seed germination is

a. 700 to 780nm b. 600 to 660nm c. 310 to 450nm d. 280 to 300nm

Ans: a

10. Minimum germination percentage recommended by Minimum Seed Certification Standards for tomato is

a. 65 b. 70 c. 80 d. 75

Ans: b

Lecture No. 27

Seed treatment

The processed seeds are treated with fungicides and insecticides to protect the seed against storage pests. The purposes of seed treatment are

- **Seed disinfection –** to eliminate pathogens which have penetrated into the living cells of the seed infected it and become established, the fungicidal treatment must actually penetrate the seed.
- **Seed disinfestations –** seeds are commonly contaminated on the surface by spores or other forms of pathogenic organisms without being penetrated or infected by the organisms (*i.e.*,) destruction of surface borne organism.
- **Seed protections –** to protect the seed and young seedlings against the pathogenic organisms either under storage or in the soil.

2. Seed treating chemicals

3. Fungicides Insecticides Botanicals

1.Seed protectants

Chemicals that can be directly applied to grains are formulations of chemicals having residual toxic or repellent action or both. Those are applied directly to the grain to prevent damage by stored product pests. Eg., clay minerals (red earth, Kaolin) before 1950. Now their use is restricted only to seeds and grains meant for animal feed. These grain protectants can be applied in the form of spray/ dust on the uninfested grain.

Example

1. Pyrethrum synergized with PBO: safest of the grain protectants available and approved for use. Available as powder 1 % PBO +0.8 % pyrethrum, 0.83 lb synergist+ 0.6 % pyrethrum also be applied in the form of spray 3-5 gallons/ 1000 bushel, 0.6 lb synergist+0.066 lb pyrethrum.
2. Premium grade Malathion: Foul smell is removed. Can be directly applied over the grain as 1 % D or as a spray 57 EC. Other chemicals include: Carbaryl,

Dichlorvos, Fenitrothion, Lindane, Malathion, PBO, Pyrethroids (Deltamethrin , Fenvalerate)

Halogenation seed treatment

It is the protective treatment given to seed in the production cycle of most of the seed. In this treatment, chlorine or iodine based halogen mixtures are prepared and treated with seed either dry or as slurry treatment.

Preparation of chlorine based halogen mixture

Calcium carbonate ($CaCO_3$)is dried in an oven at 100° C for 24 hours. Bleaching powder (Calcium Oxychloride) and arappu (*Albizia amara*) leaf powders are mixed with the $CaCO_3$ in the ratio of 5:4:1 ($CaCO_3$: $CaOCl_2$: arappu leaf powder) and is kept in airtight container for impregnatim for 3-4 days. Then the mixture is used for treating the seed @ 3 g kg^{-1} of seeds. For slurry treatment, 5 ml of water per kg of seed is used for mixing the halogen mixture with the seed.

Iodine based halogen mixture

3 mg of iodine crystal is impregnated in 3 g of dry $CaCO_3$ in an air tight container for 3-4 days. The iodinated mixture is used for seed treatment @ 3 g kg^{-1} of seed.

Advantages

- It is a dual purpose treatment where seed can be used as grain on non disposal.
- It gives protection against natural deterioration by reducing the free radical formation.
- It is less harmful to human and animals.
- Maintain high germination of seeds during storage.
- Growth & vigour improved significantly
- Protect seeds from storage pests.
- Significantly reduce storage fungi.
- Enhance field establishment.
- Early plant growth.
- Leaf area and chlrophyll content increased.
- Augment crop yield.
- Chemical is eco-friendly and cost effective.

Characteristics of a good seed protectants

1. It must be effective against all diseases.
2. Cheep and easy to handle.
3. Non injurious to seed under prolonged storage.
4. Non injurious to users and non-corrosive to machineries.
5. Stable in the package on the seed or in the soil.
6. Compatible with inoculants.

Bulk treatment for stored pests

In cases of large quantities available for seed treatment ,gaseous treatment is recommended .Fumigation is the seed treatment given in the form of gas under air tight chamber. They have the advantage of (i) very rapid action against insects and (ii) it has high penetrability. The commonly used fumigants are:

Solid form – Celphos, Quickphos,

Liquid form – CTC – LB, ethylene dibromide.

The effect of fumigation depends upon

1. The moisture content of seed.
2. Concentration / dosage of fumigant.
3. Duration of treatment.
4. Degassing is important.
5. Type of fumigation.
    - Spot fumigation – are done in godowns.
    - Fumigatorium.
6. Frequency of treatment.

Advantages of seed protectants over fumigants

- Used as a prophylactic treatment
- Can be effective when the grains are stored in loose containers where fumigation is not possible
- Less dangerous than fumigants
- Don’t affect germination adversely

- One application at harvest time is sufficient for one year

Benefits or adventages of seed treatment

a) **Protects the seed from seed rot and seedling blights**
   Pythium and rhizoctonia will rot the seed even before it emerges. Mechanical injury can be protected using fungicide coating.

b) **Improves germination**
   Controlling seed borne fungi.

c) **Provides protection from storage pest**
   20% loss due to storage pest.

d) **Controlling soil insects**
   Nematodes, maggots, roots grub.

e) **Addition of nutrition**
   Addition of nutrients to the seeds by seed pelleting.

f) **Facilitate easy sowing**
   Increasing the size of seed signluation of fuzzy seeds.

g) **Inoculation of bio-fertilizers / or bio-control agents**
   To increase nitrogen fixation. *Trichoderma virida* to control wilt disease in pulses.

h) **To remove dormancy factors**
   Removal of hard seed coat – acid heat treatments.

Conditions of seed that need seed treatment

- **Injured Seed –** invasion of pathogens.
- **Diseased seed –** infected from harvest to storage.
- **Undesirable soil conditions –** cold storage, damp soil endemic to diseases like wilt, root rot etc.
- **Disease free seed.**

Equipments used for Seed Treatment

1) Slurry Treaters

Slurry Treaters

2) Direct Treaters

Direct Treaters

3) Home-made drum mixer

Precautions in Seed Treatment

Most products used in the treatment of seeds are harmful to humans, but they can also be harmful to seeds. Extreme care is required to ensure that treated seed is never used as human or animal food. To minimise this possibility, treated seed should be clearly labelled as being dangerous, if consumed. The temptation to use unsold treated

seed for human or animal feed can be avoided if care is taken to treat only the quantity for which sales are assured.

Care must also be taken to treat seed at the correct dosage rate; applying too much or too little material can be as damaging as never treating at all. Seed with a very high moisture content is very susceptible to injury when treated with some of the concentrated liquid products.

If the seeds are to be treated with bacterial cultures also, the order in which seed treatments should be done shall be as follows

i. Chemical treatments
ii. Insecticide and fungicide treatments
iii. Special treatments

Other invigourative seed treatments

Seed fortification

It is a kind of seed treatment and it is used to invigorate the seed using vitamins, minerals, and chemicals. Tomato seeds are soaked in Vitamin E dissolved in acetone during storage.

Seed infusion

Seeds that are susceptible to soaking injury and seeds with internal seed borne diseases which need penetration of chemical to kill the pathogen are soaked in alcohol dissolved nutrients like vitamin, pesticides and can be dried quickly. Infusion of Topsin, thiram into vegetable seeds.

Seed Colouring

Seeds can be coloured with non-toxic dyes like methylred, bromocresol green, methylene blue and rosebengal dyes. They can help in lot identity, variety identity, brand specificity, identity of A.B.R. line, to indicate the efficiency of seed treatment etc. To colour faded seeds caused due to ageing but still vigorous.

Seed Tapes

These are tapes embedded in paper or gel. Pretreated seeds are placed equidistantly in the gel and cooled. These tapes can be rolled out in the field, covered with soil and watered.

Seed hardening

It is a method followed for improving the germination of seeds sown in arid regions. Pre-sowing hardening of seed helps in modifying the physiological and biochemical nature of seed protoplasmic characters and increasing the physiological activity of the embryo and associated structures.

This leads to increase in elasticity of cell wall and developments of a stronger and efficient root system.

Seed treatment with bio-fertilizers

To facilitate fixing of atmosphere nitrogen and conserve fertilizer utilization this treatment is done.

Rhizobium	-	Cowpea, Lab-lab
Azospyrillum, Azotobactor	-	Bhendi
Carrier	-	Rice or sorghum gruel

Pelleting

Seed pelleting is a pre-sowing management where the seed is enclosed in a filler material using an adhesive, just large enough to produce a globular unit of standard size to facilitate precision planting and to serves as a mechanism of applying needed materials on the seed.

Advantages

- Uniformity in seed size
- Singling of seeds and prevention of clogging
- Precision planting
- Supply of growth regulator and micronutrients/ needy substances
- Localization of fertilizer / nutrients

- Provide ballistic ability at aerial seeding
- Protect seed from external organism
- Remedy for seed germination in problematic soils
- Reduces seed rate
- Enhances field establishment
- Improvement in yield
- Low cost technology

SEED COATING

Seed coating is a technique by which additivies such as pesticides nutrients or nitrifying bacteria are applied to the external surface *i.e*., seed coat. But in contrast to pelleting the coating conforms to the individual seeds shape and does not normally significantly modify the seeds size.

Recommendation of seed treatment for different crops

S.No.	Name of Crop	Pest/Disease	Seed Treatment	Remarks
1.	Chillies	Anthracnose spp. Damping off	Seed treatment with *Trichoderma viride* 4g/kg, Carbandazim @ 1g/100 gm seed.	-do-
2.	Bhendi	Root knot nematode	*Paecilomyces lilacinus* and *Pseudomonas fluorescens* @ 10 gm/kg as seed dresser.	-do-
3.	Tomato	Soil borne infection of fungal disease Early blight Damping off Wilt	*T. viride* @ 2 gm/100gm seed. Captan 75 WS @ 1.5 to 2.0 gm a.i./litre for soil drenching. *Pseudomonas fluorescens* and *V. clamydosporium* @ 10gm/kg as seed dresser.	For seed dressing metal seed dresser/earthern pots or polythene bags are used.
4.	Coriander	Wilt	*Trichoderma viride* @ 4 gm./kg seed.	-do-
5.	Brinjal	Bacterial wilt	*Pseudomonas fluorescens* @ 10gm/kg.	-do-

6.	Leguminous Vegetables	Soil borne infection Nematode	*Trichoderma viride* @ 2 gm/100gms. seed. Carbofuran/Carbosulfan 3% (w/w)	-do-
7.	Cruciferous vegetables (Cabbage, Cauliflower, Broccoli, Knol-khol, radish)	Soil / Seed borne diseases (Damping off) Root knot nematode	Seed treatment with *Trichoderma viridi* @ 2 g / 100 g seeds Captan 75% WS @ 1.5 to 2.5 gm a.i./litre for soil drenching. *Pseudomonas fluorescens* and *Verlicillium clamydosporium* @ 10gm/kg seed as seed dresser	-do-
8.	Potato	Soil and Tuber borne diseases	Seed treatment with MEMC 3% WS @ 0.25% or boric acid 3% for 20 minuts before storage.	
9.	Capsicum	Root knot nematode	*Pseudomonas fluorescens 1% WP, Paecilomyces lilacirius* and *Verticillium chlamydosporium* 1% WP @ 10g/kg as seed dresser.	

http://dacnet.nic.in/ipmweb/ipmhome/Seedtreatment.htm

Questions

1. Seed pelleting is

a. Pre- sowing seed treatment b. Pre-storage seed treatment

c. Mid-storage seed treatment d. none

Ans: a

2. Hardened seed performed well in

a. Marginal lands b. Wet lands c. Rainfed sowing d. Garden land

Ans: c

3. Stratification is the treatment given to break

a. Immature embryo dormancy b. Mechanical dormancy

c. Physical dormancy d. All

Ans: a

4. Physiological dormancy is due to

a. Absence of PGR b. Hard seed c. Physical dormancy d. All

Ans: a

5. Dormancy of apple seeds is broken by

a. Scarification b. Cold stratification c. Growth regulator d. All

Ans: b

6. Priming is much suited pre sowing seed treatment for

a. Sub optimal condition b. Dry lands c. Optimum condition d. None

Ans: a

7. Infusion of Plant Growth Regulator into the seed through organic solvent

a. Dry permeation b. Hydration – dehydration

c. Hardening d. Priming

Ans: a

8. Polyethylene Glycol is useful in

a. Priming b. Hydro priming c. Osmotic priming d. None

Ans: c

9. The commonly used fumigants are

a. Celphos b. Quickphos, c. Ethylene di bromide. d. All

Ans: d

10. Scarification is followed to break dormancy in seeds due to the presence of

a. Hard seed coat b. Immature embyo c. Inhibitors d. None

Ans: a

Lecture No. 28

Seed storage

Seed storage is preservation of seed with initial quality until it is needed for planting. The ability of seed to tolerate moisture loss allows the seed to maintain the viability in dry state. Storage starts in the mother plant itself when it attains physiological maturity. After harvesting the seeds are either stored in ware houses or in transit or in retail shops. During the old age days, the farmers were used farm saved seeds in little quantity, but introduction of high yielding varieties and hybrids and modernization of agriculture necessitated the development of storage techniques to preserve the seeds.

The practice of storing the seeds starts from the ancient days itself, following simple and cheap techniques eg. Placing the seeds in salt, red earth treatment to red gram etc. But the same practices are not hold good for the present day agriculture, because

- large quantity to be stored
- exchange of varieties and species
- exchange of genes

The type of material to be stored decides the techniques to be followed for safe storage. Now a days storage technique changed from ordinary godown storage to cryogenic tank storage and even gene storage.

Stages of Seed Storage

- The seeds are considered to be in storage from the moment they reach physiological maturity until they germinate or until they are thrown away because they are dead or otherwise worthless.
- The entire storage period can be conveniently divided into following stages.
- Storage on plants (physiological maturity until harvest).
- Harvest, until processed and stored in a warehouse.
- In - storage (warehouses)
- In transit (Railway wagons, trucks, carts, railway sheds etc.).
- In retail stores.

- On the user's farm.

Purpose of seed storage

Storage is needed to maintain the seed in good physical and physiological condition from the time they are harvested until the time they are planted.

Objective of seed storage

To maintain initial seed quality viz., germination, physical purity, vigour etc., all along the storage period by providing suitable or even better conditions

Types of storage

1. Storage at ambient temperature and humidity

Seeds can be stored in piles, single layers, sacks or open containers, under shelter against rain, well ventilated and protected from rodents and store at least for several months.

2. Dry storage with control of moisture content but not temperature

Orthodox seeds will retain viability longer, when dried to low moisture content (48%) and then stored in a sealed container or in a room in which humidity is controlled, than when stored in equilibrium with ambient air humidity. Cool condition is especially favourable.

3. Dry storage with control of both moisture content and temperature

This is recommended for many orthodox species which have periodicity of seeding but which are planted annually in large scale afforestation projects. A combination of 4-8% moisture content and 0 to 5° temperature will maintain viability for 5 years or more.

4. Dry storage for long-term gene conservation

Long-term conservation of gene resources of orthodox agricultural seeds is -18°C temperature and 5±11% moisture content

5. Moist storage without control of moisture content of temperature

Suitable for storage of recalcitrant seeds, for a few months over winter. Seeds may be stored in heaps on the ground, in shallow pits, in well drained soils or in layers in well ventilated sheds, often covered or mixed with leaves, moist sand, peat or other porous materials. The aim is to maintain moist and cool conditions, with good aeration to avoid overheating which may result from the relatively high rates of respiration associated with moist storage. This may be accomplished by regular turning of the heaps.

6. Moist cold storage, with control of temperature

This method implies controlled low temperature just above freezing or less commonly, just below freezing. Moisture can be controlled within approximate limits by adding moist media e.g., sand, peat or a mixture of both to the seed, in proportions of one part media to 1 part seed by volume, and re-moistening periodically or more accurately by controlling the relative humidity of the store. This method is much applicable to temperate recalcitrant genera.

7. Cryopreservation

It is also called as cryogenic storage. Seeds are placed in liquid nitrogen at -196°C. Seeds are actually placed into the gaseous phase of the liquid nitrogen -150°C for easy handling and safety. Metabolic reactions come to a virtual standstill at the temperature of liquid nitrogen and the cells will remain in an unaltered state until the tissues are removed from the liquid nitrogen and defrosted. Therefore, little detrimental physiological activity takes place at these temperatures, which prolongs the storage life of seeds. It is not practical for commercial seed storage, but is useful to store the valuable germplasm.

Harrington thumb rule on seed storage

The following thumb rules by Harrington are useful measures for assessing the effect of moisture and temperature on seed storage. These rules are as follows:

- For every decrease of 1% seed moisture content, the life of the seed doubles. This rule is applicable when moisture content between 5 and 14%.

- For every decrease of 5°C (10°F) in storage temperature the life of the seed doubles. This rule applies between 0°C to 50°C.
- Good seed storage is achieved when the % of relative humidity in storage environment and the storage temperature in degrees Fahrenheit add up to hundred but the contribution from temperature should not exceed 50°F.

Nomograph

Roberts (1972) developed formulae to describe the relationship between temperature, seed moisture content and period of viability. From these relationships it was possible to construct a seed viability nomograph. These nomographs are helpful in predicting the retention of seed viability in defined storage environment for a particular period or to determine combinations of temperature and moisture content which will ensure the retention of a desired level of seed viability for a specific period.

Maintenance of viability in storage

- Store well mature seeds
- Store normal coloured seeds
- Seeds should be free from mechanical injury
- Seeds should be free from storage fungi or micro organisms 5. Seeds should not have met with adverse conditions during maturation 10. Storage godown should be fumigated to control storage insects, periodically
- Storage environment or godown should be dry and cool.
- Seeds should be dried to optimum moisture content
- Required R.H. and temperature should be maintained during storage.

- Seeds should be treated with fungicides before storage
- Suitable packaging materials should be used for packing.

Factors influencing seed storage

1. Biotic
2. A biotic

1. Biotic factors

a. Factors related to seed

- Genetic make up of seed
- Initial seed quality
- Provenance
- Seed moisture content

b. Other biotic

- Insects
- Fungi
- Rodents
- Mishandling during sampling, testing

2. Abiotic factors

- Temperature
- Relative humidity
- Seed store sanitation
- Gaseous atmosphere
- Packaging material
- Seed treatment

1. a. Seed factors

1. **Genetic factors**

The storage is influenced by the genetic make up of the seed. Some kinds are naturally short lived eg. Onion, Soybeans, Ground nut etc., Based on the genetic make up seeds are classified into

- Micro biotic – short lived
- Meso biotic- medium lived
- Macro biotic – long lived

Initial seed quality

Barton (1941) found that the seeds of high initial viability are much more resistant to unfavourable storage environmental conditions than low viable seed. Once seed start to deteriorate it proceeds rapidly. The seed which injured mechanically suffered a lot and loses its viability and vigour very quickly. Generally small seeds escape injury whereas large seeds are more likely to be extensively damaged eg., bean, lima-bean and soybean. Spherical seeds usually give more protection than flat or irregularly shaped seeds

Effect of provenance

The place where the seed crop was produced greatly influences the storability.

eg., Red clover seeds grown in Canada stored for 4 years with 80 per cent germination whereas, seeds grown in England and New Zealand stored only for 3 years with per cent germination. This is due to different climatic conditions and soil types prevailing in different places.

Effect of weather

Fluctuating temperature during seed formation and maturity will affect seed storage. Pre-harvest rain may also affect the viability.

Pre harvest sanitation spray

In pulses, insect infestation comes from field eg., bruchids.

Seed moisture content

Most important factor influences the storability. The amount of moisture in the seeds is the most important factor influencing seed viability during storage.

Generally if the seed moisture content increases storage life decreases. If seeds are kept at high moisture content the losses could be very rapid due to mould growth very low moisture content below 4% may also damage seeds due to extreme desiccation or cause hard seededness in some crops.

Since the life of a seed largely revolves around its moisture content it is necessary to dry seeds to safe moisture contents. The sage moisture content however depends upon storage length, type of storage structure, kind / variety of seed type of packing material used. For cereals in ordinary storage conditions for 12-18 months, seed drying up to 10% moisture content appears quite satisfactory. However, for storage in sealed containers drying upto 5-8 % moisture content depending upon particular kind may be necessary.

Classification seed based on moisture content and storability

Orthodox

The seeds able to tolerate moisture loss and less seed moisture favours the storage *i.e*., decreased moisture increased storage period. Eg. Rice, sorghum and most of the cultivated species.

Recalcitrant

Just opposite to the orthodox. Seeds not able to tolerate moisture loss. Required high moisture for viability maintenance.

Microflora, Insects and Mites

The activity of all these organisms can lead to damage resulting in loss of viability. The microflora activity is controlled by Relative Humidity temperature and Moisture Content of seed.

Treated seeds with fungicides can be stored for longer periods.

Fumigation to control insects will also help to store longer period.

Fumigants - eg., methyl bromide, hydrogen cyanide, ethyline dichloride, carbon tetra chloride, carbon disulphide and napthalene and aluminimum phosphine.

2. Abiotic factors

Relative humidity

Relative humidity is the amount of H_2O present in the air at a given temperature in proportion to its maximum water holding capacity. Relative Humidity and temperature are the most important factors determining the storage life of seeds. Seeds attain specific and characteristic moisture content when subjected to given levels of atmospheric humidity. This characteristic moisture content called equilibrium moisture content.

Equilibrium moisture content for a particular kind of seed at a given Relative Humidity tends to increase as temperature decreases. Thus the maintenance of seed moisture content during storage is a function of relative humidity and to a lesser extent of temperature. At equilibrium moisture content there is no net gain or loss in seed moisture content.

Temperature

Temperature also plays an important role in life of seed. Insects and moulds increase as temperature increases. The higher the moisture content of the seeds the more they are adversely affected by temperature. Decreasing temperature and seed moisture is an effective means of maintaining seed quality in storage.

Gas during storage

Increase in O_2 pressure decrease the period of viability. N_2 and CO_2 atmosphere will increase the storage life of seeds.

Questions

1. Bruchid is a

a. Field pest b. Storage pest

c. Parasite d. Field carryover storage pest

Ans: d

2. For safe storage the best-suited storage place will have

a. High temperature b. Low temperature

c. High humid d. cool and dry atmosphere

Ans: d

3. On proper seed storage seed quality is

a. Deteriorated b. Improved

c. Maintained d. None

Ans: c

4. Thumb rule for safe seed storage has been developed by

a. Thompson b. Harrington

c. Basu d. Justice

Ans: b

5. Nomograph was developed by

a. Roberts b. R.N.Basu

c. Lagon d. Agarwal

Ans: a

6. Nomograph is useful to predict

a. Germination percentage b. Seed viability period

c. Seed vigour d. Seed storage pest

Ans: b

Lecture No. 29

Seed packing and godown storage

Seed packaging is the process of filling, weighing and sewing of bags with seed. An ideal storage facility should satisfy the following requirements

- It should provide maximum possible protection from ground moisture, rain, insect pests, moulds, rodents, birds, fore etc., It should provide the necessary facility for inspection, disinfection, loading, unloading, cleaning and reconditioning.
- It should protect grain from excessive moisture and temperature favourable to both insect and mould development, it should be economical and suitable for a particular situation

The factors to be considered while selecting the packaging materials are,

- Kind of seeds to be packed.
- Quantity of seed
- Value of seed
- Cost of packaging material
- Storage environment in which the packed materials will be held.
- Period of storage.
- Transport of seed

Types of seed storage

(a) Bulk (open) storage:

It is preferred over bag storage for the following reasons

- Large quantities of food grain can be stored
- No difficulty in loading and unloading of grain
- No need to purchase storage containers like gunnies

- Insect incidence is less than bag storage, even this can be eliminated by fumigation in situ
- Avoids waste from leaking bags
- Easy inspections- saves labour and time.

