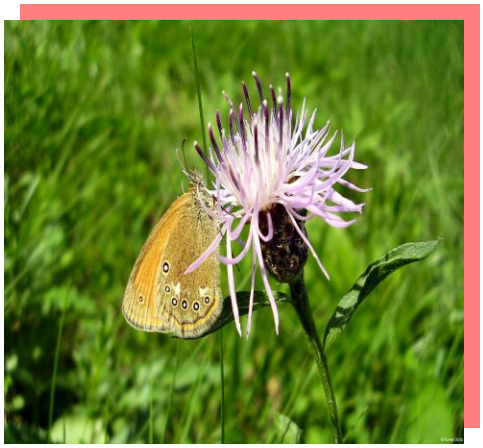
Tropical and Subtropical Vegetables



1. Tropical and Sub-Tropical Vegetables (HPV 200) 3 (2+1)

Area, production, economic importance and export potential of tropical and sub-tropical vegetable crops. Description of varieties and hybrid, climate and soil requirements, seed rate, preparation of field, nursery practices; transplanting of vegetable crops and planting for directly sown/transplanted vegetable crops. Spacing, planting systems, water and weed management; nutrient management and deficiencies, use of chemicals and growth regulators. Cropping systems, harvest, yield and seed production. Economic of cultivation of tropical and sub-tropical vegetable crops; post-harvest handling and storage. Marketing of tomato, brinjal, chillies, okra, amaranthus, cluster beans, cowpea, lab-lab, snap bean, cucurbits, moringa, curry leaf, portulaca and basella.

***Practical**: Identification and description of tropical and sub-tropical vegetable crops; nursery practices and transplanting, preparation of field and sowing/planting for direct sown and planted vegetable crops. Herbicide use in vegetable culture; top dressing of fertilizers and intercultural; use of growth regulators; identification of nutrient deficiencies. Physiological disorder. Harvest indices and maturity standards, post-harvest handling and storage, marketing, seed extraction (cost of cultivation for tropical and sub-tropical vegetable crops), project preparation for commercial cultivation.*

Lecture. 1.

Definition, importance, scope and problems of vegetable production

- Definition
- Rich source of basic and protective elements.
- More yield per unit area.
- More net returns per unit area per day.
- Role in Agro-forestry.
- Employment of great number of man power per unit area.
- Sustainability for succession and inter cropping resulting in greater intensity of cropping.
- Flexibility in production Programme.
- Aesthetic value of vegetables.
- Problems and prospects of vegetable production in India.

Definition

Horticulture is gaining importance as it gives more returns per unit area and also gives nutritious food to human beings thereby improves quality of life and enhances the aesthetic beauty of nature. Vegetable growing is one of the major branches of horticulture and from the point of view of value of the products; it is the most important branch.

"Vegetables are defined as edible herbaceous plants/plant parts consumed as raw or after cooking and rich in vitamins and minerals low in calorific value". In technical sense all parts are vegetables used for consumption. The term, however, is usually applied to the edible plants which store up reserve food in roots, tubers, bulbs, stems, petioles, leaves, buds, flowers, fruits, and seeds which are eaten either cooked or raw.

Growing vegetables is not only important for providing the protective food but also serve as an important subsidiary food playing a more significant role in the food consumption. They are rich in nutrients and are essential components of a balanced diet. Vegetables contribute vitally to the general wellbeing due to the following reasons.

Rich source of basic and protective elements:

Vegetables are rich in carbohydrates, proteins, minerals, vitamins and other protective substances. They are important for neutralizing the acidic effect produced during digestion of

meat, cheese and other fatty foods and roughages promote digestion and help to prevent constipation. The vitamins which are available in almost all kinds of vegetables produce profound and specific physiological effects in human body.

Ten mineral elements are required apart from carbohydrates and proteins for proper growth and development of human health. Out of this calcium, iron and phosphorous are required in larger quantities but they are not present in sufficient amount in other food stuff except vegetables. Iodine and sodium elements are also supplied by vegetables. The nutrients, source and deficiency symptoms presented in table 1.

Table 1: Nutrient, source and deficiency symptoms of vegetables.