Bulk seed storage

(b) Bag storage

Commodities are mostly stored in gunnies. Storage in bags requires considerable labour, but the minimum investment is enough on permanent structures and equipment. The storage in ags has the advantage of being short-term storage. Bag storage can be done under a roof alvanized iron sheets, a plastic covering where grain is intended for very early onward movement. Bags can be easily handled for marketing purpose. There is no sweating of bags as they are arranged in racks with proper interbag space, but, initial cost is high and they can easily pickup infestation and retain even after treatment.

Classification of packaging materials or containers used for bag storage

1. Moisture and vapour pervious containers

These containers allow entry of water in the form of vapour and liquid. These are suited for short term storage. The seeds in these containers will attain seed equilibrium moisture with the surrounding atmosphere eg., cloth bags, gunny bags etc.

2. Moisture impervious but vapour pervious containers

These allow entry of water in the form of vapour and not in liquid. The seeds in these containers can't be carried over for long period in hot humid conditions. eg., polythene bags of < 300 gauge thickness and urea bags.

3. Moisture and vapour proof containers

These containers will not allow entry of moisture in the form of liquid or vapour. These are used for long term storage even in hot humid conditions if the seeds are sealed at optimum moisture content eg., polythene bags of > 700 gauge thickness, aluminium foil pouches, rigid plastics etc.

Storage godowns

Either bulk or bag storage seeds are stored in storage godowns. These godowns should be condstructed with rat proof,ventilation ,insulation ,it should be moisture proof.

Precautions in storage godown

Stacking

Seeds have to be stored and preserved on scientific lines in godowns till they are issued to growers. The bags containing seeds cannot be just dumped inside the godown, for it will not facilitate proper storage. Proper stacking ensures free access to the stocks in all parts of the godown for inspection and helps in effective disinfestations work. Generally, three methods of stacking are being followed: 1. Simple, 2.Cross and 3. Block method. 6-8 bags height

For best storage performance,

- The produce must be thoroughly cleaned and graded,
- Dried to the safe storage moisture level of 10-12 % for cereals and 7-9% for oil seeds on wet basis) for a safe storage period of 6-12 months,
- Storage structures should to be properly repaired, cleaned and disinfected,
- Structures should bear the load of seeds stored and do not permit contact/ exchange with outside humid air,
- Structures should be constructed in the coolest part of the house/ farm.

Steps necessary for good storage practice

Stored product pests can be managed either behaviouraly (traps *viz.,* probe traps, light traps, pitfall traps etc.,) or with several preventive and curative measures (both chemical and non-chemical methods). Once a facility is obtained, a number of steps are to be taken to ensure safe storage of grains. These steps comprise,

- **Before storage**

  - Checking for leakage of rain water and sufficiency of drainage facilities

- Cleanliness of the facility and environment
- Assessment of capacity of the facility
- Pesticidal treatment
- Security and firefighting arrangements and
- Repairs to available equipment

- **2. After receipt of seed**
  - Inspection for variety and soundness of quality
  - Inspection carefully for infestation, it any, and when present, for type and extent of infestation,
  - Inspection whether grain has excess moisture, whether it had been heated up in earlier storage and has any musty or rancid odour
  - Any grain rendered wet or damaged to be segregated and salvaged with facilities available and check the weight received

3. During storage

- Maintenance of cleanliness
- Ensuring aeration where necessary
- Checking for leakage after rains
- Inspection for insects, rats and mites at fortnightly intervals
- Watch for advancement in deterioration, if any,
- Pesticidal treatments necessarily based on observations
- Ensuring disposal where called for, and
- Arrangement for segregation, salvage and processing, wherever, damage owing
- To leakage of water and other causes might have taken place.

Seed storage godown sanitation

- Storage environment should be free from insects and rodents
- Chemicals such as insecticides, fertilizers should not be stored along with seeds.
- Storage room should be kept cool and dry
- Fumigation may be done whenever needed

- Use wooden pallets for arranging the bags in cris-cross manner for effective ventilation on all sides of the bags.
- Seed bags should be stacked upto 6-8 tires depending upon density of seeds
- Restocking once in 3 months or less is important for prolonging seed viability
- Before storage disinfect the godowns by spraying malthion 50% E.C. @ 5 lit /100 m^2 areas.
- If old gunnies, cloth bags and containers are to be used these should be fumigated with aluminium phosphide.
- Size of the stack should be 30x20 feet facilitate fumigation under gas proof or polythene covers.
- Periodical inspections should be carried out and control measures to be taken *i.e.*, malthion 50% E.C. @ 5 lit /100 m2 area should be applied in every 3 weeks
- It must be borne in mind that fumigation, particularly repeated fumigation, may seriously reduce the vigour and even the germination capacity of seeds. Seeds with m.c. greater than 14% should be dried to below this value before fumigation

Questions

1. Write example for moisture vapour proof container

   a. Cloth bag b. Paper bag

   c. Jute bag d. Tin

   Ans: a

2. Commonly used package material for packing flower and vegetable hybrid seeds

   a. Jute bag b. Aluminium foil pouches

   c. Tin d. All

   Ans: b

Lecture No. 30

Seeds act and rules

Introduction

The seed is an important agricultural input and it plays vital role in increasing production and productivity. There is a need to safeguard the farmers with the supply of genetically pure and quality seeds. Any new variety produced by the Scientist has to be multiplied many times to meet the needs of the farmers. In order **to ensure the availability of quality seeds**, **Government of India has enacted Seeds Act, 1966 and Seed rules, 1968. The seed (Control) order, 1983 was** promulgated under essential commodities act, 1955 in order to ensure the production, marketing and equal distribution of the seeds.

Seeds Act, 1966

The object of Seed Act is to regulate the quality of certain notified kind / varieties of seeds for sale and for matters connected therewith. The seed act passed by the Indian Parliament in 1966 was designed to create a 'Climate' in which the seeds man could operate effectively and to make good quality seed available to cultivators. **Seeds rule** under the act was **notified in September 1968** and **the act was implemented entirely in October, 1969**. This act extent to the whole of India and it has **25 sections.**

Seed legislation could broadly be divided into two groups

1. Sanctioning legislation

Sanctioning legislation authorizes formation of Advisory bodies, Seed Certification Agencies, Seed Testing laboratories, Foundation and Certified Seed Programmes, Recognition of Seed certification Agencies of Foreign countries Appellate authorities etc.

2. Regulatory legislation

Regulatory Legislation controls the quality of seeds sold in the market including suitable agencies for regulating the seed quality. On quality control basis, the Seeds Act could conveniently be divided into the following:

I. Minimum limit and labelling of the notified kind / varieties of seed

a. Power to notify the kind / variety

b. Labelling provisions

c. Seed testing

d. Seed analyst

e. Seed inspectors

f. Penalty

g. General provisions

II. Seed Certification

III. Restriction of Import and Export of Seeds

1. Minimum limits and labelling

Quality control as envisaged in the Act is to be achieved through pre and post marketing control, voluntary certification and compulsory labelling of the seeds of notified kind / varieties.

(a) Power to notify the kind / varieties

New varieties evolved by the State Agricultural Universities and ICAR institutes are notified and released /notified respectively under section 5 of the seeds act in consultation with the central seed committee and its sub committees constitute under section 3 and 3(5) of the Seeds Act. As on date more than 2500 varieties and 130 varieties were notified and denotified under this section. List of varieties notified and denotified from 1969 to 2005 are compiled and made available in the form of a book called **catalogue of varieties notified and denotified** under section 5 of the Seeds Act. Functions of the Central Seed Committee and its sub-committee are defined in Clauses 3 and 4 of part II of seed rule.

(b) Labelling provision

Minimum limits for germination, physical purity and genetic purity of varieties / hybrids for crops have been prescribed and notified for labelling seeds of notified kind / varieties under section 6(a) of the Seeds Act. Size of the label, colour of the label and content of the label were also notified under sub clause (b) of Section 6 of Seeds Act. Colour of the label is opal green and size of the label is 10 cm x 15 cm or proportionate thereof. Responsibility for making labelling content of mark or label, manner of marking, false / misleading statement on label etc, are defined under clause 7,8,9,10,11 and 12 of part V of seeds rule.

Section 7 of the act regulates the sale of notified kind or varieties. Accordingly no person shall keep for sale, offer to sell, barter or otherwise supply any seed of any notified kind or variety, after the dates recorded on the container mark or label as the date unto which

the seed may expected to retain the germination not less than prescribed under clause (a) of section 6 of the Act.

(c)Seed Testing

There is a provision to set up a central seed laboratory and state seed laboratory to discharge functions under section 4(1) and 4(2) of the Seed Act. In the year 1968 there were 23 state seed testing laboratories in the country. At present there are 86 Seed testing laboratories functioning in the country. During 1995-96 these laboratories tested about 5 lakh samples. Seed testing laboratories have been assigned certain important functions under part III (5) of Seed Rule.

(d)Seed Analysts

State Government could appoint the Seed Analysts through notification in the Official Gazette under Section 12 of the Seed Act defining his area and his jurisdiction. Seed Analyst should posses certain minimum qualification as prescribed under clause 20 part IX of Seed Rule.

(e)Seed Inspectors

Classes of seed

The State Government, under section 13 of the Act may appoint such a person as it thinks fit, having prescribed qualification (Clause 22 part IX of Seed Rule) through notification, as a Seed Inspector and define the areas within which he shall exercise jurisdiction for enforcing the seed law. He will be treated as a public servant within a meaning of section 21 of the I.P.C. (45 of 1860). He has power to examine records, register document of the seed dealer. He will also exercise such other powers as may be necessary for carrying out the purposes of this Act or rule made there under. Duties of Seed inspectors are defined in clause 23 of part IX of Seed rule. He can issue, stop sale order in case the seed in question contravenes the provision of relevant Act and rules for which he can use form No.III. When he seizes any record, register documents or any other material, he should inform a magistrate and take his order for which he can use form No.IV.

(f)Penalty

If any person, contravenes any provision of the Act or Rule, or prevents a seed inspector from taking sample under this Act or prevents a Seed Inspector from exercising any other power conferred on him could be punished under section 19 of the act with a fine of five hundred rupees for the first offence. In the event of such person have been previously convicted of an offence under this section with imprisonment for a term, which may extend to six months or with fine, which may extent to one thousand rupees or with both.

II. Seed certification

The object of the seed certification is to maintain and make available to the public through certification high quality propagating material of notified kind / varieties so grown and distributed as to ensure genetic identity and genetic purity. The certified standards enforce are Indian minimum seed certification standards and seed certification procedures form together for the seed certification regulations. Seeds of only those varieties which are notified under section under Section 5 of the seeds act shall be eligible for certification.

- Breeder seed
- Foundation seed
- Certified Seed

Breeder seed

- Breeder seed is a seed directly controlled by the breeder.
- Breeder seed should be genetically so pure as to guarantee that in the subsequent generation.
- Breeder seed could not come under the purview of seed certification as it is not meant for public sale.
- Breeder seed should be packed and supplied with breeder's golden yellow colour tag as per the guideline given in Indian Minimum Seed Certification standards. It is also the fact that no standard for breeder seed have been prescribed.

Foundation seed

- Foundation class of seed and certified class of seed are to be certified by the Certification Agencies as per the Indian Minimum Seed Certification Standards.

- Section 8 of the Seeds Act provide state government or the Central Government consultation with State Government may be notification in official gazette, established certification agencies for the state to carry out the functions entrusted to certification agency by or under this Act (Part IV, clause 6, part VI clause 14 of Seeds Rule).

Certified seed

- Seed act section 9 provides any person desires of producing certified seed shall register his name with concerned seed certification agency duly remitting the prescribed fee in form No.1 for grant of certificate. Certificate could be granted in form No.11 after meeting the requirement of certification agency prescribed under Part VII clause 15, 16 and 17 of Seed rule.
- It should have the minimum genetic purity of 99%
- Certified seed may be the progeny of certified seed , provided this reproduction does not exceed two generations beyond foundation seed and provided that if certification agency determines the genetic and physical purity, if not be significantly altered
- In case of highly self pollinated crops certification of one further generation may be permitted
- Certified seed produced from certified seed ,shall be eligible for further seed increase under certification, except in case of highly self pollinated crops, where certification of one further generation may be permitted
- Certification tags issued once for certified seed not eligible for further seed increase under certification
- For paddy and wheat, certified seed produced from certified seed is eligible for certification by NSC up to two generations from foundation seed

Chapter 1 in seed act

Preliminary

Short title, extent, application and commencement

1. (1) This Act may be called the Seeds Act, 2004. (2) It extends to the whole of India . (3) Save as otherwise provided in this Act, it shall apply to- (a) every dealer; and (b) every producer of seed except when the seed is produced

by him for his own use and not for sale. (4) It shall come into force on such date as the Central Government may, by notification, appoint.

Definitions.

2. In this Act, unless the context otherwise requires, - (1) "agriculture" includes horticulture, forestry and cultivation of plantation, medicinal and aromatic plants; (2) " Central Seed Testing Laboratory " means the Central

Seed Testing Laboratory established or declared as such under sub-section (1) of section 32; (3) "Certification Agency" means an agency established under section 26 or accredited under section 27 or recognised under section 30; (4) " Chairperson " means the Chairperson of the Committee; (5) " Committee " means the Central Seed Committee constituted under sub-section (1) of section 3; (6) " container " means a box, bottle, casket, tin, barrel, case, receptacle, sack, bag, wrapper or other thing in which any article or thing is placed or packed; (7) " dealer " means a person who carries on the business of buying and selling, exporting, or importing seed, and includes an agent of a dealer; (8) " export " means taking out of India by land, sea or air; (9) " farmer " means any person who cultivates crops either by cultivating the land himself or through any other person but does not include any individual, company, trader or dealer who engages in the procurement and sale of seeds on a commercial basis; (10) " horticulture nursery " means any place where horticulture plants are, in the regular course of business, produced or propagated and sold for transplantation; (11) " import" means bringing into India by land, sea or air; (12) " kind " means one or more related species or sub-species of crop plants each individually or collectively known by one common name such as cabbage, maize, paddy and wheat; (13) " member " means a member of the Committee ;

(14) " misbranded " - A seed shall be deemed to be misbranded if- (i) it is a substitute for, or resembles in a manner likely to deceive, another variety of seed under the name of which it is sold, and is not plainly and conspicuously labelled so as to indicate its true nature; (ii) it is falsely stated to be the product of any place or country; (iii) it is sold by a name which belongs to another kind or variety of seed; (iv) false claims are made for it upon the label or otherwise; (v) when sold in a package which has been sealed or

prepared by, or at the instance, of the dealer and which bears his name and address, the contents of each package are not conspicuously and correctly stated on the outside thereof within the limits of variability prescribed under this Act; (vi) the package containing it, or the label on the package bears any statement, design or device regarding the quality or the kind or variety of seed contained therein, which is false or misleading in any material particular or if the package is otherwise deceptive with respect to its contents; (vii) it is not registered in the manner required by or under this Act; (viii) its label contains any reference to registration other than the registration number; (ix) its label does not contain a warning or caution which may be necessary, and sufficient, if complied with, to protect human, animal and plant life and health or to avoid serious prejudice to the environment; (x) the package containing it or the label on the package bears the name of a fictitious individual or company as the dealer of the kind or variety; or (xi) it is not labelled in accordance with the requirements of this Act or the rules made thereunder; (15) "notification" means a notification published in the Official Gazette; (16) " prescribed " means prescribed by rules made under this Act; (17) " producer " means a person, group of persons, firm or organisation who grows or organizes the production of seeds; (18) " registered kind or variety " , in relation to any seed, means any kind, or variety thereof, registered under section 13;

19) " Registration Sub-Committee " means the Registration Sub- Committee constituted under sub-section (1) of section 7; (20) " regulation " means a regulation made by the Committee under this Act; (21) " seed " means any type of living embryo or propagule capable of regeneration and giving rise to a plant of agriculture which is true to such type; (22) "Seed Analyst" means a Seed Analyst appointed under section 33; (23) "Seed Inspector" means a Seed Inspector appointed under section 34; (24) " seed processing " means the process by which seeds and planting materials are dried, threshed, shelled, ginned or delinted (in cotton), cleaned, graded or treated; (25) " spurious seed " means any seed which is not genuine or true to type; (26) " State Government " ,in relation to a Union territory, means the administrator thereof; (27) " State Seed Testing Laboratory " , in relation to any State, means the State Seed Laboratory established or declared as such under sub-section (2) of section 32 for that State;

(28) " transgenic variety " means seed or planting material synthesized or developed by modifying or altering the genetic composition by means of genetic engineering;

(29) “ variety ” means a plant grouping except micro-organism within a single botanical taxon of the lowest known rank, which can be (i) defined by the expression of the characteristics resulting from a given genotype of that plant grouping; (ii) distinguished from any other plant grouping by expression of at least one of the said characteristics; and (iii) considered as a unit with regard to its suitability for being propagated, which remains unchanged after such propagation, and includes propagating material of such variety, extant variety, transgenic variety, farmers' variety and essentially derived variety. Footnote: "essentially derived variety", in respect of a variety (the initial variety) shall be said to be essentially derived from such initial variety when it- (a) is predominantly derived from such initial variety, or from a variety that itself is predominantly derived from such initial variety, while retaining the expression of the essential characteristics that result from the genotype or combination of genotypes of such initial variety; (b) is clearly distinguishable from such initial variety; and (c) conforms (except for the differences which result from the act of derivation) to such initial variety in the expression of the essential characteristics that result from the genotype or combination of genotypes of such initial variety; Extant variety - "extant variety" means a variety available in India which is- (a) notified under section 5 of the Seeds Act, 1966; or (b) farmers' variety as defined in PVP Act; or (c) a variety about which there is common knowledge; or (d) any other variety which is in public domain.

Questions

1. Under seeds Act, 1966 labeling is compulsory (True/False)

   Ans: True

2. Seed Act was formulated and enacted during

   a. 1966 and 1969 b. 1966 and 1968

   c. 1963 and 1966 d. 1988 and 1990

   Ans: b

3. Section 5 of seeds act (1966) deals with

   a. Notification b. Central Seed Committee

   c. Appellate Authority d. Definition of seeds

   Ans: a

4. Seed Act was implemented in India from

   a. Jan 1, 2005 b. Dec 2, 1966

   c. Oct 2, 1969 d. 29th Dec, 1966

   Ans: d

5. Seeds (control) order is proposed during

   a. 1983 b. 1955

   c. 1966 d. 1968

   Ans: a

6. Seed rule was formulated during

   a. 1965 b. 1985

   c. 1966 d. 1968

   Ans: d

Lecture No. 31

Central seed committee, central seed certification board, state seed certification agency, central and state seed testing laboratories

Central seed committee

The Central Government shall, as soon as may be after the commencement of Seed Act, constitute a Committee called the Central Seed Committee to advise the Central Government and the State Governments on matters arising out of the administration of this Act and to carry out the other functions assigned to it by or under this Act.

The Committee shall consist of the following members, namely:-

i. A Chairman to be nominated by the Central Government;
ii. Eight persons to be nominated by the Central Government to represent such interests that Government thinks fit, of whom not less than two persons shall be representatives of growers of seed;
iii. One person to be nominated by the Government of each of the States.

The members of the Committee shall, unless their seats become vacant earlier by resignation, death or otherwise, be entitled to hold office for two years and shall be eligible for renomination. The Committee may, subject to the previous approval of the Central Government, make bye-laws fixing the quorum and regulating its own procedure and the conduct of all business to be transacted by it.

The functions of the Committee or any sub-committee thereof may be exercised notwithstanding any vacancy therein. The Central Government shall appoint a person to be the secretary of the Committee and shall provide the Committee with such clerical and other staff as the Central Government considers necessary.

Central seed certification board

The Central Government shall, by notification in the Official Gazette, establish a Central Seed Certification Board (hereinafter referred to as the Board) to advise the

Central Government and the State Governments on all matters relating to certification, and to co-ordinate the functioning of the agencies established under section 8.

The Board shall consist of the following members, namely:-

i. A Chairman to be nominated by the Central Government;
ii. Four members, to be nominated by the Central Government from out of the persons employed by the State Governments as Directors of Agriculture;
iii. Three members, to be nominated by the Central Government from out of the persons employed by the Agricultural Universities as Directors of Research;
iv. Thirteen persons, to be nominated by the Central Government to represent such interests as that Government thinks fit, of whom not less than four persons shall be representatives of seed producers or tradesmen.

A member of the Board shall, unless his seat becomes vacant earlier by resignation or otherwise, be entitled to hold office for two years from the date of his nomination provided that a person nominated under clause (ii) or clause (iii) of sub-section (2) shall hold office only for so long as he holds the appointment by virtue of which his nomination was made.

Certification agency

The State Government or the Central Government in consultation with the State Government may, by notification in the Official Gazette, establish a certification agency for the State to carry out the functions entrusted to the certification agency by or under this Act.

Grant of certificate by certification agency

1. Any person selling, keeping for sale, offering to sell, bartering or otherwise supplying any seed of any notified kind or variety may, if he desires to have such seed certified by the certification agency, apply to the certification agency for the grant of a certificate for the purpose.
2. Every application under sub-section (1) shall be made in such form, shall contain such particulars and shall be accompanied by such fees as may be prescribed.

3. On receipt of any such application for the grant of a certificate, the certification agency may, after such enquiry as it thinks fit and after satisfying itself that the seed to which the application relates conforms to the minimum limits of germination and purity specified for that seed under clause (a) of section 6, grant a certificate in such form and on such conditions as may be prescribed.

Revocation of certificate

If the certification agency is satisfied, either on a reference made to it in this behalf or otherwise, that-

a. The certificate granted by it under section 9 has been obtained by misrepresentation as to an essential fact; or
b. The holder of the certificate has, without reasonable cause, failed to comply with the conditions subject to which the certificate has been granted or has contravened any of the provisions of this Act or the rules made there under;

Then, without prejudice to any other penalty to which the holder of the certificate may be liable under this Act, the certification agency may, after giving the holder of the certificate an opportunity of showing cause, revoke the certificate.

Appeal

1. Any person aggrieved by a decision of a certification agency under section 9 or section 10, may, within thirty days from the date on which the decision is communicated to him and on payment of such fees as may be prescribed, prefer an appeal to such authority as may be specified by the State Government in this behalf:

   Provided that the appellate authority may entertain an appeal after the expiry of the said period of thirty days if it is satisfied that the appellate was prevented by sufficient cause from filing the appeal in time.
2. On receipt of an appeal under sub-section (1), the appellate authority shall, after giving the appellant an opportunity of being heard, dispose of the appeal as expeditiously as possible.

3. Every order of the appellate authority under this section shall be final.

Central Seed Laboratory and State Seed Laboratory

(1) The Central Government may, by notification in the Official Gazette, establish a Central Seed Laboratory or declare any seed laboratory as the Central Seed Laboratory to carry out the functions entrusted to the Central Seed Laboratory by or under this Act. The Seed Testing Laboratory at the Indian Agricultural Research Institute, New Delhi, has been notified as the Central Seed Testing Laboratory and it was established during 1960. The functions assigned to this laboratory are:

   a. Initiate testing programme in collaboration with the State Seed Laboratories designed to promote uniformity in test results between all seed laboratories in India.
   b. Collect data continuously on the quality of seeds found in the market and make this data available to the Committee;
   c. Carry out such other functions as may be assigned to it by the Central Government from time to time; and
   d. Act as referee laboratory in testing seed samples for achieving uniformity in seed testing. The State Seed Testing Laboratories are required to send five percent samples to the Central Seed Testing Laboratory along with their analysis results.

(2) The Act envisages the establishment of State Seed Testing Laboratories in each State by notification in the official Gazette. The functions assigned to this laboratory are to carry out the seed analysis work of the State in a prescribed manner. There are eight notified Seed Testing Laboratories are available in Tamil Nadu.

Questions

1. Central Seed Testing Laboratory was established during

   a. 1960 b. 1966

   c. 1968 d. 1969

   Ans:a

2. Central Seed Testing Laboratory was located at

   a. Chennai b. New Delhi

   c. Varanasi d. Hyderabad

   Ans:b

3. Number of notified Seed Testing Laboratory at Tamil Nadu

   a. 2 b. 4

   c. 8 d. 5

   Ans:c

4. Referee testing o seeds is being conducted at

   a. State seed testing lab

   b. Private seed testing lab

   c. Accredited seed testing lab

   d. Central seed testing lab

   Ans:d

Lecture No. 32

Seed law enforcement

Seed Inspectors

The State Government may by notification in the Official Gazette, appoint such persons as it thinks fit, having the prescribed qualifications, to be Seed Inspectors and define the areas within which they shall exercise jurisdiction.

Every Seed Inspector shall be deemed to be a public servant within the meaning of section 21 of the Indian Penal Code (45 of 1860) and shall be officially subordinate to such authority as the State Government may specify in this behalf.

Powers of seed inspector

(1) The Seed Inspector may-

a. Take samples of any seed of any notified kind or variety from-

i. any person selling such seed; or

ii. any person who is in the course of conveying, delivering or preparing to deliver such seed to a purchaser or a consignee; or

iii. a purchaser or a consignee after delivery of such seed to him;

b. Send such sample for analysis to the Seed Analyst for the area within which such sample has been taken;

c. Enter and search at all reasonable times, with such assistance, if any, as he considers necessary, any place in which he has reason to believe that an offence under this act has been or is being committed and order in writing the person in possession of any seed in respect of which the offence has been or is being committed, not to dispose of any stock of such seed for a specific period not exceeding thirty days or, unless the alleged offence is such that the defect may be removed by the possessor of the seed, seize the stock of such seed;

d. examine any record, register, document or any other material object found in any place mentioned in clause (c) and seize the same if he has reason to believe that it may furnish evidence of the commission of an offence punishable under this Act; and

e. Exercise such other powers as may be necessary for carrying out the purposes of this Act or any rule made there under.

2. Where any sample of any seed of any notified kind or variety is taken under clause (a) of sub-section (1), its cost, calculated at the rate at which such seed is usually sold to the public, shall be paid on demand to the person from whom it is taken.

3. The power conferred by this section includes power to break-open any container in which any seed of any notified kind or variety may be contained or to break-open the door of any premises where any such seed may be kept for sale: Provided that the power to break-open the door shall be exercised only after the owner or any other person in occupation of the premises, if he is present therein, refuses to open the door on being called upon to do so.

4. Where the Seed Inspector takes any action under clause (a) of sub-section (1), he shall, as far as possible, call not less than two persons to be present at the time when such action is taken and take their signatures on a memorandum to be prepared in the prescribed form and manner.

5. The provisions of the Code of Criminal Procedure, 1898 (5 of 1898), shall, so far as may be, apply to any search or seizure under this section as they apply to any search or seizure made under the authority of a warrant issued under section 98 of the said Code.

Procedure to be followed by Seed Inspectors

1. Whenever a Seed Inspector intends to take sample of any seed of any notified kind or variety for analysis, he shall-

a. Give notice in writing, then and there of such intention to the person from whom he intends to take sample;
b. Except in special cases provided by rules made under this Act, take three representative samples in the prescribed manner and mark and seal or fasten up each sample in such manner as its nature permits.

2. When samples of any seed of any notified kind or variety are taken under sub-section (1), the Seed Inspector shall-

a. Deliver one sample to the person from whom it has been taken;
b. Send in the prescribed manner another sample for analysis to the Seed Analyst for the area within which such sample has been taken; and

c. Retain the remaining sample in the prescribed manner for production in case any legal proceedings are taken or for analysis by the Central Seed Laboratory under sub-section (2) of section 16, as the case may be.

3. If the person from whom the samples have been taken refuses to accept one of the samples, the Seed Inspector shall send intimation to the Seed Analyst of such refusal and thereupon the Seed Analyst receiving the sample for analysis shall divide it into two parts and shall seal or fasten up one of those parts and shall cause it, either upon receipt of the sample or when he delivers his report, to be delivered to the Seed Inspector who shall retain it for production in case legal proceedings are taken.

4. Where a Seed Inspector takes any action under clause (c) of sub-section (1) of section he shall use all dispatch in ascertaining whether or not the seed contravenes any of the provisions of section 7 and if it is ascertained that the seed does not so contravene, forthwith revoke the order passed under the said clause or, as the case may be, take such action as may be necessary for the return of the stock of the seed seized;

a. If he seizes the stock of the seed, he shall, as soon as may be, inform a magistrate and take his orders as to the custody thereof;
b. Without prejudice to the institution of any prosecution, if the alleged offence is such that the defect may be removed by the possessor of the seed, he shall, on being satisfied that the defect has been so removed, forthwith revoke the order passed under the said clause.

5. Whereas Seed Inspector seizes any record, register, document or any other material object under clause (d) of sub-section (1) of section 14, he shall, as soon as may be, inform a magistrate and take his orders as to the custody thereof.

Report of Seed Analyst

1. The Seed Analyst shall, as soon as may be after the receipt of the sample under sub-section (2) of section 15, analyse the sample at the State Seed Laboratory and deliver in such form as may be prescribed, one copy of the report of the result of the analysis to the Seed Inspector and another copy thereof to the person from whom the sample has been taken.

2. After the institution of a prosecution under this Act, the accused vendor or the complainant may, on payment of the prescribed fee, make an application to the court for

sending any of the samples mentioned in clause (a) or clause (c) of sub-section (2) of section 15 to the Central Seed Laboratory for its report and on receipt of the application, the court shall first ascertain that the mark and the seal or fastening as provided in clause (b) of sub-section (1) of section 15 are intact and may then dispatch the sample under its own seal to the Central Seed Laboratory which shall thereupon send its report to the court in the prescribed form within one month from the date of receipt of the sample, specifying the result of the analysis.

3. The report sent by the Central Seed Laboratory under sub-section (2) shall supersede the report given by the Seed Analyst under sub-section (1).

4. Where the report sent by the Central Seed Laboratory under sub-section (2) is produced in any proceedings under Section 19, it shall not be necessary in such proceedings to produce any sample or part thereof taken for analysis.

Restriction on export and import of seeds of notified kinds or varieties

No person shall, for the purpose of sowing or planting by any person (including himself), export or import or cause to be exported or imported any seed of any notified kind or variety, unless-

a. It conforms to the minimum limits of germination and purity specified for that seed under clause (a) of section 6; and
b. Its container bears, in the prescribed manner, the mark or label with the correct particulars thereof specified for that seed under clause (b) of section 6.

Recognition of seed certification agencies of foreign countries

The Central Govt. may, on the recommendation of the Committee and by notification in the Official Gazette, recognise any seed certification agency established in any foreign country, for the purposes of this Act.

Penalty

If any person-

a. contravenes any provision of this Act or any rule made thereunder; or
b. prevents a Seed Inspector from taking sample under this Act;**or**
c. prevents a Seed Inspector from exercising any other power conferred on him by or under this Act;
d. he shall, on conviction, be punishable-

i. for the first offence with fine which may extend to five hundred rupees, and

ii. in the event of such person having been previously convicted of an offence under this section, with imprisonment for a term which may extend to six months, or with fine which may extend to one thousand rupees, or with both.

Forfeiture of property

When any person has been convicted under this Act for the contravention of any of the provisions of this Act or the rules made there under, the seed in respect of which the contravention has been committed may be forfeited to the Government.

Offences by companies

1. Where an offence under this Act has been committed by a company, every person who at the time the offence was committed was in charge of, and was responsible to the company for the conduct of the business of the company, as well as the company, shall be deemed to be guilty of the offence and shall be liable to be proceeded against and punished accordingly:

2. Provided that nothing contained in this sub-section shall render any such person liable to any punishment under this Act if he proves that the offence was committed without his knowledge and that he exercised all due diligence to prevent the commission of such offence.
(2) Not withstanding anything contained in sub-section (1), where an offence under this Act has been committed by a company and it is proved that the offence has been committed with the consent or connivance of, or is attributable to any neglect on the part of, any director, manager, secretary or other officer of the company, such director, manager, secretary or other officer shall also be deemed to be guilty of that offence and shall be liable to be proceeded against and punished accordingly.

Questions

1. The seed samples drawn by the Seed Inspector is to verify

   a. Labelling b. Field Inspection

   c. Sowing report d. None

   Ans: a

2. Seed Inspector can draw the sample at selling point. True/False

   Ans: True

Lecture No.33

Seed control order (1983) and new seed policy (2002)

Restriction of Export and Import of Seeds

There is a provision to restrict export and import of seeds of notified kinds or varieties. The section 17 defines as under "No person shall for the purpose of sowing or planting by any person (including himself) export or import or cause to be exported or imported any seed of any notified kind or variety unless

- it conforms to the minimum limits of germination and purity specified for that seed under clause (a) of Section 6 and
- its container bears in the prescribed manner the mark or label with the correct particular thereof specified for that seed under clause (b) of section

Seed (Control) order, 1983

Issue of Licence to dealers

All persons carrying on the business of selling, exporting and importing seeds will be required to carry on the business in accordance with terms and conditions of licence granted to him for which dealer has to make an application in duplicate in Form 'A' together with a fee of Rs.50/- for licence to licensing authority unless the State Government by notification exempts such class of dealers in such areas and subject to such conditions as may be specified in the notification.

Based on such enquiry as it thinks fit for licensing authority may grant in form 'B' or refuse in provisions of the order. The refusal to grant licence shall be accompanied by clear recording of reasons for such refusal.

Renewal of Licence

A holder of licence shall be eligible for renewal upon and applicable being made in the prescribed form 'C' (in duplicate) together with a fee of rupees twenty before the expiry of licence or at the most within a month of date of expiry of license for which additional fee of Rs.25/- is required to be paid.

Appointing of Licensing authority

The state government may appoint such number of persons as it thinks necessary to be inspector and define the area of such inspector's jurisdiction through notification in the official gazette.

Time limit for analysis of samples by seed testing lab

Time limit for analysis of samples by seed testing lab and suspension / cancellation of license may be done by Licensing authority after giving an opportunity of being heard to the holder of license, suspend or cancel the license on grounds of mis-representation of a material in particular or contravention in provision of the order.

Suspension / Cancellation of license

The Licensing authority may after giving an opportunity of being held to the holder of license, suspend or cancel the license on grounds of mis-representation of material in particular or contravention in provision of the Order.

Appeal

The state government may specify authority for hearing the appeals against suspension / cancellation under this order and the decision of such authority shall be final. Any person aggrieved by an order of refusal to grant or amend or renew the license for sale, export / import of seed may within 60 days from the date of Order appeal to the designated authority in the manner prescribed in the Order.

Miscellaneous

The licencing authority may on receipt of request in writing together with Rs.10/- can amend the licence of such dealer. Every seed dealer are expected to maintain such books, accounts and records to this business in order and submit monthly return of his business for the preceding months in Form 'D' to the licencing authority by 5th day of every month

Plant variety protection (PVP) and the Indian Agriculture

(Protection of Plant Variety & farmers right Bill, 2001)

The principle objective of the Plant Varieties Act is to stimulate both the private and public investment in the plant breeding research, and enhance the interest of the plant breeders in the development of outstanding crop varieties and / or propagating materials

by granting variety protection rights, such as control over seed production, marketing, export and import of seeds in respect of the new varieties developed by them. The varieties so protected shall be termed as 'protected varieties'.

Rights of the Holders of Protected Varieties

1. The private organizations / individuals shall have exclusive rights on the funds / dividends arising out of the sale of seeds.
2. The Government of India shall have the exclusive rights on the funds / dividends arising out the sale, in respect of all such protected varieties.

Exchange of Germplasm

The National Bureau of Plant Genetic Resources (NBPGR) shall freely exchange germplasm with all such countries who allow free access to their germplasm with a provision that the germplasm so supplied shall not be transferred to any other country without the authorization by the Government of India (GOI).

Protection of Extent Vareities / Propagating Materials

The 'Export Varieties', that is, the varieties released and notified under the Seeds Act may be granted protection on request for a period of 15 years for crop species and 18 years for tree species. After the expiry of the prescribed period they shall be dealt with in the same manner as the germplasm exchange.

Protection of New Plant Varieties / Propagating Materials

The new variety shall be protected for a period of 15 years for crop species and 18 years for tree species, only if it conforms tot he following criterion:

1. It is clearly distinguishable in regard to at least one identifiable character from all other known varieties of that crop and satisfies the requirements such as, distinctness, uniformity and stability.
2. It has not been marketed in India, prior to the date of filing the application.
3. In other countries it has not been marketed for more than past six years.

Compulsory Licence

The 'Authority' at its discretion may give licence to a person(s) or agency(ies) to whom it considers appropriate for seed production and seed sale of specific varieties for specific periods on prescribed terms and conditions.

Researchers Rights

Nothing in this Act abridges or restricts the rights of the researcher to have free and complete access to protected materials for research use.

Community Rights

The Act recognises the contribution of Indian farmers towards the conservation of local germpalsm / land races.

Farmers Rights

1. The traditional rights of farmers to save, use, exchange, share and sell propagated material / seed.

The farmers will be entitled for suitable compensation from the breeder of the protected variety or sellers in the event of failure in the stated performance of protected variety.

The Intellectual Property Rights (IPRs) are generally being applicable to industrial property only. The patent laws of India did not provide for IPRs on living organisms including plant varieties. The question of plant variety protection has been brought in to sharp focus by Agreement on Trade Related Aspects of Intellectual Property Rights (TRIPS) which is a part of Agreement establishing World Trade Organization (WTO). India is a signatory to TRIPS agreement, which casts an obligation on member countries to provide for a system of plant variety protection either through patents or through a *sui generic* legislation framework or a combination thereof. Under these agreements, a legislative framework for plant variety protection has to be provided by member countries within a specified time period. While this has lent some urgency to the question of plant variety protection, the question of plant variety rights, even independent of the obligations posed by TRIP's agreement, has been under active consideration in view of our strong agricultural research system. The plant breeding programmes have become more sophisticated and high input based. The extent of investment by the State on public

research, in evolving varieties of commercial significance, is coming down with responsibility of evolving new varieties of crops of commercial significance being left to the private sector commercial organisations. There is also a move on the part of the international research institutions, which at one time played a pioneering role in plant breeding and genetic work, to focus on pure or strategic research. In the wake of the global economic liberalization, it is only expected that agriculture is accorded the status of an industry and given all incentives and impetus, normally required for a fast developing, competitive business. To meet our food demands, as well as to exploit our export potential in agricultural commodities, development and use of new plant varieties having specific agronomic nutritive or market preference characteristics are essential. New varieties may be bred for higher yields, greater resistance to biotic and abiotic stresses, longer shelf life, better consumer preference, higher industrial value, low input requirements and so on. To meet these demands the variety improvement activities based on conventional as well as biotechnological methods requires heavy investments both in scientific, man power and economic terms. It is therefore, understandable that the fruits of such intensive efforts will have to be protected from misuse, and also ensuring an appropriate incentive (reward) to the breeder.

New seed policy (1988)

The Government of India evolved a New seed policy implemented from **October 1,1988.** The policy laid special emphasis on

- Import of high quality of seeds
- A time bound programme to modernize plant quarantine facilities
- Effective implementation of procedures for quarantine /post entry quarantine
- Incentives to encourage the domestic industry
- Import of quality seeds.

1. Bulk import of seeds of coarse cereals, pulses and oil seeds may replace (or) displace the local productions.
2. Transfer of technology may not be actual one, because due to bulk import of seeds or import of technology, instead we **can import the germplasm of superior variety if any and could be developed locally to meet the demand**

(i.e.,) incorporate the advantages of exotic variety to the local types(or) even direct multiplication's after adaptive trials.

3. As we have superior varieties of international standard (e.g.) Maize, Sorghum, Bajra, or even in oil seeds like groundnut etc., the **bulk import is not necessiated**. Instead **we need varieties suitable to agroclimatic zones besides higher yields.**
4. Import of flower seeds could be encouraged in order to earn foreign exchange through export of flowers and it can be imported under (OGL) open general license. But there is a fear of introduction of new pest and diseases as they are coming without post entry quarantine checkup.

Strengthening of quarantine

Since, 1st October 1988 only bulk imports of seeds were under taken without any progress either in the strengthening of quarantine facilities.

Threat of pest and disease

Introduction of new pest and disease would pose a new problem due to bulk import due to lack of post entry quarantine. To avoid this threat, the imported seeds should be subjected to testing and it should be done by one person from ICAR. Entry of exotic variety without proper field testing may change the disease pattern if that particular strain is becoming susceptible to existing pathogens.

(e.g.) Kernal bunt - which was not noticed in the previous years, is now a major disease on wheat after the introduction of Kalyansona.

Genetic erosion

It is another danger, due to introduction of similar strains there is a danger of genetic uniformity and eliminates local diversified strains which leads to problem of non-availability of improved strains if there is any out break of disease.

Incentives to domestic seed industry

Indigenous seed production / seed industry will be affected because of the entry of multi nation diseases. Since the policy is allowing indiscriminate bulk imports through

private sectors at the same time the import duty on seeds has been reduced to 15 per cent. Import duty on advanced machines and equipment used in seed production or processing has also been reduced and interest on post shipment credit has also been slashed down to help importers. Income tax rebate and deduction are available to the tax paying units on the revenue expenditure or in house research and development. Incentives are also being provided to seeds located in backward areas and growth centres.

Application of biotechnology in agriculture

The multination would prevent the III world countries in enjoying the full benefit of biotechnology. **The bulk import of seed indicates accepting the monopoly rights and the limitation of potential bio-technology in agriculture.**

Advantages of biotechnology in agriculture

Certain plants fertilize themselves through nitrogen fixation, which is one of the most promising areas of genetic engineering. Bacterium on the roots of plants like groundnut and soybean take nitrogen from the air and transform it into nitrates. Scientists are studying the possibility of transforming the genes responsible for nitrogen fixation in wheat, rice, and maize (in which nitrogen fixation doses not occur). They feel new strains can be grown without expensive chemical fertilizers.

National seed policy, 2002

The Seed Act 1966, seed control order 1983 and New Policy on Seeds Development, 1988, from the basis of promotion and regulation of the Indian Seed Industry.

The "New Seed Policy" of 1988 shared in a new aria of growth and phenomenal development. Because it allowed limited import of commercial seed, remove curbs on imports of seeds of vegetables, Flowers and ornamentals plants and even allowed import of seed of course cereals, pulses and oil seeds for a period of two years.

The important constrains were

- Non existence of National Seed Policy.
- IPR laws.
- Restrictions and licenses on seed exports and imports.
- Lack of incentives for the public and private seed sectors of the country.

India later developed the national seed policy in 2002.The main objectives are the provision of an appropriate climate for the seed industry to utilize available and prospective opportunities, safe guarding of the interests of Indian farmers and the conservation of agrobiodiversity.

Thrust areas

1. Varietal Development and PVP
2. Seed Production.
3. Quality Assurance.
4. Seed Distribution and Marketing.
5. Infrastructure facilities.
6. Transgenic plant varieties.
7. Import of seeds and planting materials.
8. Export of seeds.
9. Promotion of Domestic Seed.
10. Strengthening of monitoring systems.

1. Varietal development and PVP

To stimulate investment in research and development (R&D) new varieties an effective *sui generic* system for IPR will be implemented

- Establishment of PVPFRA (Plant Varieties Protection and Farmers Rights authority, to implement PVPFRA Act, 2001.
- Under this Act, plant varieties will be registered based on Novelty, Distinctness, Uniformity and Stability (DUS) Characters.
- Farmers Rights: Farmers can save use, exchange, share of or sell seeds of protected variety but not under the brand name
- Researchers Rights: Seed/planting material of protected varieties can be used for research and breeding new varieties.
- Breeders Rights: Benefit a rising out of use of varieties upon commercialization of seeds of new variety will be shared with respective breeder.

- Community Rights: Benefit sharing with Farmers / Village communities will be ensured for contributing in evaluation of plant variety upon registration.

2. Seed production

India seed programme will adheres to generation system of multiplication namely nucleus, breeder, foundation and certified seed.

Public seed sector will be restructured and will continue to have free access to breeder seed, while Private Seed Sector will have conditional access. Seed village scheme will be facilitated to upgrade the quality of farmers saved seeds.

Seed Replacement will be raised progressively, National Seed Map will be prepared to identity potential areas of seed production, seed banks will be established with cold storage facilities, seed minikits will be supplied for popularizing new varieties and will Seed Crop Insurance will be encouraged.

3. Quality Assurance

- New Seed Act will be enacted.
- National Seed Board will be established as apex body in place of existing Central Seed Committee to implement New Seed Act.
- National Seeds Register will be maintained varieties will be registered based on "Value for cultivation and Usage". (VCU).

Farmers will retain rights to save, use, exchange, share or sell seeds of any variety but not under the brand name.

4. Seed Distribution and Marketing

1. Seed distribution and marketing of any variety will be subject to register in NSB.
2. National Seed Grid will be established as a data base on seed requirement, production, distribution and farmers preference.
3. Access to finance from commercial banks will be facilitated.
4. Availability of high quality seed will be ensured through improved distribution system and efficient marketing set up.

5. Infrastructure facilities

1. National seed research and training centre (NSRTC) will be set up.
2. Seed processing and storage facilities will be augmented.
3. Computerized National Seed Grid will be established to provide information on seed marketing.

6. Transgenic Plant Varieties:

1. All GM crops will be tested for environment and bio safety before commercial release as per EPA (1986)
2. Seeds of GM crops will be imported only through NBPGR as per the EPA (1986)
3. Required infrastructure will be developed for testing, identification and evaluation of transgenic planting material.

7. Import of seeds and planting material

1. Provision will be made to make available best planting material from any where in the world to Indian farmers without any compromise on quarantine requirements.

8. Export of seeds

1. Long term policy will be evolved to exploit varied agro climatic condition of India and strong seed production system, to raise seed export from present level of less than 1% to 10% by 2020.
2. Seed export promotion zones will be established and strengthened.
3. Data Bank on International Market will be created.

9. Promotion of Domestic Seed Industry

It will be facilitated by providing incentives to domestic seed industry, financial support through NABARD, commercial and co- operative banks, considering tax rebate/concessions for R&D, reduction of import duty on machines and equipments used for seed production and encouragement of membership in national and inter national organization related to seed.

10. Strengthening of monitoring systems

Strengthening of Department of Agricultural and Co-operation (DAC) which will supervise the implementation of National Seed Policy.

National Seed Policy will be vital in doubling food production of India.

Recent developments in Indian Seed Industry

In the growth of seed industry, during 1963 NSC/SFCI was established with the objective of producing foundation and certified seeds. Later on TDC (1969), SSC (1980) and STR (1979) were established. Now 21 STR centres 36 BSP centres and 24 crop based BSP centres on specialized crops. Uniform pricing of breeder seed was adopted in the country. The pricing of foundation and certified seeds is being done through central/state pricing committees; pricing of seed produced by private sector is highly variable. To encourage private seed sector and also to enhance seed developmental programmes in the country, Govt. of India introduced NSPD programme with the objective to import quality seeds time bond programme to strengthen the Indian seed industry effective observance of procedures for quarantine/post quarantine and several incentives to domestic seed industry.

India is the leading country in the world with respect to development of hybrid technology. This has resulted in the development of hybrids in bajra, jowar, maize, castor, sunflower, cotton, pigeon pea, rice, safflower and several vegetable crops. Public sector organization are mostly concentrating on self pollinated crop varieties and hybrids in few crops resulted in the dependency of farmers on the private sector seed in case of low volume crops and hybrids in field and vegetable crops.

As per the investment in the biotechnology in concerned our public and private sector agencies could not cope up with developed countries. At present the share of public is around 40% and private sector is 60%. However efficient marketing of seeds may be possible by sale promotion in India and abroad by public sector agencies.

The private seed sector agencies have an important role in growing seed industry by establishing independent investments in research and development. Infrastructure development for seed production, storage and conditioning, upgrading of quality assurance system, competitive/ complementary role in the development of seed industry. Strengthening of R&D activities can be possible by increasing the research sources in public sector, investment in varietal development in private sector, contract research services by private sector using the resources by public sector, private and public sector should be mutually supportive, removal of all restrictions by central/states for acquisition

of land/use. On today 25 private seed companies have research and development base in India.

The introduction of new varieties in the seed markets, the present system is unsatisfactory, time consuming and biased, responsible for stopping/delaying/not making superior hybrid seeds to the farmers. The new system, the GOI is going to adopt is based on the establishment of National Register or varieties / hybrids, registration based on DUS system. This system should be implemented by independent body under Seed Act 1966 and will be helpful to increase the production and availability of quality seed.

Questions

1. The seed control order emphasizing the need for

   a. Certification b. Seed testing

   c. License for sale of seed d. Notification

   Ans:c

2. The New Seed Policy was introduced in seed industry during

   a. 1988 b. 1999

   c. 1969 d. 2001

   Ans:a

3. Seeds (control) order was proposed during

   a. 1983 b. 1955 c. 1966 d. 1968

   Ans:a

4. Plant quarantine act was passed during the year

   a. 1981 b. 1976 c. 1967 d. 1966

   Ans:a

5. Protection of Plant Variety and Farmer's Right Bill was proposed during

   a. 2005 b. 2001

   c. 1999 d. 2002

   Ans:b

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Lecture No. 34

Seed village concept (or) Compact Area Approach

Seed is the starting point of agriculture and dictates ultimate productivity of other inputs. Good quality seed alone increases the yield by 15-20 per cent. To meet the potential challenge of catering to the food need of 1.4 billion people of our country by 2025, a quantum increase in agricultural productivity is very much essential and hence production and distribution of high quality seeds of improved varieties/ hybrids to the farming community is becoming increasingly important. The expansion of agriculture under tropical conditions due to the improvement of cultivars with juvenile period imposed scientific and technological challenges concerning the seed production under different environmental conditions.

The seed programme includes the participation of state government, SAU system, public sector, cooperative and private sector institutions. With the best efforts of all these organized sectors, only 15-20 per cent of the total requirement of quality seed is being met with. In most kind of seeds, the farmers depend on their own farm saved seeds for crop production which needs certain basic practices of selection of good seeds for sowing. Moreover the crops are raised for market and a small portion of the grains are separated, stored and used as seeds in the next season which may not meet the quality aspects as expected for a seed which results in poor field stand, and ultimately yield. Quality seed is the key input for realizing potential productivity. As the quality deteriorates during subsequent generations the old seed must be replaced with fresh lots of quality seeds. Ideally seed should be replaced every year for hybrids and every three to four years for non-hybrids. Therefore it is necessary to improve the availability of quality seeds to raise the Seed Replacement Rate (SRR). Despite implementation of the organized seed programme, the seed replacement rate has only reached 15 per cent and there exists an alarming gap between the demand and supply of quality seeds. The role of private seed industry in the production and distribution of quality seeds is well recognized in the Indian' seed industry. However, they remain generally in the production of low volume high value seeds, which cater to the needs of only few selected farmers. .

The distribution of high volume low value seeds such as rice varieties, oil seeds and pulses are still with the public sector organization. The non-availability of quality seeds in oilseeds and pulses is one of the main reasons for its lower seed replacement rate. The immediate increase in the productivity and production of these crops can be achieved by a higher distribution of quality seeds of new and high yielding varieties. There is vast scope to produce and distribute quality seeds in these crops for which seed village concept is a navel and highly practical approach and needs to be promoted to facilitate production and timely distribution of quality seeds of desired varieties at village level. In this context, the concept of seed village which advocates village self-sufficiency in production and distribution of quality seeds is getting momentum.

Seed village

A village, wherein trained group of farmers are involved in production of seeds of various crops and cater to the needs of themselves, fellow farmers of the village and farmers of neighboring villages in appropriate time and at affordable cost is called "a seed village".

Concept

- Organizing seed production in cluster (or) compact area.
- Replacing existing local varieties with new high yielding varieties.
- Increasing the seed production.
- To meet the local demand, timely supply and reasonable cost.
- Self sufficiency and self reliance of the village.
- Increasing the seed replacement rate.

Features

- Seed is available at the door steps of farms at an appropriate time
- Seed availability at affordable cost even lesser than market price
- Increased confidence among the farmers about the quality because of known source of production

- Producer and consumer are mutually benefited
- Facilitates fast spread of new cultivars of different kinds

Establishment of seed villages

The present programme of seed village scheme is having two phases

I. Seed production of different crops

Seed village concept is to promote the quality seed production of foundation and certified seed classes. The area which is suitable for raising a particular crop will be selected and raised with single variety of a kind.

1. Selection of area

The area with the following facilities will be selected.

1. Irrigation facilities

2. Suitability of climatic conditions to raise the crop for more than one season

3. Labour availability

4. Knowledge of local farmers on that particular crop

5. Occurrence or out break of pest and diseases

6. Past history of the area for suitability to raise seed crop

7. Average rainfall and distribution

8. Closeness to an urban area for easy movement of seed and other inputs

2. Seed Supply

Suitable area for seed production will be identified by the scientists. The foundation/ certified seeds or University labeled seeds will be supplied by the University through Krishi Vigyan Kendras (KVKs) and Research Stations at 50% subsidy cost to the identified farmers in the area. The farmers will use these quality seeds and take up their own seed production in a small area (1 acre) for their own use. The crops are Rice, Pulses and Oilseeds.

Capacity building

In order to harness the synergy between technologies and the community participation, special emphasis is being given to build farmer's capacity to produce quality seeds. Training on seed production and seed technology to the identified farmers for the seed crops grown in the seed villages will be given for technology empowerment of farmers.

Duration of the training : 3 days
First one day training : At the time of sowing
Training on : Isolation distance, sowing practices, seed treatment, and other agronomic practices.
Second one day training : During flowering
Training on : Identifying off-types and removal, maintenance of seed plots, plant protection measures, maturity status and harvesting methods.
Third one day training : After harvest
Training on : Seed cleaning, grading, seed treating, bagging and storage aspects, seed sampling and sending to seed testing laboratory for analysis.

A seed grower forum will be organized for further empowerment of technology and marketing. .

Seed village programme in Tamil Nadu

In order to promote quality seeds for improving production and productivity, Tamil Nadu Agricultural University is implementing Seed Village Scheme for Development and Strengthening of Seed Infrastructure facilities for production and distribution of quality seeds through three Research Stations and 13 Krishi Vigyan Kendras of TNAU with financial support of Government of India. Karnataka and Andra Pradesh states are also implemented seed village concept effectively.

II. Establishing seed processing unit

Post-harvest seed handling is a vital component of the total technology in marketing available good quality seeds of improved varieties. If the seeds are not processed and handled properly, all the past efforts in production may be lost. Thus seed processing and packaging is very important aspect in seed production.

- The location of seed processing centers is based on the available infrastructure and convenience. Such a place will be well connected with roads and transportation facilities. Each seed processing center will have the following infrastructure. .
- Seed grader cum cleaner
- Bag closer, trolleys, scales and furniture
- Building to house equipment
- Seed storage structure
- Seed threshing and drying yard

Information center

The information center will have internet facility to provide access to information on seed demand and market trends, agriculture market index, weather forecast, plant protection measures etc.,

Advantages of Seed Village Concept or Compact Area Approach

1. Solve the problem of isolation. Mainly in cross pollinated crops like maize, sunflower where it required more isolation distance the problem will be solved by raising a single variety in a large area. Mechanization is possible from sowing to harvesting
2. Post harvest handling of seed is easy.

3. Because of a single variety, the problem of varietal admixture during processing, drying will be avoided

4. Seed certification official will cover large area per unit time

5. Totally it reduces the cost of cultivation

6. Seed will be with high genetic, physical purity

Questions

1. A trained group of farmers are involved in production of seeds in a village called
   a. Seed village b. Contract farming
   c. Quality seed production d. None
   Ans: a

2. Seed Village Concept emphasis the quality seed production : True / False
   Ans: True

Ex. No.1 Studies on seed structure

Seeds are the basic unit of identification of crop species and cultivars can be distinguished from one another either by morphological or physiological or biochemical characteristics and these characteristics are to be reproducible on repeated cultivation under normal agro climatic conditions for maintenance of seed quality in terms of genetic purity. Genetic purity is the trueness of the cultivar where it should be reproduced or resembles its mother in all characters. Botanically seed is defined as a ripened ovule containing an embryo in arrested state of development usually with a food reserve and a protective coat. In seed technological term, the part of a plant used for sowing to raise the crop or any propagative material is known as seed.

Morphological features of seed

The morphological features of seed are associated with physical characteristics and presence or absence of any appendages. Irrespective of seed/species, most common features useful in identification are shape, base of lemma, rachilla hairs, deviation of lateral/dorsal nerves, wrinkling of lemma and palea, shape and hairiness of lodicules etc., in monocots. In dicots, shape, surface texture, micropyle region, hilum, raphe and seed coat characteristics are highly useful in identification of species. In some crops certain special structures serve as identifying characters. But in all species, seed colour and shape serve as eminent charactes of seed identification. Some prominent identifying characters in crop seeds/ varieties are as follows.

Seed size

Seeds can be identified based on the length, width and thickness.

Shape

It is one of the main diagnostic characters of seed. The seeds may be globose or sub-globose or oblong or orbicularor round or flat or rectangular, square, elliptic, etc.,

Seed weight

Seed weight is indicated as the number of seeds per unit weight like gram or kilogram or weight of 1000 seeds. Seed weight often varies considerably within species

because of genetic characters. But is should not be mistaken with the special variations due to the environmental conditions and fertility status of soil.

Surface texture

Seed surface varies from very smooth and glossy to rough and fibrous. Botanical terms applied to the seed surface are smooth, glabrous, wrinkled, ribbed, punctuate, reticulate, pulp, tomentose and hairy.

External structures

Seed coat

It is the outer covering of seed which gives protection. It is developed from the two integuments of ovule. The outer layer of seed coat which is smooth and rough is known as tests and it is formed from outer integument. The inner layer of seed coat is called as Tegmen and is formed from inner integument.

Pericarp

The body of a fruit developed from the ovary wall and enclosing the seed

Raphe

The area between the micropyle and chalaza. The raphe will be visible on the seed coat of some species.

Micropyle

The point where the integuments meet at nuclear apex.

Hilum

It is the scar left on the seed where it was formerly attached to the funicle or placenta.

Caruncle

White spongy out growth of the micropyle seen near the hilum of seed. Eg. Castor, tapioca

Appendages

External attachments on the seed that favours dispersal of seeds or in identification of genotypes.

Aril

Coloured fleshy mass present on the outside of the seed

a. Awn : Thread like projection at the tip of seed. Eg. Paddy

b. Aril	:	Eg. Nutmeg
c. Caruncle	:	Eg. Castor, Tapioca
d. Hairs	:	Minute thread like appendages present on the surface of the seed. Eg. Cotton, Tomato
e. Wings	:	It is the papery structure attached to the side of the seed coat either to a specific side or to all sides. Eg. Moringa

Internal features

Embryo

It is a miniature plant consisting of plumule, radicle and cotyledon (embryonic axis + cotyledon). Plumule + radicle without cotyledon is known as primary axis.

Endosperm

Storage tissue of the seeds which are formed by fusion of pollen cell or sperm nuclei with polar nuclei. It is triploid in nature and non viable.

Cotyledon

It is the storage tissue of dicots and is a part of the embryo. It is viable.

Scutellum

It is the cotyledon of monocot seeds. It is viable

Coleoptyle

It is the covering tissue of miniature plumule, the shoot portion in monocots.

Coleorhiza

It is the covering tissue of radicle, the root portion in monocots.

Plumule

It is a miniature part of shoot region seen both in docots and monocots.

Radicle

Miniature part of root region.

Hypocotyl

Part of seedling which is below the cotyledon and above the radicle.

Perisperm

It is an unutilized part of the nuclear region which is normally visible as a papery growth outside the endosperm and inside the seed coat.

Epicotyl

Part of seedling above the cotyledon and below the primary leaf of seed

Parts of seedling

a) Root

Part seen below the soil surface

b) Shoot

Part seen above the soil surfact

c) Cotyledonary leaf

In dicots, it is the first leaf developing from the seed which gives food to the growing seedlings.

d) Primary leaves

First formed true leaves of plumule, seen in between two cotyledonary leaves. The seedling will be auto tropic after formation of leaves as photosynthesis starts after this stage.

Exercise ; a. study the structure of following horticultural crop seeds

Sl. No.	Crop	Cotyledon	Storage tissue	Endosperm	Germination	Special features
1.	Tomato (*Lycopersicum esculentum)*					
2.	Brinjal (Solanum melongena)					
3.	Chilli (Capsicum annum)					
4.	Gos (cucumis spp.)					
5.	Onion (Allium cepa)					
6.	Bhendi (Abelmoschus esculentus)					
7.	Carrot (Daucus carota)					

8.	Coriander (Coriandrum sativum)					
9.	Pepper (Piper nigrum)					
10.	Cardamom (Cinnamomum cardamom)					
23.	Cabbage (Brassica oleraceae cv. Capitata)					
24.	Cauliflower (Brassica oleraceae cv. Botrytis)					
28.	Lettuce (Lactuca sativa)					
29.	Fenugreek (Trigonnela foenum graecum)					

b. Examine the specimen and draw the structures of various seeds.

Ex. No.2. Study on varietal characters

Introduction

With advances in time and development of breeding techniques , new varieties with specific features are being introduced . The introduction of PPVFRA warrants characterization of each and every varieties including farmers owned varieties. Hence it is necessary to know about the characters of all varieties especially the notified varieties which will also be helpful in conducting roughing operation resulting in production of genetically pure seeds.

Charactertistics of advanced varieties

Tomato

Variety	Duration	Plant characters	Fruit characters
CO 1	135 days	Semi-determinate, dwarf, semi-spreading	Nearly round and smooth, pale green when unripe and red when ripe. Susceptible to cracking
CO 3 (Marutham)	100-145 days	Determinate, dwarf, compact, less sprading	Fruits are borne in clusters, round, globular, smooth, medium sized, parrot green when unripe and capsicum red when fully ripe.
PKM 1	135 days	Determinate, short statured, less spreading with dark green leaves, less hairy.	Flat round with 5-6 grooves, dark green when unripe and capsicum red with prominent green shoulders even after ripening.

Brinjal

CO 1	160 days	Erect, compact, bushy with	Oblong – medium sized, with

		green stem and leaves and greenish purple petiole	pale green shade under white background
CO 2	--	Compact, erect	Fruits have dark purple stripes intermingled with light green colour oblong with smooth calyx.
Annamalai	--	Erect with profuse branching, stem slightly hairy, free from prickles, petiole midriff and veins of the leaves are purple	Long and purple colour.
PKM 1	150 – 155 days	--	Fruits are small with green stripes

Chilli

K-1	210 days	Fall and spreading	Red colour, long
CO 1	210 days	Erect, medium tall, compact	Bright shiny red long with sharp tip and bulged shoulders
PKM 1	180 days	Dwarf	Bold pools with dark red colour

Pumpkin

CO 1	180 days	Vigorous vine and spreads upto 1.2 m, stem often roots at the nodes	Globular, flattened at the base.
CO 2	135 days	Moderately vigorous vines, less sprading	Small, slightly ridged, bright orange coloured flesh.

Ash gourd

CO 1	150 days	Vines moderately	Large fruits, oblong oval in

		vigorous. Leaves dark green	shape, ashy coated
CO 2	120 days	Moderately vigorous, medium dark green leaves	Small fruit, ashy coated oblong and compressed on both sides

Snake gourd

CO 1	135 days	Stem light yellowish green with light green leaves	Round at base with prominent bottle neck at the top, medium sized, attractive green.

Bitter gourd

CO 1	--	--	Dark green, medium long (30 cm) and thick with characteristic warts.
MDU 1	--	--	Long fruits with white colour

Annual moringa

PKM 1	--	Height 4 m/year small leaflets dark green on upper side and pale in lower side.	Flowers in clusters, pods round medium length (70 cm) and weight (150g) with pointed tip.
PKM 2	--	Fast growing, height 4.8 m/year	Pods angular, long pods and heavy fruit weight (280 g)

Exercise: Study the characters of some of the popular national varieties

Ex. No.3. Identification of contaminants

The maximum exploitation of a superior crop variety is possible only if strict attention is paid to maintain high genetic purity, physical purity and physiological quality of the seed. Purity of a variety can deteriorate due to several factors during production cycles. Sources of contamination may be

i) cross – pollination from different cultivars

ii) transmission of designated diseases or

iii) mechanical admixture from adjacent crop during harvest

The major sources of contaminants of seed quality can be classified as genetic and physical contaminants.

1. Genetic contaminants

a. Off – types

Off-types is a plant, which differs, in morphological characters from the rest of the population of a crop variety. They do not confirm to the characters as described by the breeder. They are easily identifiable as it deviates from the given set of morphological characters such as i) bulb, tuber, root features, ii) plant type, branching, pigmentation, mottling, hairiness, stem features, leaf shape and arrangement iii) colour, shape and size of flower and flower parts and iv) colour, size and shape of fruit and seed, iv) characteristics such as duration to flower and maturity, v) tillering, v) male sterility and vi) resistance to disease etc. It may belong to same species of a given variety. Plants of a different variety are also included under off-types.

Mutants, male variants, female variants, contaminant sex expressing plants (*i.e*.,) cucumber etc., are also trated as off types.

To designate a plant as an off type, tracing to any variety is not necessary. During field inspection, an off-type is counted irrespective of its growth stage. If the crop plants and off-types differ so widely in growth stages and contamination is not possible at any stage, then the producer should be informed for their removal.

b. Selfed fruits

In hybrid seed production of tomato, brinjal and muskmelon, selfed fruits are treated as contaminants. The fruits in the seed parent developed due to self-fertilization

from improperly emasculated flowers and flowers which escaped crossing are called selfed fruits.

c. Pollen shedders

These are contaminant plants in the production of parental lines and hybrids. By exploiting male sterility. (Genetic or Cytoplasmic) male sterile line (Line "a"), male fertilie maintainer (Line "B") and restorer (Line "R") are involved in parental and hybrid seed production.

"A" line or male sterile line cannot produce mature, reproductive pollen because of its male sterility. "B" line or male fertile maintainer resembles "A" line in all morphological character, but produces mature viable pollen grains. When "A" line and "B" line are crossed the resultant progeny is male sterile "A" line. In hybrid seed production, male sterile "A" line and "R" line are allowed to cross and the resulting hybrid is male fertile which produces healthy pollen. Hence the presence of "B" line in the "A" line during AxB or AxR crossing programme is called pollen shedder. Some times "A" line tends to exhibit symptoms of fertility on one or more side tillers or one side or part of an ear head. These plants are also called as pollen shedders.

d. Shedding tassels

Tassel is the male or staminate inflorescence at the tip of a sweet corn plant. Shedding tassel means those plants which are shedding pollen in female parent rows. In counting process sucker tassels, portions of tassels and tassels on main plants should be counted as shedding tassel, only when 5 cm or more of the entire spike, the side branches or a combination of the two have the anthers exerted from the glumes and are shedding pollen. Tassels, which have exerted, but not yet shed, are not to be counted, even though these tassels are to be mentioned as "Not commenced shedding". Producer must be informed of these and asked to rogue these tassels before pollen shedding.

II. Physical contaminants

a. Inseparable other crop plants

These plants are very similar and resemble closely to the seed crop plants in habit and growth characters. Separation of 'other crop seeds' is also difficult even by mechanical means. Since these other crop plants have similar habit and growth characters, counting is to be taken up along with other contaminants. Presence of other

crop plants in the seed field must be informed to the producer and asked to remove in time.

b. Objectionable weed plants

Weeds whose seeds are difficult to be separated once mixed with crop seed or which are poisonous or injurious or having smothering effect on the main crop or are difficult to eradicate once established or are having high multiplication ratio thus making their spread quick are termed as 'Objectionable weed plants'.

Exercise: Identify the various contaminants in the given seed production plot and draw Pictures

Ex.No.4. Field inspection and counting procedures

The primary objective of conducting field inspection is to verity the factors which can cause irreversible damage to seed quality by causing genetic and physical contamination.

The objective of field inspection is to verify the following factors:

1. Cropping history
2. Seed source
3. Unit of seed certification
4. Isolation distance
5. Genetic and physical contaminants
6. Border rows

1. Cropping history of seed field

The seeds left scattered in the field from the last crop may cause genetic or physical contamination of the seed crop by volunteer plants. Hence in the previous year or season the same crop of lower standard should not have been grown. The volunteer plants should be destroyed by irrigation and subsequent ploughing, just before sowing or planting.

2. Seed source

Source of seed of the seed crop should be approved and should satisfy the specific requirement of purity. It is verified by checking the certification tag of the source seed used for sowing

3. Unit of seed certification

One unit shall consist of 10 hectares of seed farm. However

i. seed fields should be separated by not more than 50 meters
ii. Planting dates do not differ by more than 7 days
iii. seed crop is of same variety and class

4. Isolation distance

It is distance provided to separate the seed crop from all possible sources of contamination during the growing period. Sources of contamination may be i. cross

pollination from different cultivars ii. transmission of designated diseases or iii. mechanical admixture from adjacent crop during harvest.

5. Genetic and physical contaminants

Proper rouging of physical and genetic contaminants must have been performed so as to confirm to the prescribed Minimum Seed Certification Standard (MSCS). Necessary guidance should be given to the farmers at each stage of field inspection.

6. Border rows

In hybrid seed production field, border rows are used to provide enough pollen and it absorbs foreign pollen thus avoiding contamination of main seed crop. Besides, the planting ratio between male and female parents is also confirmed. Rouging space should also be verified wherever applicable.

Stages and number of field inspection

The number of field inspections and the stages of crop growth at which the field inspection should be conducted vary from crop to crop. It depends upon duration, and nature of pollination of the seed crop. If the crop is grown for hybrid seed production, the no. of field inspections during the flowering stage should be more than in the case of self pollinated / cross / often cross pollinated varieties. In the vegetatively or asexually propagated crops such as potato they are classified as sprouting seedlings, tuberisation, tuber hardening, and haulm cutting stages. The root and bulb crops, inspection at lifting and replanting stage is essential. In cauliflower, the stages comprises are curd formation and bolting and in knol-khol, it is knob formation and bolting and in cabbage it is head formation and bolting.

In cross – pollinated crops inspections during flowering are essential to verify free from genetic contamination. In self-pollinated crops inspection during flowering may help to distinguish off-types. Inspections of cross – pollinated crops at flowering stage must be made without prior intimation to the grower.

For self- pollinated crops, vegetatively propagated crops and for lifting and replanting inspection in root and bulb crops advance intimation can help to reduce the number of inspections.

They key points to be observed at each stage of inspection

	Stage of crop	Key points to be observed at inspection
1.	Pre flowering	a. Verification of seed source b. Confirmation of acreage given in the report c. Land requirement to keep check on genetic as well physical contamination and spread of disease inoculum d. Planting ratio e. Border rows f. Isolation distance g. Guide the grower in identification of off-types, pollen shedder, diseased plants, shedding tassels, etc.
2.	Flowering stage (May be IInd and III rd inspections when 5% of plants begin to flower)	a. Confirm the observation of plants inspection were correct b. Confirm whether grower had continued thorough roughing after the previous inspection. c. Verify the removal and occurrence of off-types, pollen shedders, shedding tassels, objectionable weed plants and diseased plants.
3.	Inspection during post flowering and pre harvesting stage	a. Confirm the correctness of observations, made in earlier inspections b. Guide the grower on roughing based on pods, ear head, seed and chaff characters, colour, shape and size c. Explain to the grower when and how to harvest the crop and process
4.	Inspection during harvest (this is the last inspection conducted on a seed crops)	a. Verify that male parent rows have been harvested separately. b. Ensure complete removal of off-types, other crops, weeds and diseased plants etc. c. Seal properly by the certification agency of the

		threshed produce after initial cleaning & drying d. Instruct the seed growers for safe storage & transporation

Minimum number of field inspections and stages

Crop	Min. no. of inspections	Stages of crop
Tomato, brinjal, chilli, bhendi, cucurbits, watermelon, melons, cucumber, celery, variety	3	1st before flowering, 2nd during flowering and fruiting stage and 3rd during mature fruit stage and prior to harvesting
Tomato, brinjal, cucurbits, watermelon, cucumber, hybrids	4	1st before flowering, 2nd and 3rd during flowering and fruiting stage and 4th at mature fruit stage and prior to harvesting
Amaranth and fenugreek	2	1st before flowering and 2nd during flowering
Lettuce	3	1st before heads (heading type) before full grown stage (non-heading type), 2nd during heads formed stage and full grown stage and 3rd during flowering stage
Cabbage and cauliflower	3	1st before marketable stage, 2nd when heads have formed and 3rd at flowering stage
Knoll-kohl	3	1st before marketable stage of knobs, 2nd when knobs have formed and 3rd at flowering stage
Cabbage, cauliflower, knoll-	3	1st before flower stalk development, 2nd during flowering and 3rd at maturity and

kohl, single cross		prior to harvest
Onion var. and hybrids bulb production	2	1st after transplanting of seedlings, 2nd after bulb have been lifted
Seed production	4	1st before flowering, 2nd and 3rd during flowering, 4th at the stage of maturity
Carrot var. and hybrids Root production	2	1st after 20-30 days of the sowing and 2nd after mother root have been lifted.
Seed production	4	1st before flowering, 2nd and 3rd during flowering, 4th at the stag of maturity
Beet root		
Root production	2	1st after 20-30 days of the sowing and 2nd after roots have been lifted
Seed production	2	1st before flowering and 2nd during flowering
Radish and turnip		
Root production	2	1st after 20-30 days of the sowing and 2nd roots have been lifted
Seed production	1	1st during flowering
Radish & turnip – foundation single crosses and hybrids	3	1st before flowering, 2nd during flowering and 3rd at maturity and prior to harvesting
Potato – tuber production	4	1st 45 days after planting in the hills and 35 days in the plains, 2nd 60-65 DAP for early var. and 70-75 DAP for late var., 3rd immediately after haulms cut / destruction and 4th 10 days after haulms cutting / destruction and before harvesting

True – tuber production	4	1st before flowering, 2nd and 3rd during flowering and 4th during harvesting

Due dates for field inspection for vegetables

Crops				
	Vegetative	Flowering	Flowering (pod / earhead /boll)	Maturity and pre – harvest
Tomato variety	50	75	--	100
Tomato hybrid	45	60	70	90
Brinjal variety	50	70	--	90
Brinjal hybrid	50	70	80	90
Bhendi	40	60	--	70
Chillies (K2)	65	95	-	105
Beans	--	50	--	70
Gourds (pumpkin, ash gourd, bottle gourd)	60	80	--	100
Gourds (snake gourd, bitter gourd, ribbed gourd)	45	60	--	75

Field counting procedures

Field counts

The purpose of field inspection is to find out the field standards of various factors in the seed form. It is impossible to examine all the plants in the seed farm. Hence, to assess the filed standards of various factors random counting is followed. Which in the field sampling of analyzing the genetic purity and health status of the crop. The number of counts taken and the method employed in taking counts vary from crop to crop. Five

counts are taken for an area of up to 5 acres (2 ha) and an additional count is taken for every additional 5 acres (2 ha) or part of as given below

Area of the field in acres	Number of counts to be taken
Upto 5 acres	5
Above 5, up to 10 acres	6
Above 10, up to 15 acres	7
Above 15, up to 20 acres	8
Above 20, up to 25 acres	9

Double count

In any inspection, if the first set of counts shows that the seed crop does not confirm to the prescribed standard for any factor, a second set of counts should be taken for that factor. However, when the first set of counts shows a factor more than twice the maximum permitted it is not necessary to take a second count. On completion of double count assess the average for the two counts. It should not exceed the maximum permissible limit.

Number of plants for a count

Some plants are planted at a narrow or wide spacing. Thus the number of plants comprising a single count differs from crop to crop as given below

No. of platns for a count

	Crop	**No. of plants/heads per count**
1.	Beans, cluster beans, cowpea, greengram, blackgram, Mustard, seasame, bengalgram, safflower, niger	500 plants
2.	Bhendi, brinjal, chilli, castor, cole crops, cotton, cucurbits, Groundnut, maize, potato, red gram, tomato and sunflower	100 plants

Points to be observed before counting

1. All plants falling in each count must be examined for each count must be examined for each factor.

2. In hybrid seed field the prescribed number of counts should be taken in each parent separately.

Contaminants to be observed

I. **Physical contaminants**

1. Inseparable other crop plants
2. Objectionable weed plants volunteer plants
3. Diseased plants

II. **Genetic contaminants**

1. Off-types
2. Pollen shedders / partials
3. Shedding tassels

a. **Off-type**

Off types are plants that differ in morphological characters from the rest of the population of a crop variety. Off-type may belong to same sp or different species of a given variety. Plants of a different variety are also included under off – types. Volunteer plants of same species and mutants are also off types

b. **Volunteer plant**

Volunteer plants are the plants of the same kind growing naturally from seed that remains in the fields from a previous crop.

c. **Pollen shedders**

In hybrid seed production involving male sterility, the plants of 'B' line present in 'A' line are called pollen shedders. Sometimes 'A' tends to exhiit symptoms of fertile anthers in the ear heads of either on the main tiller or side tiller and these are called partials. These partials are also counted as pollen shedders.

d. Shedding tassels

These plants which shed or shedding pollen in female parent rows, when 5 cm or more of the entire spike, which shed or shedding are counted.

e. **Inseparable crop plants**

These are plants of different crops which have seeds similar to seed crop

Crop	**Inseparable crop plants**
Wheat	Barley, oats, gram and triticale

Barley	Oats, gram, wheat and triticale
Oats	Barley, gram, wheat and triticale
Triticale	Wheat, barley, oats, gram and rye

f. **Objectionable weed plants**

These are weeds, whose seeds are difficult to be separated once mixed, poisonous, difficult to eradicate, separate and causes mechanical admixtures. The following are objectionable weed plants in vegetables.

Bhendi	:	Wild okra
Bitter gourd var. hybrids	:	Balsam apple
Cucumber	:	Cucumsis hardwickii
Long melon	:	Weed melong
Musk melon	:	C. prophekarum
Snake gourd	:	Trichosanthes palmate, T. Lobata
Water melon	:	Wild water melon
Amaranth	:	Wild amaranth
Fenugreek	:	Senji
Lettuce	:	Wile lettuce

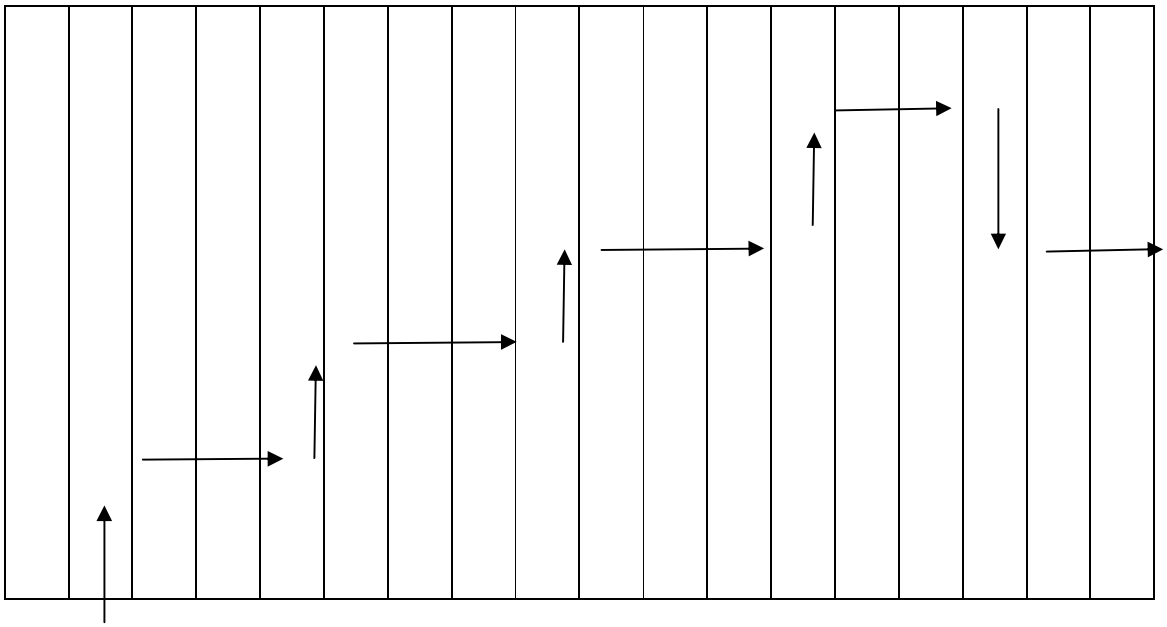
i**. Designated diseases in vegetables**

Seeds are known carriers of harmful pathogens internally or externally or by both causing diseases which make a seed lot unfit for use. During field inspection symptoms of these designated diseases should be observed and counted during vegetative, flowering and maturity stages as indicated in IMSCS. The list of designated diseases in vegetable crops is given below.

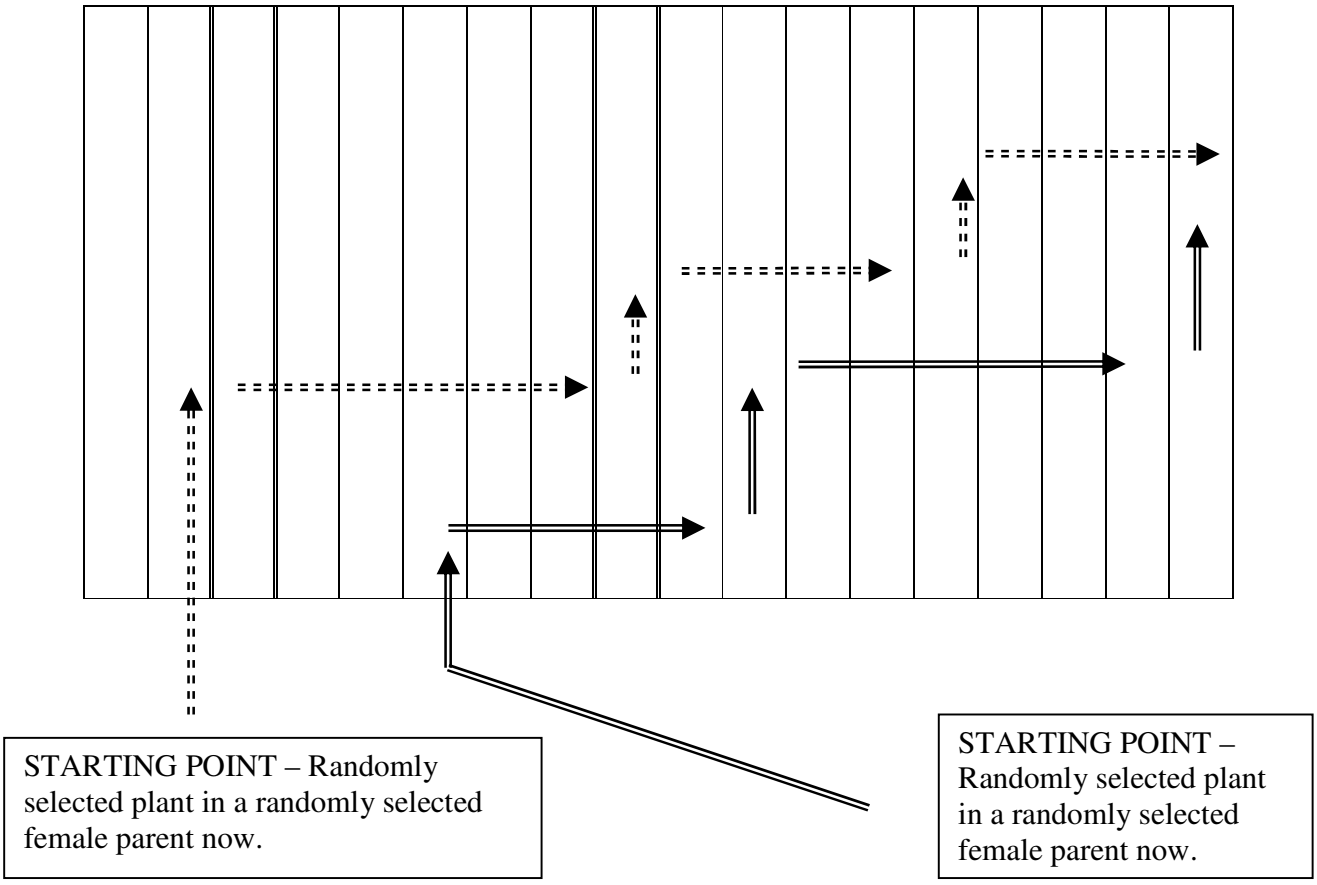
Tomato	:	Early blight
Brinjal	:	Phomopsis blight
Chillie	:	Leaf blight, anthracnose ripe rot
Musk melon	:	Cucumber mosaic virus
Multiple onion	:	Bacterial brown rot (*Pseudomonas aerugnioba)* bacterial soft rot (*Erwinia carotovota)*, basal rot (*Fusarium oxysporum)*

Potato (seed)	:	Mild mosaic (3%), server mosaic, leaf roll and yellw (1%); brown rot (*Pseudomonas aerugnioba)* 3 plants ha-1
celery	:	Leaf blight (septoria appicola); root rot (Phoma apiicola)
Lettuce	:	lettuce mosaic virus
Cabbage	:	Black leg (*Leptosphaeria maculans)*
Cauliflower	:	Black rot (*Erwinia carotovora)*
Know – khol	:	Soft rot (*Erwinia carotovora)*
Radish	:	Black leg, black rot
Potato	:	Mild mosaic (1-3%); severe mosaic, leaf roll and yellows (0.5-1.0%); total virus (1-3%); brown rot (*Pseudomonas solanaceous)* seed tubers showing visible symptoms of late blight (*Phytophthora infestans),* dry rot (*Fusarium caeniteum)* or charcoal rot (*Macrophomnia phaseoli) (1%), wet rot (*Sclerotium rolfsii) nil; common scab (*Streptomyces scabies) – 3-5%; black scurf (*Rhizoctonia solani) – 5%; total diseases – 5%.

Procedure for counting in row crops of open pollinated verities

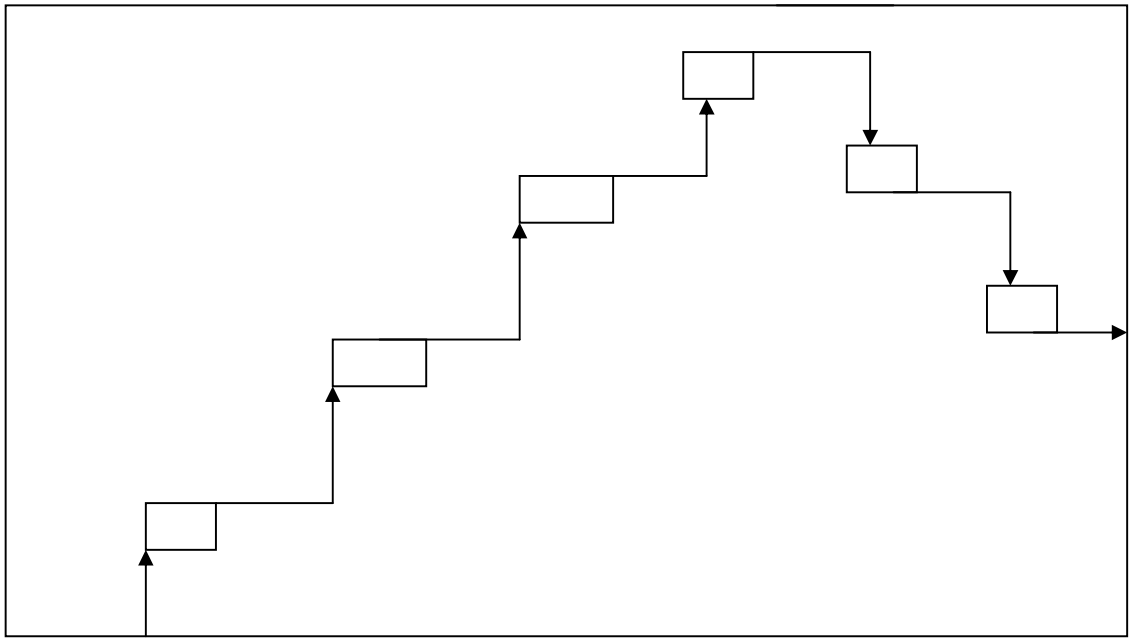


STARTING POINT- Randomly selected plant in a randomly selected row



Caution

In the case of seed production field involving crosses, count should be made in female parent rows first then cross over to female parent row according to the pre-determined number of rows. Repeat this process until required numbers of plants are counted. Then enter a male parent row and count in the same manner.



Starting point – This is one square meter within this area count the number of off types, objectionable weeds, inseparable other crop plants affected by designated diseases. Now move over the predetermined number of steps and continue similar counts.

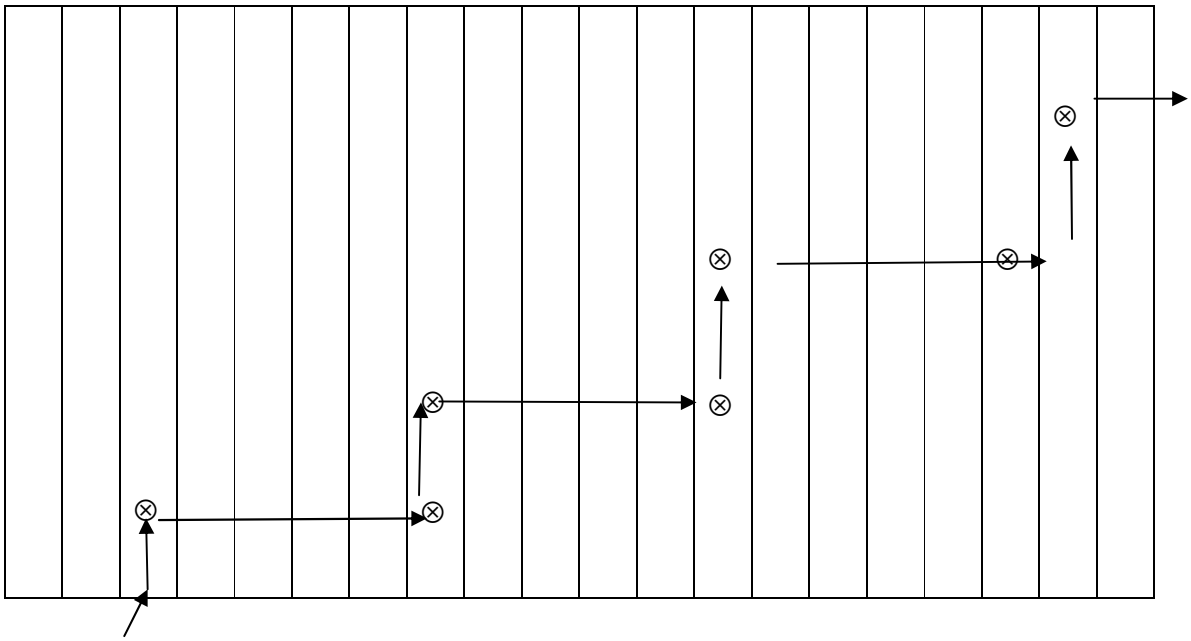
Caution

In the case of broadcast crop estimate the average number of plant / haad population per square meter or per arm strech (and finger closed) in 5 different locations. Then make necessary counts in one square meter space. Move over to another location according to the predetermined number of steps both horizontally and vertically and determine the factors in the one square meter space. Repeat this process until the prescribed numbers of count have been made.

Procedure for counting in medium spaced row crops (beans, cowpea, gram, leaf crops, moong, mustard, peas, sesamusm, safflower, cluster beans and black gram)

Area of the seed field	:	18 acres
No. of counts required	:	8 counts
No. of plants per count	:	500
Total no. of plants to be counted	:	4000
No. of plants per step	:	10
No. of steps required per count	:	50
No. of steps required for & count	:	400
No. of steps to be made per row	:	5 or enough to Include 50 plants

PRE DETERMINED NO. OF ROWS TO CROSS OVER : 4



Exercise: Take field counts and report the results in the given seed production plots

Ex.No. 5. Visit to varietal and hybrid seed production field

Selection of land

In varietal and hybrid seed production plot, selection of land is important. The selected field should be fertile good irrigation and drainage facilities. In addition the selected seed production plot should have proper isolation from contaminants and from the other varieties of the same crop. Not only in the plot within the isolation also should the contaminants and other varieties not present. Hence, in the seed production plot of both varieties and hybrids following factors are to be considered and checked for production of quality seed.

Isolation

- Isolation is separation of seed crop from other crops of same variety or other varieties or source of contamination (Weed spp.) for maintenance of genetic purity.
- The isolation may be space isolation, time isolation, barrier isolation and geographical isolation.

Space isolation

- It is the measurable distance provided between contaminants seed crop and other varieties of the same crop.
- It varies with crops depending upon the pollination behaviour. The isolation distance will be less for self pollinated crops and the distance will be more in case of crops pollinated crops.
- Isolation should be seen even for contaminating weed species.
- The isolation distance will be different for varieties and hybrid where varieties will have lesser isolation than hybrids.
- It is the most important factor influencing the genetic purity of the seed
- It is the easiest management technique for genetic purity maintenance (GPM).

Isolation distance requirement for different crops as per certification standards

Sl. No.	Crop	F.S. (m)	C.S. (m)
1.	Tomato	50	25
2.	Chillies	400	200
3.	Brinjal	200	100
4.	Gourds	1000	500
5.	Bhendi	400	200

Time isolation

- It is separation of varieties / species / contaminants by adjusting the sowing date in such a way that both crop does not come to flowering at the same time.
- It is not widely practiced in crops of indeterminate growth habit due to their continuous flowering habit (Eg. Redgram, Pearl millet).
- Here as the crop comes to flowering at different dates / duration of crossing is modified and the genetic purity in maintained.
- Time isolation is not accepted under certification.

Barrier isolation

- It is separation of crop by raising a barrier in between the crops / varieties expected contamination.
- The barrier may be either living or non-living
- Polythene sheet can be used as barrier
- Thickly grown dense tree crops like *Casuarina,* Daincha, *Seabania are raised as barriers to* avoid contamination between two crops / varieties / contaminations
- It acts as a filter for pollen from other fields.

Geographical isolation

- It is the isolation provided by sowing the crop with different altitudes
- It is possible only in hilly area
- Crops raised in lower terrace will not contaminate crops of higher terrace as there will be in difference flowering.

Planning methods

Seed crop prefers ridges and furrow method of sowing rather than beds and channels, since the earlier system helps in increasing the availability of soil moisture. Depth of sowing is another factor deciding the success of initial establishment in field. Normally sowing seeds at 1-3 cm depth is prefereable for good establishment.

Spacing / plant density

Plant spacing between and within rows also influences the seed yield and quality. Good aeration in seed crop is important for reducing disease incidence and improving pesticide coverage when chemicals are used. Low plant density will increase the ability of weeds to establish. Too low plant density increases the potentiality of the crop to lodge before harvest. Crop density will also affect cultivation practices and harvest, especially in hybrids when the male and female parents are harvested separately. High plant density results in low availability of light, due to shade effect and reduces seed yield and quality.

Row ratio

The ratio of male and female rows in seed production plot is termed as row ratio and it is one of the important factor that influence the seed yield. For obtaining higher seed yield, this ratio has to be optimum. The row ratio should be planned in such a way that the male rows should be able to pollinate the female rows more effectively. In case of hybrids, two specific in bred lines namely female and male lines are required. The following planting ratio may be adopted for each crop as per the certification procedure.

Border rows

Usually border rows will be raised with male parental lines.

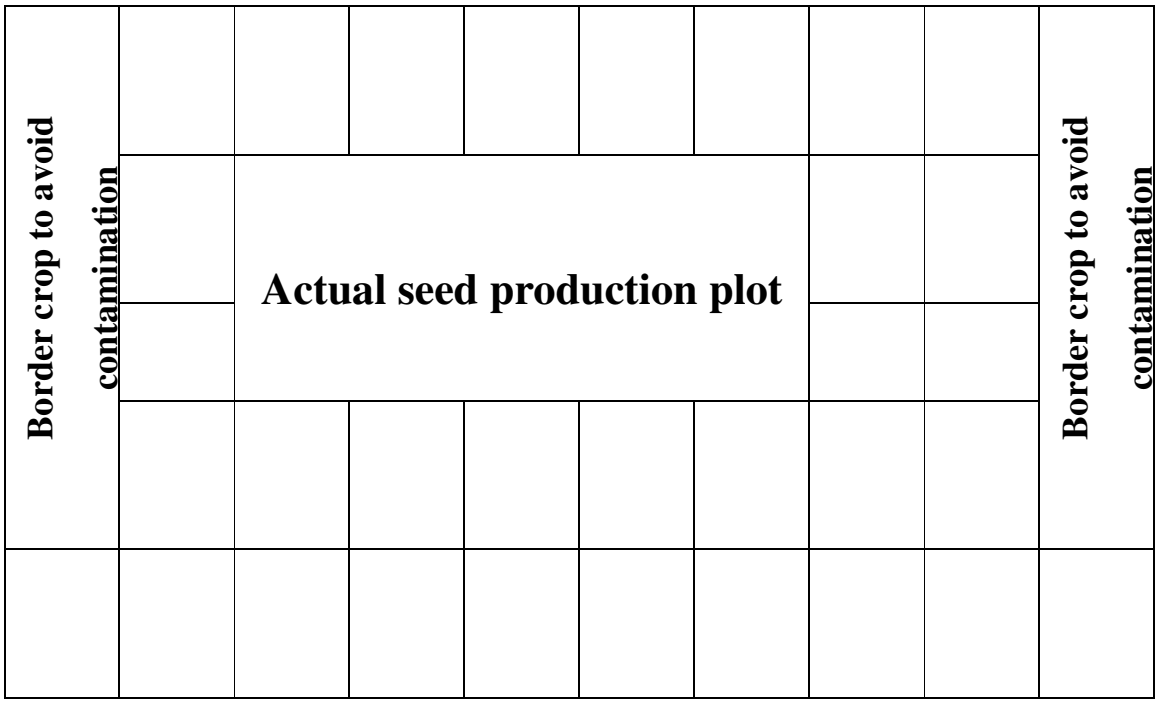
Advantages of border rows

- Helps in protecting the crop from contamination
- Barrier to prevent contamination by pollen from other sources
- Supply additional pollen to the female parent thereby increasing the seed set
- Helps in reducing the isolation distance
- Eg. In maize, for every 15m of isolation border row can be substituted.

Live markers : Live plants used for identification of male line. They should have distinguishable morphological characters (Eg.) Sunflower, Daincha.

Tomato varietal seed production

Border crop to avoid contamination



Border crop to avoid contamination

Chilli hybrid seed production

Border Row (Male)												
Border row (Male)	Female (5)					Male (1)	Female (5)					Repeat the row Ratio (5:1)	Border row (Male)
	*	*	*	*	*		*	*	*	*	*		
	*	*	*	*	*		*	*	*	*	*		
	*	*	*	*	*		*	*	*	*	*		
	*	*	*	*	*		*	*	*	*	*		
	*	*	*	*	*		*	*	*	*	*		
Border Row (Male)													

Chilli varietal seed production

Border crop to avoid contamination

Border crop to avoid contamination									Border crop to avoid contamination
		Actual seed production plot							

Border crop to avoid contamination

Brinjal hybrid seed production (10:1)

Border Row (Male)								
Border row (Male)	Female (10)					Male (1)	Repeat the row Ratio (5:1)	Border row (Male)
	*	*	*	*	*	@		
	*	*	*	*	*	@		
	*	*	*	*	*	@		
	*	*	*	*	*	@		
	*	*	*	*	*	@		
Border Row (Male)								

Brinjal varietal seed production:

Border crop to avoid contamination

Border crop to avoid contamination									Border crop to avoid contamination
		Actual seed production plot							

Border crop to avoid contamination

Cucurbits hybrid seed production (4:1)

Border Row (Male)												
Border row (Male)	Female (4)					Male (1)	Female (4)					Repeat the row Ratio (4:1)	Border row (Male)
	*	*	*	*	*		*	*	*	*	*		
	*	*	*	*	*		*	*	*	*	*		
	*	*	*	*	*		*	*	*	*	*		
	*	*	*	*	*		*	*	*	*	*		
	*	*	*	*	*		*	*	*	*	*		
Border Row (Male)													

Cucurbits varietal seed production:

Border crop to avoid contamination

Border crop to avoid contamination									Border crop to avoid contamination
		Actual seed production plot							

Border crop to avoid contamination

Exercise: Write about your visit to the seed production plot and comment on it

Ex. No. 6. Study of harvest indices, fruit grading and seed extraction techniques

The fruit of angiosperms is the mature ovary or ovaries of one or more flowers, sometimes with accessory structures from other parts of the flowers. Thus fruits can simply be termed as seed bearing structures. A fruit consists of two parts (1) The seeds which develop from the ovules (2) The pericarp or the covering of the fruit which is derived from the wall of the ovary and. In many cases the pericarp is thin and dry but sometimes it is thick and fleshy and can be distinguished into 3 layers (i) exocarp (ii) mesocarp and (iii) endocarp. Fruits can thus be broadly classified into (a) dry and (b) fleshy fruits. What ever may be the type of fruit, after harvesting seeds have to be carefully extracted from the fruits. The seed extraction procedure may differ depending upon the type of fruits.

Dry fruits

The seed removal from the dry fruits is known as threshing or dry extraction. It is done either manually or mechanically. Manual extraction is by beating the bearing structures with seed pliable bamboo sticks or by beating the fruit structures against a hard surface. Threshers and used for mechanical extraction. While using threshers care should be taken to avoid mechanical injury e.g., all agricultural crops.

Wet fruits

Different wet extraction methods are applied for extracting the seeds of wet fleshy fruits especially vegetables like tomato, brinjal and gourds. Among these, extraction is easier in brinjal and ashgourd as the fleshy pulp's interference is less. Here, the seeds are separated from pulp using a sharp knife and are washed with adequate water. For removal of slimyness, seeds are soaked in 0.1% hydrochloric acid (HCl) for 2-3 minutes and after then thoroughly washed with water to remove the traces of acid on the seed coat.

In tomato, seed extraction is done by the following methods.

(i) Fermentation

Fruits with pulp and seed are in a container and kept as such for 24-48 hrs. The seeds will settle down. The decayed pulp and immature seed will float. The settled seeds are separated and repeatedly washed with water and then shade dried followed by sun drying for 8 - 12 hrs.

Advantages

(1) Does not involve high cost.

(2) Does not require skilled labours.

Disadvantages

(1) Time taken for seed extraction is more.

(2) Seed recovery is very low due to natural process.

(3) The colour of the seed will be dull.

(4) Due to microbial action, the seed borne pathogens may develop.

(5) If not dried properly, the germination of the seeds will be affected.

(ii) Acid method

The fruits are cut at the bottom and the pulp without fruit rind is squeezed. Hydrochloric acid (HCl) is added to the pulp @ 10 ml/kg of pulp. This is kept as such for 20-30 minutes with frequent stirring. After 30minutes, the floating traction is removed and the seeds settled down are washed with adequate water for 3 to 4 times. The seeds are then shade dried followed by sun drying. Care should be taken to avoid logging of seeds while drying.

Advantages

(1) High seed recovery

(2) The seed borne pathogen adhering to the seed coat is removed

(3) The colour of the seed coat is bright and so the market value is increased.

(4) Germination is improved since the overall seed quality is increased.

(5) Time taken for seed extraction is very less.

Disadvantages

(1) Cost of seed extraction is more since it involves chemical cost.

(2) If the traces of acid are not thoroughly washed, it may affect the germination.

(iii) Alkali method

The fruits are squashed and alkali mixture (900 g of ordinary washing soda added to 4 litres of boiling water) is added is equal volume. When the alkali mixture is cooled, allow it all to sland overnight in an earthern pot. Next day, all the seeds will settle down at the bottom of the container and the liquid is decanted off. Seeds are washed thoroughly with clean water and allowed to dry in the sun

Advantages

(1) The seed recovery is higher, compared to fermentation method.

Disadvantages

(1) The toxicity of the chemical may be injurious to the seeds

(2) The luster of the seeds will be lost

(3) If the conc. of alkali is high, it will affect the viability of seeds

(4) Due to corrosive nature of alkali, the seed coat and other constituents are damaged.

Seed extraction in cucurbitaceous vegetables

Cucurbits

The cucumber family (*Cucurbitaceae*), commonly referred to as 'cucurbits', includes Cucumbers, melons, squashes, pumpkins and gourds. They are warm season crops and very susceptible to frost regions having high temperatures and low humidity are ideal for the production of cucurbit seeds. The seeds of the cultivated cucurbits vary in size, shape, colour, the presence of absence of a margin and in the type of scar formed

at the hilum. In general, each seed has a firm testa of several layers, a thin collapsed perisperm and endosperm and a large embryo. The embryo consists of two large, flat, leaf like cotyledons and a small radicle.

Seed Extraction Techniques

For 'wet seeds' such as cucumber, wax gourd, bitter gourd and melons, cut the fruit lengthwise and scrape seeds out with a spoon. Allow seeds and the jellylike surrounding liquid to sit in a container at room temperature for 1-2 days. Fungus may start to form on top. Stir daily. The jelly will dissolve and good seeds will sink to bottom while remaining debris and immature seeds can be rinsed away. Spread seeds on a paper towel or screen until dry.

For 'dry seeds' such as luffa and bottle gourd, keep the seeds in the fruit until they naturally separate from the flesh. This can be identified when you shake the fruit, the sound of seeds moving inside is heard. Cut off the bottom of the fruit and shake the seeds out, winnow to clean the remaining chaff, then place the seed on a screen for further drying before storage.

It is wise to complete the seed extraction and drying on the same day, therefore, referring the weather forecast and choosing fine day the work is to be started from early morning.

Exercise:

Collect information on various extraction techniques adopted in various crops

Collect pictures on seed harvesters and extractors

Compare the quality variations observed in the various extraction techniques

Crop	**Harvest indices**	**Extraction techniques**	**Grading techniques**

Exercise No. 7. Seed production planning – calculation of area requirement for different classes of seed and seed production economics

Seed is a commercial product and it requires proper planning for regular and uninterrupted supply of seed for commercial production. Knowledge on economics motivates the proper planning for higher profit.

Basic information needed on planning for seed production for different classes of seeds in varieties and hybrids

Quantity of seeds required = Area x Seed rate

Area to be covered = Quantity of seeds required / Seed yield

Example

A farmer wants to cover an area of 2000 ha under certified seed production. What will be the quantity of breeder seed, foundation seed and certified are requirement to cover the above area?

Area = 2000 ha

Seed rate = 20 kg/ha

Yield = 1000 kg

Quantity of C.S. require to cover 2000 kg	=	2000 x 20	=	40,000 kg
Area is required for produce 40, 000 kg of C.S.	=	40,000/1000	=	40 ha
Quantity of F.S. needed to cover the area of 40 ha	=	40 x 20	=	800 kg
Area needed to produce 800 kg of F.S.	=	800 / 1000	=	0.8 ha
Quantity of B.S. needed to cover the 0.8 ha	=	0.8 x 20	=	16 kg
Area of B.S. to produce 16 kg	=	16/1000	=	0.016 ha

Result

	C.S.	F.S.	B.S.
Area (ha)	40	0.8	0.016
Quantity (kg)	40,000	800	16

2. Calculate the area is quality of F.S. & B.S. needed to cover and area of 1000 acres of hybrid seed production in tomato?

Seed yield of A, B & R line	=	200 kg/ac
B.S. & F.S	=	100 kg/ac
Seed rate	=	2 kg/ac
Area	=	1000 ac
Quantity of seeds require for 1000 ac at rate of 2 kg/ac	=	1000 x 2
	=	2000 kg/ac
Area required for produce 2000 kg at the rate of 2000 kg/ac		
(i.e.) seed yield	=	2000 / 200=10 ac
Quantity of seeds (A x R) required for covering 10 a/c		
Quantity of seeds needed for A line	=	10 x 2=20 kg
Area under F.S		
A x R lines at rate of 20 kg & 10 kg A	=	20/200=0.1 ac
R	=	10/200=0.05 ac
Quantity of F.S. needed to cover the area for A x B x R		
A	=	0.1 x 2 = 0.2 kg
B	=	0.1 x 2 = 0.2 kg
R	=	0.05 x = 0.05 kg
Area under B.S. needed to produce, A, B&R at yield of 100 kg		
A&B	=	0.2/100=0.002ac
R	=	0.05/100=0.005ac
Quantity of B.S. needed at 2 kg of A &B	=	0.02 x 2 = 0.004 kg
Quantity of B.S. needed at 1.0 kg for R	=	0.005 x 1 = 0.005 kg

Parental line	**F.S.**			**B.S.**		
	A	**B**	**R**	**A**	**B**	**R**
Area (ac)	0.1	0.1	0.05	0.02	0.02	0.005
Quantity	0.1	0.2	0.05	0.04	0.004	0.005

3. Target area 7,000 ac under C.S. production what will be the quantity of B.S., F.S & C.S area to cover that area?

Seed rate	=	30 kg/ha
Seed yield	=	1000 kg/ha
Area	=	7000 ac
Quantity of C.S. to cover 7,000 ac @ 30 kg/ac	=	7000 x 30
Area needed to produce 2, 10,000 kg of C.S. @ yield of 1000 kg/ac	=	2,10,000/1000
		210 ac
Quantity of F.S. needed to cover of 210 ac	=	210 x 30
	=	6300 kg
Area needed to produce 6300 kg of F.S. at yield of 1000 kg/ac	=	6300/1000
	=	6.3 ac
Quantity of B.S. to cover 6.3 ac	=	6.3 x 30 = 189 kg
Area of B.S. to produce 189 kg@yield of 1000 kg/ac	=	189/1000
	=	0.189 ac

C.S.	**F.S.**	**B.S.**	
Area (ac)	210	6.3	0.189
Quantity (kg)	2,10,000	6300	189

Calculate the area and quantity of F.S & B.S. needed to cover an area of 30,000 ac under hybrid?

Seed yield (A, B & R line)

Certified seed	=	400 kg/ac
Foundation seed	=	200 kg/ac
Breeder seed	=	100 kg/ac
Seed rate A & B	=	2 kg/ac
Seed rate	=	1 kg/ac
Area needed to produce hybrid seed	=	30,000 ac
Quantity of seed needed @ 2 kg/ac for 30,000 ac	=	30,000 x 2

= 60,000 kg

Area needed to produce 60,000 kg @ yield of 400 kg= 60,000/400

= 150 ac

Quantity of seed A x B needed to cover 150 ac (or)

Quantity of seed require A=150x2 = 300 kg

R = 150 x 1 = 150 kg

A x B lines at rate of 300 kg & 150 kg

Quantity of seed required for F.S

For A line = 1.5 x 2 = 3 kg

B line = 1.5 x 2 = 3 kg

R line = 0.75 x 1 = 0.75 kg

Area under B.S. to produce A,B,R @ yield 100 kg /ac

A line = 3/100 = 0.03 kg/ac

B line = 3/100 = 0.03 kg/ac

R line = 0.75/100=0.0075/ac

Quantity of B.S. needed @ Ax B

A & B = 0.03 x 2 = 0.06 kg

R = 0.007 x 1 = 0.007 kg

	C.S.			**F.S.**			**B.S.**		
	A	B	R	A	B	R	A	B	R
Area	150	150	75	1.5	1.5	0.75	0.03	0.03	0.007
Quantity (kg)	300	300	150	3	3	0.75	0.06	0.06	0.007

Exercise No. 8. Visit to seed production and processing unit

Ex. No. 9. Seed sampling equipments mixing and dividing methods

Seed sampling is to draw a portion of seed lot that represents the entire seed lot.

Introduction

Seed lot - It is a uniformly blended quantity of seed either in bag or -in bulk.

Seed Size	Maximum quantity per lot
Larger than wheat and paddy	20,000 kg
Smaller than wheat and paddy	10,000 kg
Maize	40,000 kg

Sampling intensity

a. For seed lots in bags (or container of similar capacity that are uniform in size)

I. up to 5 containers — Sample each container but never, < 5 Primary sample

6-30 " — Sample atleast one in every 3 containers but never > than 5 P. S.

31-400 " — Sample atleast one in every 5 containers but never < 10 P. S.

401 or more — Sample atleast one in every 7 containers but never < 80.

II. When the seed is in small containers such as tins, cartons or packets a 100 kg weight is taken as the basic unit and small containers are combined to form sampling units not exceeding this weight e.g. 20 containers of 5 kg each. For sampling purpose each unit is regarded as one container.

b. For seeds in bulk

Up to-500kg	-	Atleast 5 Primary sample
501 - 3000 Kg	-	1 Primary sample for each 300 kg but not less than 5 Primary sample
3001-20,000 Kg	-	1 Primary sample for each 500 kg but not less than 10 Primary sample
20,001 and above	-	1 Primary sample for each 700 kg but not less than 40

Primary sample

Principles of sampling

Sample is obtained from seed lot by taking small portion at random from different places and combining them. From this sample smaller samples are obtained by one or more stages. In each and every stage thorough mixing and dividing is necessary.

Methods of sampling

a. Hand sampling

This is followed for sampling the non free flowing seeds or chaffy and fuzzy seeds such as cotton, tomato, grass seeds etc., In this method it is very difficult to take samples from the deeper layers or bag. To over come this, bags are emptied completely or partly and then seed samples are taken. While removing the samples from the containers, care should be taken to close the fingers tightly so that no seeds escape.

b. Sampling with triers

By using appropriate triers, samples can be taken from bags or from bulk.

1. Bin samplers

Used for drawing samples from the lots stored in the bins.

2. Nobbe trier

The name was given after Fredrick Nobbe- father of seed testing. This trier is made in different dimensions to suit various kinds of seeds. It has a pointed tube long enough to reach the centre of the bag with an oval slot near the pointed end. The length is very small. This is suitable for sampling seeds in bag not in bulk.

3. Sleeve type triers or stick triers

It is the most commonly used trier for sampling: There are two types *viz*.,

1. With compartments 2. Without compartments.

It consists of a hollow brass tube inside with a closely fitting outer sleeve or jacket which has a solid pointed end. Both the inner tube as well as the outer tube has been provided with openings or slots on their walls. When the inner tube is turned, the slots in the tube and the sleeve are in line. The inner tube may or may not have partitions.

This trier may be used horizontally or vertically. This is diagonally inserted at an angle of 30^0C in the closed position till it reaches the centre of the bag. Then the slots are opened by giving a half turn in clockwise direction and gently agitated with inward push and jerk, so that the seeds will fill each compartment through the openings from different layers of the bag, then it is again closed and with drawn and emptied in a plastic bucket. This trier is used for drawing seed samples from the seed lots packed in bags or in containers.

Types of samples

1. Primary sample

Each probe or handful of sample taken either in bag or in bulk is called primary sample.

2. Composite sample

All the primary samples drawn are combined together in suitable container to form a composite sample

3. Submitted sample

When the composite sample is properly reduced to the required size that to be submitted to the seed testing lab, it is called submitted sample. Submitted sample of requisite weight or more is obtained by repeated halving or by abstracting and subsequently combining small random portions.

4. Working sample

It is the reduced sample required weight obtained from the submitted sample on which the quantity tests are conducted in seed testing lab.

Weight of submitted sample

The minimum weights for submitted samples for various tests are as follows

1. Moisture test

100 gm for those species that have to be ground and 50 gm for all other species. 2.For verification of species and cultivar

2. For verification of species and cultivars

Crop	Lab only (g)	Field plot & Lab (g)
Peas, beans, maize, soybean and crop seeds of similar Size	1000	2000

Barley, oats, wheat and crop seeds of similar size	500	1000
Beet root and seeds of similar size	200	500
All other genera	100	250

3. For other tests like purity and count of other species

Crop	Size of seed lot (kg)	Size of submitted sample	Size of working purity	Sample count of other species
Brinjal	20,000	1000	140	1000
Chillies	10,000	70	7	70
Bhendi	10,000	7	7	7
Tomato (variety)	10,000	100	10	100
Tomato (hybrid)	10,000	100	10	100
Cabbage	10,000	100	10	100
Cauliflower				
Knolkhol				

The samples taken may packed in bags, sealed and marked for identification. For moisture testing the samples should be packed separately in moisture proof polythene bag and kept in the container along with the submitted samples.

Information to accompany the sample

Date Kind Variety

Class of seed Lot No.

Quantity of seed in lot (kg)

Tests) required (1) Purity (2) Germination (3) Moisture

Senders Name and Address

Types of sample used in Seed Testing Laboratory

Service sample **-** Sample received from the farmers

Certified sample **-** Sample received from certification agencies or officers

Official sample - Sample received from the seed inspectors.

Mixing and dividing of seeds

The main objective of mixing and dividing of seeds is to obtain the representative homogenous seed sample for analysis by reducing the submitted sample to the desired size of working sample.

Method of mixing and dividing

1. Mechanical dividing
2. Random cups method
3. Modified halving method
4. Spoon method
5. Hand halving method

I. Mechanical method

The reduction of sample size is carried out by the mechanical dividers suitable for all seeds except for chaffy and fuzzy seeds.

Objective of mechanical dividing

- To mix the seed sample and make homogenous as far as possible
- To reduce the seed sample to the required size without any bias
- The submitted sample can be thoroughly mixed by passing it through the divider to get 2 parts and passing the whole sample second time and 3rd time if necessary to make the seeds mixed and blended so as to get homogenous seed sample when the same seeds passed through it into approximately equal parts.
- The sample is reduced to desired size by passing the seeds through the dividers repeatedly with one half remain at each occasion.

Types of mechanical dividers

1. Boerner divider

It consists of a hopper, a cone and series of baffles directing the seeds into 2 spouts. The baffles are of equal size and equally spaced and every alternate one leading to one spout. They are arranged in circle and are directed inward. A valve at the base of the hopper retains the seeds in the hopper. When the valve is opened the seeds fall by gravity over the cone where it is equally distributed and approximately equal quantity of seeds will be collected in each spout. A disadvantage of this divider is that it is difficult to check for cleanliness.

2. Soil divider

It is a sample divider built on the same principles as the Boerner divider. Here the channels are arranged in a straight row. It consists of a hopper with attached channels, a

frame work to hold the hopper, two receiving pans and a pouring pan. It is suitable for large seeds and chaffy seeds.

3. Centrifugal or Gamet Divider

The principle involved is the centrifugal force which is used for mixing and dividing the seeds. The seeds fall on a shallow rubber spinner which on rotation by an electric motor, throw out the seeds by centrifugal force. The circle or the area where the seeds fall is equally divided into two parts by a stationary baffle so that approximately equal quantities of seed will fall in each spout.

II. Random cup method

This is the method is suitable for seeds requiring working sample upto 10 grams provided that they are not extremely chaffy and do not bounce or roll (e.g.) Brassica spp.

Six to eight small cups are placed at random on a tray. After a preliminary mixing the seed is poured uniformly over the tray. The seeds that fall into the cup is taken as the working sample.

III. Modified halving method

The apparatus consists of a tray into which is fitted a grid of equal sized cubical cups open at the top and every alternate are having no bottom. After preliminary mixing the seed is pouted evenly over the grid. When the grid is lifted approximately half the sample remains on the tray. The submitted sample is successively halved in this method until a working sample size is obtained.

IV. Spoon method

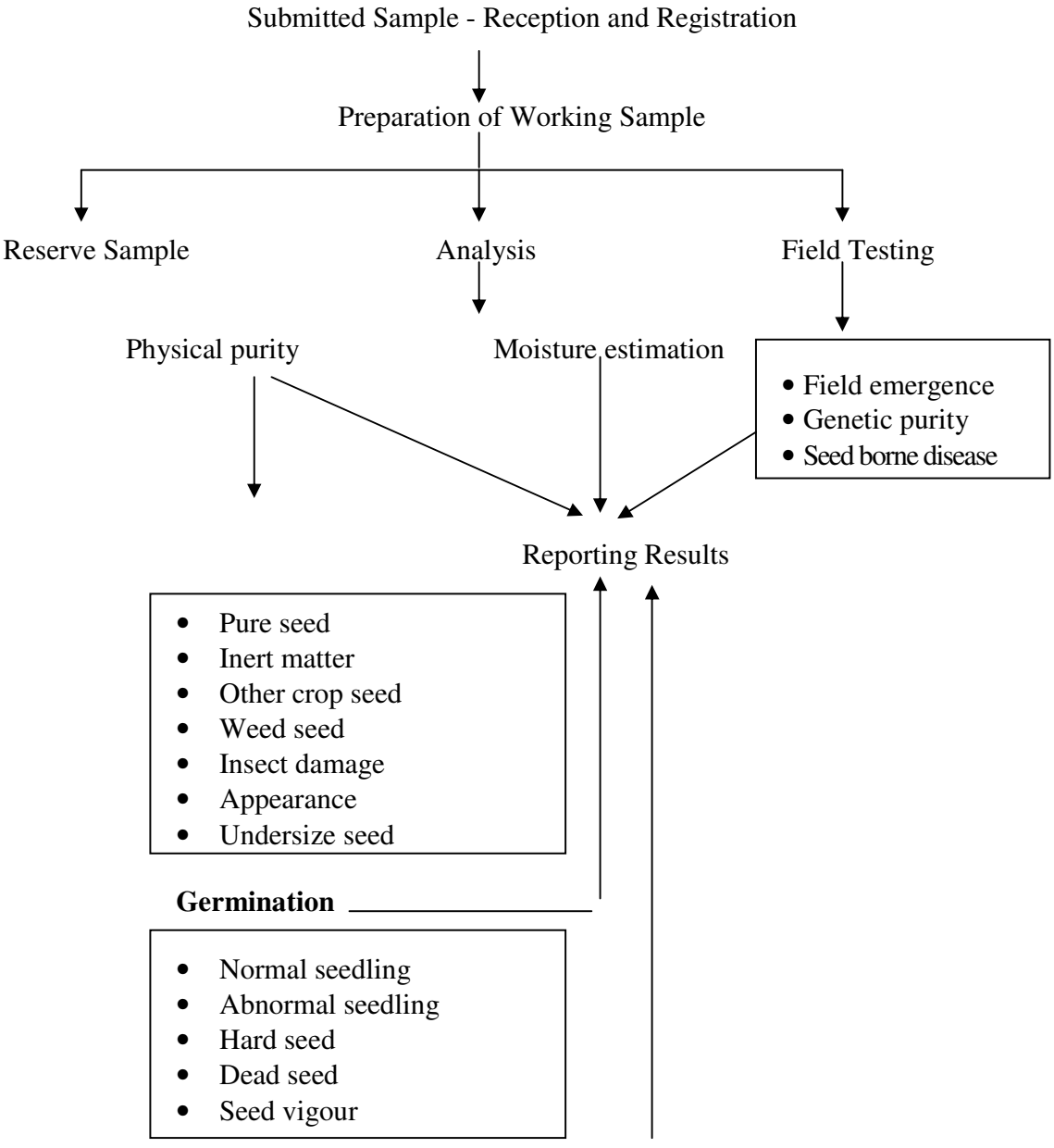
This is suitable for samples of single small seeded species. A tray, spatula and a spoon with a straight edge are required. After preliminary mixing the seed is poured evenly over the tray. The tray should not be shacked there after. With the spoon in one hand, the spatula in the other and using both small portions of seed from not less than 5 random places on the tray should be removed. Sufficient portions of seed are taken to estimate a working sample of approximately but not less than the required size.

V. Hand halving method

This method is restricted to the chaffy seeds. The seed is poured evenly on to a smooth clean surface and thoroughly mixed into a mound. The mound is then divided

into 1/2 and each half is mound again and halved to 4 portions. Each of the 4 portions is halved again giving 8 portions. The halved portions are arranged in rows and alternate portions are combined and retained. The process is repeated until the sample of required weight is obtained.

Steps followed in seed testing laboratory



Exercise

Draw the pictures of various equipments used in sampling and dividing.

How will you obtain working samples from given submitted samples.

Ex.No. 10. Estimation of moisture

Seed moisture is one of the intrinsic factor that affects the quality of seed particularly in storage of seeds. In seed storage and seed quality are important

Seed moisture

Seed moisture is one of the most important deciding factors of seed viability and quality during storage. Hence, determination of seed moisture content and drying to the safe moisture content is utmost important before transit and storage. Moisture content of the seed sample is defined as that loss of weight when it is dried in accordance with the rules or the amount of water collected when it is distilled (ISTA, 1985). It is expressed as percentage of the original weight of sample (wet basis).

Principle

Moisture present in the seed is removed completely as much as possible without oxidation or decomposition or loss in other volatile substances by applying heat. The weight loss due to drying is estimated and the moisture content is calculated.

Objective

- To study the different methods of seeds moisture estimation
- To assess the moisture content of a given seed lot
- To study the pattern of water imbibition in different crop seeds

Precautions

For moisture determination, the samples received in seed testing laboratory mush be packed in moisture vapour proof containers. Samples should not be exposed to open atmosphere to avoid hydration or drying of seeds. Relative humidity in the laboratory must be less than 70% during testing. Lapse of time should not be more than 3 minutes after opening of container for the species which requires grinding and 30 seconds for species which requires no grinding.

Indirect methods

Indirect methods of moisture estimation based on the dielectric property (conductivity and resistance) of seed are moisture meter and nuclear magnetic resonance methods (NMR). The moisture meter is working on the principle that the amount of

moisture present in the seed is directly proportionate to the electrical conductivity and reversely proportionate to the electrical resistance of the seed.

Direct methods

Air oven method

This is the most practical and basic method prescribed by ISTA (1985). In this method, moisture present in the seed is completely evaporated either after grinding or without grinding by heating in oven (high or low constant) and the amount of moisture loss by weight is estimated and expressed in percentage. The sample is weighed approximately 4-5 g for seeds having less than 8 mm size and 10 g for seeds having more than 8 mm size, in duplicate. The sample should be weighed in 3 decimal places.

Grinding

Large seeds must be ground before drying (eg. Barley, paddy, sorghum, maize, groundnut, chickpea, gram, peas, soybean, cotton, castor). For cereals and cotton, fine grinding is necessary so that at least 50% of the ground seed should pass through 0.5 mm wire mesh sieve and not more that 10% retain on 1.0 mm sieve. For large seeds, coarse grinding is necessary so that at least 50% of the material should pass through 4.0 mm sieve size (legume and tree seeds). Species which require grinding before drying are : Paddy, wheat, oat, barley, sorghum, maize, black gram, green gram, chickpea, pigeon pea, peas, beans, soybean, groundnut, castor, cotton etc., However, cereals and cotton requires find grining.

Pre-drying

For seeds which require graining and with more than 17% (10% for soybean and 13% for rice) moisture content, pre-drying is necessary. For oilseed with high moisture content, just cutting into pieces is enough. For maize with more than 25% moisture, seeds should be spread in a layer not more than 20 mm and dried at 700C for 2-5 hours. For other species with more than 30% moisture, seeds should be dried in warm places, over night. In other cases, the samples should be pre-dried in an oven at 1300C for 5-10 minutes. After weighing the sample, it should be placed for about 2 hours, before second stage of drying for tempering.

Low constant oven method

Weigh the container and its cover before and after taking the sample in the container. Then place the container with seed in an oven maintained at 103 ± 2^0C for 17 ± 1 hour. This method is suitable for oily seeds such as onion, capsicum, brinjal, soybean, radish, groundnut, castor, mustard, sesame, cotton etc.,

High constant oven method

The sample is dried in an oven at 130 ± 3 for about 4 hours for maize, 2 hours for other cereals and 1 hour for others. This method is suitable for all other species except those seeds contain volatile oil. The containers used for moisture estimation by above methods should be made up of glass or non corrosive metals with wider mouth. While drying, spreading seed in uniform layer (not more than 0.3 g cm^{-2}) is necessary. After drying the seeds either in low or high constant ovens, the seed samples are placed in desiccators containing calcium chloride (CaCl2) for few minutes and weighed and the percentage moisture content is calculated using the following formula:

$$\text{Moisture content (\%)} = \frac{M2-M3}{M2-M1} \times 100 = \frac{\text{Loss in weight}}{\text{Weight of seed}} \times 100$$

Where,

M_1 = Weight of the empty container and cover

M_2 = Weight of container with seed before drying

M_3 = Weight of container with seed after drying

In the event of moisture estimation by stage drying, the percentage moisture content is calculated using the following formula

Moisture content (%) = S1 +S2 – (S1 x S2 /100)

Where,

S_1 = Moisture loss in first stage of drying

S_2 = Moist loss in second stage of drying

Tolerance

Between two samples or replications, the difference should not exceed 0.2 %. Based on the ISTA congress held at Ottawa in 1985, the tolerance limit is rebuilt as follows:

Categories of seed	Tolerance
Small seeds with less than 12% moisture content	0.3
Large seeds with less than 12% moisture content	0.4
Small seeds with less than 12% moisture content	0.5
Large seeds with less than 12-25% moisture content	0.8
Large seeds with less than 25% moisture content	2.5

Exercise

List out the other types of moisture estimation

Draw the picture of moisture meter

Estimate the moisture content of green samples by oven method

M1 = Initial weight of the moisture bottle

M2 = Weight of moisture bottle with seed

M3 = Moisture content of the sample after drying

Ex. No. 11. Purity analysis – equipments used – reporting results

The physical purity analysis of a seed sample in the seed testing lab. refers to the determination of the different components of the physical purity viz., pure seed; other crop seeds, weed seeds and inert matter.

Objective

The objective of the purity analysis is to determine whether the submitted sample (by inference of the seed lot) conforms to the prescribed quality standards in regard to purity components.

Method

1. The working sample

The purity analysis is done on the working sample of prescribed weight drawn from submitted sample.

The analysis may be made on one working sample of the prescribed weight, or on two sub-samples of at least half this weight, each independently drawn.

2. Weighing the working sample

The no. of decimal places to which the working sample and the components of the working sample should be weighed as below:

Weight of the working sample in gram	The no. of decimal places required	Example
< 1	4	0.7534
1- 9.999	3	7.534
10 - 99.99	2	75.34
100 - 999.9	1	753.4
1000 or more	0	753.4

3. Purity separation

The working sample after weighing is separated into its components viz., pure seed, other crop seed, weed seed and inert matter.

Pure seed

The seeds of kind/ species stated by the sender. It includes all botanical varieties of that kind/species.

Immature, undersized, shrivelled, diseased or germinated seeds are also pure seeds.

It also includes broken seeds, if the size is > ½ of the original size. Except in leguminosae, and cruciferae where the seed coats entirely removed are regarded as inert matter.

Other crop seed

It refers to the seeds of crops other than the kind being examined.

Weed seed

It includes seeds of those species normally recognized as weeds or specified under seed Act as a noxious weed.

Inert matter

It includes seed like structures, stempieces, leaves, sand particles, stone particles, empty glumes, lemmas, paleas, chaff.

Awns, stalks longer than florets, spikelets are to be removed and treated as inert matter.

4. Method of purity separation

Place the sample on the purity work board after sieving / blowing operations and separate into other crop seeds, weed seeds and inert matter.

After separation, identify each kind of weed seeds, other crop seeds as to genus and species. The names and no. of each are recorded.

The type of inert matter present should also be noted.

5. Calculation

All the four components must be weighed to the required no. of decimal places. The percentages of the components are determined as follows.

$$\textbf{\% of component} = \frac{\text{Weight of individual component}}{\text{Total weight of all components}} \times 100$$

If there is a gain or loss between the weight of the original samples and the sum of all the four components is in excess of one percent, another analysis should be made.

6. Duplicate tests

Analysis result near the border line in relation to the seed standards, one more test is done and the average is reported.

However, if a duplicate analysis is made of two half-samples, or whole samples, the difference between the two must not exceed the permissible tolerance.

If the difference is in excess of the tolerance, analyse further pairs (but not more than 4 pairs in all) until a pair is obtained which has its member within tolerance.

7. Determination of other crop seeds & weed seeds by number / kg

Whole submitted sample is used and the number per kg may be calculated and reported even if the working sample is less than a Kg.

8. Determination of other distinguishable varieties (odv)

Ten times, the size of working sample is used. It is determined based on the morphological characters of the seeds. The authentic samples should be available for comparison.

The number of ODV should be calculated and reported as no / kg of seed.

9. Calculation of results

The **% by weight of each of the component** should be calculated to **one decimal place**.

10. Reporting results

The result of each component is given in one decimal place and the total of all components must be 100.

Components of <0.05% shall be reported **as Trace**.

If the result for a component is nil, this must be shown **as'- 0.0-'** in the appropriate space.

Equipments used for purity analysis

1. Seed blower

It is a mechanical device used to separate inert matter from the working sample for the crop species like poaceae. It has an electric motor with a fan to blow air at uniform velocity. There are 2 plastic columns one for larger seeds and the other for smaller seeds.

The plastic column is provided with a semi-circular outlet where the terminal velocity of wind can be adjusted.

A time clock is also provided for the automatic running of the blower. The inert matter is separated by stratification using the terminal velocity of air.

2. Purity work board

This is used for effective separation of different components. At the centre of the board, there is an illumination by which the emptiness of the seed is easily identified.

Seed standards for physical purity

S. No.	Crop	Class	
		Foundation Seed (%)	**Certified Seed (%)**
1.	Bhendi	99.0	99.0
2..	Others	98.0	98.0

Exercise

- Conduct the purity analysis test with the given sample and report the results
- Draw the structure of purity work board and other structures required for purity analysis

Ex.No.12. Seed germination testing – tetrazolium test – evaluation

1. SEED GERMINATION TESTING

Principles

Germination tests shall be conducted with a pure seed fraction. A minimum of 400 seeds are required in four replicates of 100 seeds each or 8 replicates of 50 seeds each or 16 replicates of 25 seeds each depending on the size of seed and size of containers of substrate. The test is conducted under favourable conditions of moisture, temperature, suitable substratum and light if necessary. No pretreatment to the seed is given except for those recommended by ISTA.

Materails required

A. Substratum

The substratum, serves as moisture reservoir and provides a surface or medium for which the seeds can germinate and the seedlings grow. The commonly used substrata are sand, paper and soil.

I. Sand

a. Size of sand particle

Sand particles should not be too large or too small. The sand particles should pass thorough 0.80 mm sieve and retained by 0.05 mm sieve.

b. Toxicity

Sand should not have any toxic material or any pathogen. If there is presence of any pathogen, found, then the sand should be sterilized in an autoclave.

c. Germination Tray

When we use the sand, germination trays are used to carry out the test. The normal size of the tray is 22.5 x 22.5 x 4 cm. They tray may either zinc or stainless steel.

B. Method of seed placement

1. Seeds in sand(s)

Seeds are planted in a uniform layer of moist sand and then covered to a depth of 1 cm to 2 cm with sand.

2. Top of sand (TS)

Seeds are pressed into the surface of the sand

C. Spacing

We must give equal spacing on all sides of facilitate normal growth of seedling and to avoid entangling of seed and spread of disease. Spacing should be 1-5 times the width or diameter of the seed.

D. Water

The amount of water to be added to the sand will depend on size of the seed. For cereals, except maize, the sand can be moistened to 50% of its water holding capacity. For large seeded legumes and maize sand is moistened to 60% water holding capacity.

II. Paper

Most widely used paper substrates are filter paper, blotter or towel (kraft paper). It should be have capillary movement of water, at vertical direction (30 mm rise / min.). It should be free from toxic substances and free from fungi or bacteria. It should \ hold sufficient moisture during the period of test. The texture should be such that the roots of germinating seedlings will grow on and not into the paper.

A. Methods

a. Top of Paper (TP)

Seeds are placed on one or more layers of moist filter paper or blotter paper in petridishes. These petridishes are covered with lid and placed inside the germination cabinet. This is suitable of those seeds which require light.

a. **Between paper (PP)**

The seeds are placed between two layers of paper

b. Roll towel method

The seeds are placed between two layers of paper and rolled in towels. The rolled towels are placed in a water source and kept in germinator or germination room

c. Inclined plate method

Germination on glass plate with germination paper and kept at an angle of 45^{0}

III. Soil

Should be non-caking, free from large particles. It must free from weed seeds, bacteria, fungi, nematode and other toxic substances. Soil is not recommended for reuse.

B. Temperature

Normally most of the seeds germinat between 20-30^0 C

C. Light

Light required seeds provided with light eg. Lettuce

Germination requirements for different crops

Crop	Substratum	Temp ^{0} C	First count (Days)	Final count (days)	Pre - treatment
Brinjal	TP,BP	20-30	7	14	EthreI (25 ppm) 48 hrs.
Tomato	TP,BP	20-30	5	14	--
Chillies	TP,BP	20-30	7	14	(Hot water 85° C 1 min)
Bhendi	BP,S	20-30	4	21	--
Onion	TP,BP	15-20	6	21	KN03
Carrot	TP,BP	20-30	7	14	KN03
Radish	TP,BP	20-30	4	10	Prechill
Cabbage					prechill
Cauliflower	TP	20-30	5	10	Prechill, KN03
Ash gourd	S	30-35	5	14	light
Biter gourd	BP,S	20-30	4	14	--
Bottle gourd	BP,S '	20-30	4	14	-

Germination apparatus

1. Germination Cabinet

This is called chamber where in temperature and relative humidity are controlled. We can maintain the required temperature

2. Room germinator

It works with same principle of germinator. This is a modified chamber of larger one and the worker can enter into it and evaluate the seedlings. Provisions are made to maintain the temperature and relative humidity. This is used widely in practice.

3. Counting Board

This is used for accurate counting and spacing of seeds. This consists of 2 plates. The basal one is stationary and top one is movable. Both top and basal plates are having uniform number of holes viz., 50/100, when the plates are in different position. After

taking the sample, the top plate is pulled in such a way that the holes are in one line so that the fixed number of seeds fall on the substratum.

4. Vacuum Counter

Consists of a head, pipe and wall. There are plates of 50 or 100 holes which can be fitted to the head. When vacuum is created the plate absorbs seeds and once the vacuum is released the seeds fall on the substrate.

5. Impression Board

Made of plastic / wood with 50 or 100 holes/pins. Here the knobs are arranged in equal length and space. By giving impression on the sand it makes uniform depth and spacing for seed.

D. Seedling Evaluation

ISTA classified the seedlings into different categories based on the development of essential structures

Categories of seedlings

1. Normal seedlings
2. Abnormal seedlings
3. Hard seeds
4. Fresh ungerminated seeds
5. Dead seeds

1. Normal seedlings

Seedlings which show the capacity for continued development into normal plant when grown in favorable conditions of soil, water and temperature.

Characters of normal seedling

1. A well developed root system with primary root except in certain species of graminae which normally producing seminal root or secondary root
2. A well developed shoot axis consists of elongated hypocotyls in seedlings of epigeal germination.
3. A well developed epicotyl s in seedlings of hypogeal germination.
4. One cotyledons in monocots and two in dicots

5. A well developed coleoptile in graminae containing a green leaf
6. A well developed plumule in dicots
7. Seedlings with slight defects are also taken as normal seedlings. Primary root with limited damage but well developed seminal root system in leguminosae (Pisum), graminae (maize), cucurbitaceae (cucumis) and malvaceae(cotton)
8. Seedlings with limited damage or decay to essential structures but no damage to conducting tissue
9. Seedlings which are decayed by pathogen but it is clearly evident that the parent seed is not the source of infection.

II. Abnormal Seedlings

Seedlings which do not show the capacity for continued development into normal plant when grown in favorable conditions of soil, water and temperature

Types of abnormal seedling

A. Damaged seedlings

Seedlings with any one of the essential structures missing or badly damaged so that the balanced growth is not expected. Seedlings with no cotyledons, with splits, cracks and lesions or essential structures and without primary root.

B. Deformed seedlings

Weak or unbalanced development of essential structures such as spirally twisted or stunted plumule or hypocotyls or epicoptyl, swollen shoot, stunted roots etc.

C. Decayed seedlings

Seedlings with any one of the essential structures showing diseased or decayed symptoms as a result of primary infection from the seed which prevents the development of the seedlings.

III. Hard seeds

Seeds which do not absorb moisture till the end of the test period and remain hard (e.g.) seeds of leguminosae and malvaceae

IV. Fresh ungerminated seeds

Seeds which are neither hard nor have germinated but remain firm and apparently viable at the end of the test period.

V. Dead seeds

Seeds at the end of the test period are neither hard nor fresh or have produced any part of a seedling. Often dead seeds collapse and milky paste comes out when pressed at the end of the test.

Retesting

If the results of a test are considered unsatisfactory it shall not be reported and a second test shall be made by the same method or by alternative method under the following circumstances.

1. Replicates performance is out of tolerance.
2. Results being inaccurate due to wrong evaluating of seedlings or counting or errors in test conditions.
3. Dormancy persistence or phytotoxicity or spread of fungi or bacteria.

The average of the two tests shall be reported.

Use of tolerances

The result of a germination test can be relied upon only if the difference between the highest and the lowest replicates is within accepted tolerances.

To decide if two test results of the same sample are compatible again the tolerance table is used.

Reporting results

The results of the germination test are calculated as the average of 4 x 100 seed replicates. It is expressed as percentage by number of normal seedlings. The percentage is calculated to the nearest whole number. The percentage of abnormal seedlings, hard, fresh and dead seeds is calculated in the same way. These should be entered on the analysis of certificate under appropriate space. If the result is nil for any of these categories it shall be reported as '0'.

Seed standards for germination

S.No.	Crop	Class of seed	
		Foundation Seed	Certified seed
1.	Gourds	60	60
2.	Brinjal	70	70
3.	Chillies	60	60
4.	Bhendi	65	65
5.	Tomato	70	70
6.	Cabbage	70	70
7.	Cauliflower	65	65
8.	Carrot	60	60
9.	Radish	70	70
10.	Beet root	60	60

Exercise

- Evaluate the germination of the given samples adopting different method of germination test.
- Draw the structures of components of germination test

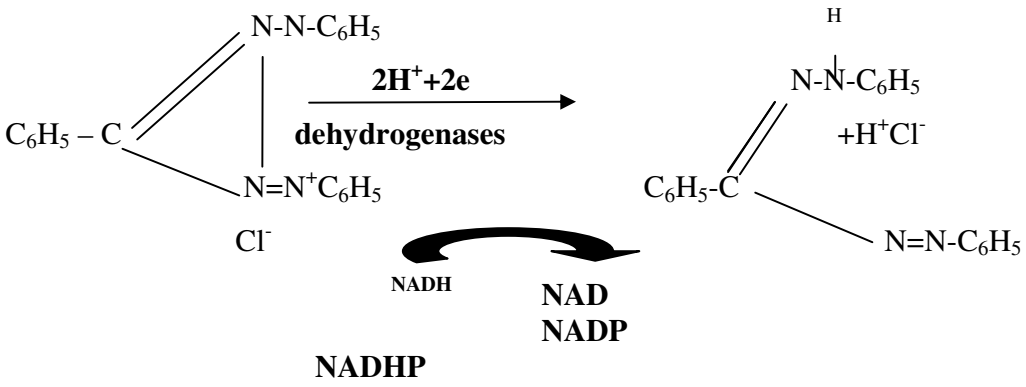
2. QUICK VIBILITY TEST

The relative long periods of time required for completion of germination tests delays the seed marketing. This necessitated the development of rapid methods for estimating the germination capacity of seeds. This test was developed by Lakon (1942) in Germany.

Principle

It is a biochemical test, in which living cells are made visible by reduction of an indicator dye. The indicator used is 2, 3, 5 triphenyl tetrazolium chloride. Within the seed tissues, it interferes with the reduction processes of living cells and accepts hydrogen from the hydrogenases. By hydrogenation of the 2, 3, 5 - tri phenyl tetrazolium

chloride; a red stable and non difficusable substance, triphenyl formazan is produced in living cells. The reaction is as follows.



2,3,5 triphenyl tetra zolium chloride Triphenyl formazon

This makes it possible to distinguish red coloured living parts of seeds from the colourless dead ones. Staining of seeds determines whether seeds are to be classified as viable. Completely stained seeds are viable partially and completely unstained seeds are non-viable

Field of application

This test is not valid for previously germinated seeds

Method of Tetrazolium testing

A. Testing sample

A representative sample of 50(or) 100 seeds is usually sufficient. However, 200 seeds, in replicates of 100 seeds is recommended.

B. Preparation of solutions

1% solution is used for seeds that are not bisected thro' the embryo, while 0.1% solution is used for seeds in which the embryo is bisected.

The pH of the solution should be between 6 and 8 for best staining. If the pH of the water is not in the natural range, the TZ salt should be dissolved in a phosphate buffer solution. The buffer solution is prepared as follows

Solution -1- Dissolve 9.078 g of KH2 P04 in 1000 ml of water

Solution -2- Dissolve 11.876 g of Na2HP04. 2H20 in 1000 ml water.

Take 400 ml of solution 1 and 600 ml of solution 2 and mix them together. In litre of buffer solution prepared as above, dissolve 10 gms of TZ salt. This gives 1% TZ solution of pH 7.0. This may be further diluted to give lower concentrations. The solution should be stored in brown bottle to prevent deterioration from light.

Methods of preparation for tetrazolium testing

The seeds are first prepared for staining then stained and evaluated for viability.

Method 1: Bisect longitudinally

(e.g) maize, sorghum, small grains, large seeded grasses. Soak the seeds in water for 3 to 4 hours. Bisect the seeds by cutting longitudinally thus exposing the mains structures of the embryo. Use one 1/2 of each seed for testing.

Method 2: Bisect laterally

(e.g.)Small seeded grasses

The seeds are cut laterally near the centre of the seed above the embryo. Place embryo end in TZ solution.

Method 3: Pierce with needle

(e.g.) Small seeded grasses

Puncture the seeds by piercing thro' the seed into the endosperm near the embryo, but avoid injury to the embryo.

Method 4: Remove seed coat (e.g) seeds with seed coats impermeable to tetrazolium.

Soak the seeds in water for 3-4 hours and then the seed coats and place the seeds in the TZ solution. In some crops like cotton a thin membrane adhering .to the cotyledons is also removed in addition to the seed coat.

Method 5: Conditioning only

(e.g) Large seeded legumes

Seeds of soybeans and other large seeded legumes may swell so rapidly and irregularly when placed directly in water or TZ solution that the seed coats burst. Hence, it is preferable to condition these seeds slowly in moist paper towels overnight before staining, so that they absorb moisture slowly without any damage to the seed.

But avoid injury to the embryo.

Method 4: Remove seed coat

(e.g) Dicots with seed coats impermeable to tetrazolium.

Soak the seeds in water for 3-4 hours and then the seed coats and place the seeds in the TZ solution. In some crops like cotton a thin membrane adhering .to the cotyledons is also removed in addition to the seed coat.

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Method 6: No conditioning or preparation

(eg.) Small seeded legumes

Seed coats of these seeds are permeable to TZ and embryos usually will stain without conditioning.

Staining

The prepared seeds should be placed in suitable container (small beakers, petridishes etc.,) and covered with TZ solution. Place the containers in an incubator at dark warm conditions of 40°C.The staining time varies for different kinds of seeds, different kinds of seeds, different methods of preparation, and different temperatures (< 1 hr to 8 hrs). When the sample has stained sufficiently the TZ solution should be discarded and the seed sample covered with water immediately. Seed samples can also be kept for 3 days at 10°C for interpretation.

Evaluation of Samples: A normal TZ stain appears cherry red.

Moncots

Non-Viable

1. All structures unstained
2. Shoot largely unstained
3. Scutellar node unstained
4. Major areas of coloeptile unstained
5. Central area of scutellum unstained
6. Insect, mechanical or other injuries causing essential structures non functional.

Dicot seeds

Non-viable

1. Embryo completely unstained
2. More than extreme tip of radical unstained
3. More than 1/2 of cotyledon tissue unstained.
4. Deep - seated necrosis at cotyledon and embryonic axis juncture or on radicle
5. Fracture dradical.

Advantages of TZ test

1. Quick estimation of viability
2. When the seed is dormant, the TZ test is extremely useful
3. Seeds are not damaged (in dicot) in anlaysis therefore they could be germinated.

Disadvantages of TZ Test

1. It is difficult to distinguish between normal and abnormal seedlings.
2. It does not differentiate between dormant and non- dormant seeds.
3. Since the TZ test does not involve micro organisms harmful to germinating seedlings are not detected.

Ex.No. 13. Seed health test – testing and identification of pathogen / insects

The health status of a seed lot, which in turn, establishes the sanitary condition of the seed is one of the important aspects of seed quality.

Seed health testing

Seed health testing is determining the presence or absence of disease causing organisms such as fungi, bacteria and viruses and insects in the seed samples. The pathogen may be carried with seeds in three ways.

I. Admixture

Pathogens are independent of seeds but accompany them. Ergot, sclerotia are mixed with healthy seeds during threshing.

II. External

The pathogen may be present on seed surface as spores, oospores and chalamydospores as in case of karnal bunt of wheat, covered smut of barley, downy mildew of pearlmillet etc. By surface sterilization external seed borne disease is killed and if symptoms produced then internal and no.

III. Internal

Pathogens establish within the seed with definite relationship with seed parts.

Working sample for carrying our health testing

The entire submitted sample, or a portion of it, depending on the test method, may be used. Normally the working sample shall not be less than 400 pure seeds.

Methods

1. Examination without incubation

Such tests give no indication as to the viability of the pathogen.

a. Direct examination

The submitted sample, or a sub-sample from it is examined, with or without a stereoscopic microscope and searched for ergots and other sclerotia, nematode galls, smut-balls, insects, mites and evidence of disease and pests in seed or in inertmatter.

b. Examination of imbibed seeds

The working sample is immersed in water or other liquid to make fruiting bodies, symptoms of pests etc. more easily visible, or to encourage the liberation of spores. After imbibition the seeds are examined either superficially or internally, preferably with the help of stereoscopic microscope.

c. Examination of organisms removed by washing

The working sample is immersed in water with a wetting agent or alcohol and shaken vigorously to remove fungal spores, hyphae, nematodes, etc., intermingled with or adhering to the seeds. The excess liquid is then removed by filtration, centrifugation or evaporation and the extracted material examined with the help of a compound microscope.

2. Examination after incubation

After incubation for a specific period, the working sample is examined for the presence of or symptoms of disease organisms, pest and evidence of physiological disturbances in the seeds and seedlings. The examination may be superficial or internal. Three types of media are commonly used:

Blotter method

- Blotters are used when pathogens are to be grown from the seeds or when seedlings are to be examined. The seeds with or without pretreatment are suitably spaced on moistened blotters during incubation as to avoid secondary spread of organisms. Lighting is provided to stimulate sporulation of fungi when needed. Some pathogens can be identified without magnification but a stereoscopic microscope or a compound microscope is often helpful in identifying spores.

2. Sand method

- Sand, artificial composts and similar media can be used for certain pathogens. The seeds, usually without pre-treatment, are sown suitably spaced in the

medium so as to avoid secondary spread of organisms and then incubated in conditions favourable for symptoms expression.

3. Agar plate method

- Agar plates are used to obtain identifiable growth of organisms from seeds. Precautions should be taken to ensure their sterilization. The seeds, normally after pre-treatment, are spaced on the surface of sterilized agar and incubated. Characteristic colonies on the agar can be identified, either macroscopically or microscopically. Lighting is often useful and germination inhibitors may be used.

4. Examination of plants

Growing plants from seed and examining them for disease symptoms is sometimes the most practicable method for determining whether bacteria, fungi or viruses are present in the sample. Seeds from the sample under test may be sown or inoculum obtained from the sample may be used for infection tests with healthy seedlings or parts of plants. The plants must be protected from accidental infections from elsewhere and conditions may require careful control.

5. Other techniques

Specialized methods involving serological reactions, phage-plaque formation, etc. have been developed for some disease organisms and may be used preferably in consultation with the seed pathologist.

Working sample for carrying our health testing

The entire submitted sample, or a portion of it, depending on the test method, may be used. Normally the working sample shall not be less than 400 pure seeds.

Incubation

10-16 days at 20^0 C under fluorescent light at convenient intervals of alternation with darkness unit the colonies are about 2 cm in diameter.

Calculation and expression of results

Results are expressed as percentage by number of seeds affected or as number of organisms in the weight of sample examined.

Exercise

- Conduct health testing and report the results
- Mention the different methodologies you adopt for identifying fungal, bacterial and viral infection.

Ex.No. 14. Visit to seed testing laboratory

Ex.No. 15. Seed invigoration techniques – hardening – pelleting

Seed vigour is the energy of the seed at the event of lowing of this seed vigour seeds are imposed with some management practices which are known as seed invigouration techniques. One of the physical and physiological seed management techniques with high adoptability are seed hardening and seed pelleting respectively.

Seed hardening

Pre-sowing hardening of seeds is one of the methods which result in modifying the physiological and biochemical nature of seeds so as to get the characters that are favourable for drought tolerance. It is also the extensive physiological reorganization induced by dehydration process. During hardening process a number of physicochemical change occurs modifying the protoplasmic characters and increasing physiological activity of the embryo and associated structures.

The physiological basis for seed hardening

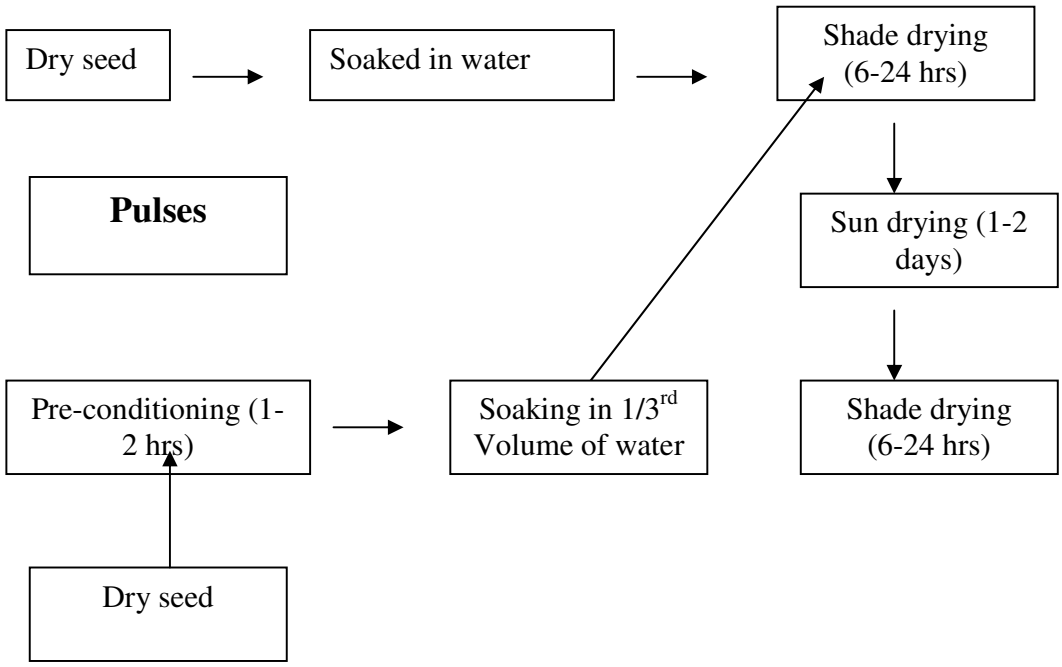
The influence results of the pre-sowing hardening treatment under drought condition is due to the following physiological changes that occurred in the seed on seed treatment.

- Greater hydration of colloids
- Higher viscosity and elasticity of protoplasm
- Increase in the physiological activity of the embryo and associated structures.
- Increase in bound water content
- Increase in intensity of photosynthesis
- Increase in hydrophyllic colloids and decrease in hydrophyllic colloids
- Increase in temperature requirement for protein coagulation
- More intensive respiration
- Lower water deficit
- Increase in water balance of plant
- More efficient root system

Methodology

Seeds are soaked in water/chemical solution in different seed to solution ratios depending on the crop. The duration of soaking also very with crop. When the moisture content of seed raises to 30 – 35% *i.e.,* when the seeds are ready to put forth radicle (Henkel, 1964) the soaking is stopped and the seeds are dried to original moisture content of 9.12% depending on the crop. While drying to avoid mechanical injury, it should be first dried under shade for 6-24 hours and should be followed by sun drying for 1 to 2 days to reduce the moisture content.

Cereals



Principle involved in seed hardening

When the dry seeds are soaked, the seed imbibes water and expands. This permits the initial process of germination but the further cell elongation and radicle emergence are prevented by shade and sun drying them to original moisture content. In pulses alone while hardening the seeds, the seeds should be preconditioned in between moist gunny bag and then are to be soaked in 1/3rd volume of water/solution to prevent soaking injury.

Chemicals used for hardening

Water itself is a good hardening material. To increase the efficacy of hardening treatment several chemical could also be chosen. But the selectivity of chemical varies

with crops. The aqueous solution of micro and macro nutrients such as sodium chloride, sodium sulphate, potassium nitrate, calcium chloride, ammonium sulphate, potassium chloride growth regulators such as gibberellic acid, chloro choline chloride, kinetin 2-chloromethyl phosphomic acid, ascorbic acid, vitamins like vitamin K3, nicotinic acid, adenine and plant products like, garlic extract, coconut water, leaf extracts of pungam (*Pungamia pinnata)* arappu (*Albizia amara)* prosopis (*Prosopis juliflora)* could be used for hardening the seeds.

Chemicals recommended for hardening different major crops

Crop	**Chemicals used**	**Concentration**	**Duration of soaking (Hrs.)**	**Seed to solution ratio**
Cholem	Potassium dihydrogen phosphate	0.5%	10	1:0.6
Cumbu	Potassium chloride	2%	16	3:1.0

Beneficial effects of seed hardening

- Accelerate rapid germination and growth rate of seedlings.
- Hardened plants recover much more quickly from wilting than tahsoe from untreated plants.
- Induces resistance to salinity as well as to drought condition
- Seeds withstand higher temperature (80-1050C) for prolonged periods (24-28hr) without loss of viability.
- Flowering is slightly accelerated
- Early emergence enables seedling to compete more effectively with weeds
- Hardened seeds perform better and result in more yields
- Hardened seeds can be stored upto 2-3 months without reduction in germination.

Seed pelleting

Seed pelleting is the process of enclosing a seed with a small quantity of inert material just large enough to produce a globular unit of standard size to facilitate precision planting.

Process of pelleting

The three basic steps involved in pelleting are stamping, coating and rolling. The seed are uniformly coated with adhesive in correct quantity initially then the filler materials are sprinkled on the coated seeds and are rolled on the filler material for effective and uniform coating.

Procedure

Seed

Adhesive + fungicide

Filler/ coating material

Adhesive + nutrients

Filler material

Adhesive + bio-inoculants + rhizobium

Materials required

1. Seed
2. Adhesive

   Gum Arabic (45%), methyl cellulose (3%), gelatin, casein casmate salts, plastic resins polyvinyl acelate, methyl ethyl cellulose (5%), polyurethane polyvinyl alcohol, poly electrolyte or dextran, poly ethylene oxide, rice gruel (5%), maida gruel (10%), sago and starch gruel.

Selection of adhesive

Selection of adhesive is based on selective purpose plastic resins; polyvinyl acetate and insoluble poly electrolyte complexes are used to bind pesticides to seeds. Polyethylene oxides prevent erosion of surface sown seed. Poly electrolytes or dextran to aggregate soil around the seeds, there by improving the aeration of sown seeds.

Filler material

Rhizobia include lime, gypsum, dolomite and rock phosphate. Other materials include clay minerals such as montmorillonite and vermiculite. Besides blood, peat, poultry manure, milk, charcoal powder, biofertilizers, leaf powders etc.

Characteristics of filler material

It should be non toxic

Friendly to both seed, adhesive and environment

Easily soluble in water

Easily available for commercial production

Low cost

Pelleting materials

- It should not have any toxicity to the seeds
- It must be possible to apply the coating on commercial basis
- Coating must be porous to allow movement of air to the seed.

Caution

Excess adhesive should not be added, it may lead to clogging of seeds

The adhesive should be with required velocity

The filler material used should be a fine powder. Then only coating will be perfect and coating also will be retained for longer period

Types of pelleting

Based on the materials used they are classified as follows.

1. Inoculant pelleting

Eg. Different biofertilizers viz., rhizobia, phosphobacteria, azospirillum, aztobactor, VAM.

2. Protective coating

Eg. Pesticide, fungicide, biocontrol agents like rhizobacteria bataticola or bacillus species or streptomyces and antibiotics.

3. Herbicide coating

Eg. Antidote, absorbents

4. Nutrient coating

Eg. Zinc sulphate, ferrous sulphate, copper sulphate, potassium di-hyrdrogen phosphate potassium chloride, borax etc.,

5. Oxygen supplier coating

Eg. Peroxides of zince or calcium

Advangates of seed pelleting

- It increases seed size
- Singling of seeds by prevention of clogging
- Precision planting
- Attraction of moisture
- Supply of growth regulators, nutrients
- Stimulation of germination
- Influence of micro environment
- Saving of chemicals / fertilizers applied to soil
- Supply of oxygen
- Protects seed at aerate seedling by improving ballistic ability
- Reduces seed rate
- Uniform field establishment
- Increase yield
- Remedy for sowing at problematic soils
- Protection from birds, animals, and insects

Exercise

Practice hardening and pelleting technique with the given sample

Ex. No. 16. Seed enhancement techniques – colour and gravity separation

Seed quality enhancement can also be achieved through the management of physical. Seed characters such as size, shape, weight and colour. Among these characters seed size, weight and colour are widely used for improving the quality of the seed either physical purity and also the physiological purity.

Size grading

Seed colour grading

It is the separaton of seed based on colour the colour of seed deviating from the normal is known as off coloured seed. These seeds occur in seed lot due to unfavourable weather condition at the time of maturation and due to long term storage.

Crop	Colour variation	Cause
Vegetable Cowpea	Dull colour known as off coloured seed	Rain or high humidity during maturation
Cluster bean	Dull colour known as off coloured seed	Rain or high humidity during maturation
Bhendi	Darkened seed	Due to storage

Seed specific gravity grading

Seeds are attacked both by storage insects and storage fungi and these reduces the weight of the seed and make them to express lesser weight on handling. These less weight seeds can be separated from the seed lot either by machine using specific gravity separator or manually adopting water or liquid floatation technique.

1. Liquid flotation

Cleaning by flotation relies on the principle that the density of the seed of a given species is specific both for filled and ill filled seed. In this method, liquids with a density or specific gravity between that of the full and empty seed are used. The specific gravity of the liquids used is such that the full seed sinks and the empty seed and light debris float.

Seed upgradation technique in bhendi

- Either before processing or after storage or due to improper processing bhendi seed may have less vigourous seed such as immature, ill filled and insect damaged seed which may adversely affect the planting value of the seed.
- Removal of this seed will favour better establishment and higher production potential.
- These seed may be removed by adaptation of a simple water floatation technique based on specific gravity for separation of good quality seed from low quality seed.

2. Specific gravity separation (Bhendi)

This method makes use of a combination of weight and surface characteristics of the seed to be separated. The principle of floatation is employed here. A mixture of seeds is fed onto the lower end of a sloping perforated table. Air is forced up through the porous deck surface and the bed of seeds by a fan, which stratifies the seeds in layers according to density with the lightest seeds and particles of inert matter at the top and the heaviest at the bottom. An oscillating movement of the table causes the seeds to move at different rates across the deck. The lightest seeds float down under gravity and are discharged at the lower end, while the heaviest ones are kicked up the slope by contact with the oscillating deck and are discharged at the upper end. This machine separates seeds of the same density but of different size and seeds of the same size but of different densities

Exercise: Do the colour grading and density grading for the given sample

Ex.No.17. Practical examination