Sl. No.	Type of mineral/vitamin & their role	Name of the vegetables	Deficiency symptoms
1.	Carbohydrates: Provide energy	Tuber vegetables *ie.,* potato, sweet potato, tapioca and yams.	Retarded growth
2.	Proteins: Made up of amino acids, growth and repair of the body	Immature seeds of lima bean, broad bean, peas, garlic, onion etc.	Retarded growth, retarded mental development, discoloration of skin, swelling of leg and feet, fatty liver (kwashiorkor)
3.	Calcium: Important for bones, teeth, blood clotting, resistance against infection	Amaranthus, cauliflower, drumstick leaves, lettuce, methi, carrot, onion, turnip, green peas, tomato, coriander, spinach, cabbage.	Irritability, retarded growth and bone weakness.
4.	Iron: Essential part of red blood corpuscles.	Moringa-leaves, amaranthus, methi, mint,coriander, drumstick, spinach.	Anemia, pale smooth tongue, pale lips.
5.	Phosphorus: Cell multiplication, proper maintenance of liquid content in the tissue,	Potato, carrot, tomato, cucumber, spinach, cauliflower, lettuce, onion.	Retarded growth

	role in oxidation of carbohydrates		
6.	Vitamin A: Provides general health	Carrot, spinach, palak, leafy vegetables, sweet potato (yellow), pumpkin (yellow).	Night blindness, respiratory infections, formation of stones in kidney, rough skin, growth in children retarded.
7.	Vitamin B complex: a) Thiamin (B_1) b) Riboflavin(B_2) c) Niacin (B_5) d) Pyridoxin(B_6)	Peas, broad bean, lima bean, garlic, asparagus, corns, tomatoes	a) Beriberi : loss of appetite b) Red coloured mouth cracks in the mouth c) Sore tongue, pellagra d) Ulcer
8.	Vitamin C: Essential for growth and resistance against diseases.	Turnip, green chilli, brussels sprout, mustard, green leafy vegetables, cole crops, bitter gourd, raddish	Scurvy, bleeding gums and mucous membrane, cold, loss of energy, delay in wound healing
9.	Vitamin D: Essential for bone and teeth	Green leafy vegetables	Bone and teeth weakness.
10.	Vitamin E: Antisterility and essential for reproduction	Cabbage, lettuce, methi, Spinach and vegetable oils	Fertility is affected
11.	Roughage: (Cellulose and fiber) Add digestion and prevent constipation	Leafy vegetables (Cabbage, Spinach, Lettuce), most root crops	Indigestion and constipation

More yield per unit area*:*

Vegetables are not only good in taste and rich in vitamins but also give higher yield per unit area than cereals and other crops. The following table 2 compares the yield per hectare of various crops.

Table 2: Comparision of yield for cereals vs vegetables.

Sl.No.	Crops	Average yield/ha in quintals
1	Wheat	20-25
2	Paddy	25-30
3	Potato	150-200
4	Cauliflower	125-175
5	Watermelon	200-225

More net returns per unit area per day:

Vegetables are important source of farm income. Most of the vegetables are quick growing and ready for harvest within a short time enabling the grower to practice succession cropping and inter cropping and thus providing the grower, with more profit compared to cereals.

Role in Agro forestry:

A number of vegetables are found to be most suitable for growing as intercrop along with trees. During early stage (up to 5 years) crops like potato, bhendi, tomato, brinjal, onion, peas etc., can be grown successfully while during later stage(from 5-10 years) crops like chilli, palak and ginger can be grown effectively .

Employment of great number of man power per unit area:

Vegetables are usually grown with intensive cultivation practices. Vegetable industry requires more labourers for one or the other operations continuously throughout the year starting from soil preparation to marketing.

Suitability for succession and inter cropping resulting in greater intensity of cropping:

Vegetables can be grown throughout the year In the perennial crop orchard vegetables can very much grown as an intercrop. Few vegetables can be grown twice or even thrice in a year.

Flexibility in production Programme:

The production programme can be adjusted and changed for better profits according to the need compared to fruit crops. In fruit crops it is difficult, time consuming and also expensive to change the production programme if it turns out to be unprofitable.

Aesthetic value of vegetables:

Immense joy and pleasure is derived in producing vegetables in kitchen gardens.

Scope of Vegetable production

- Vegetables combat under nourishment and are known to be the cheapest source of natural protective food.
- As per nutritionists, per capita requirements of vegetables should be 300g, in which 115 g leafy vegetables, 70g root vegetables and 115 g others.
- The deficiency of vitamin 'A' causes night blindness.
- The deficiency of vitamin 'B_1 causes beriberi disease.
- Scurvy disease is due to deficiency of vitamin 'C'.
- Vitamin E is also known as antisterility vitamin.
- Agathi (seobania) is the richest source of protein and calcium.
- Rajira leaves are the richest source of Vitamin A followed by colocossia
- Radish leaves are the richest source of riboflavin followed by fenugreek leaves.
- Vitamin 'D' is essential for prevention of rickets, osteomalacia and dental diseases.
- The synthesis of prothrombin and normal blood cloting regulate by the vitamin 'C'.
- The deficiency of calcium in body causes rickets and osteomalacia.
- Phosphorus is essential in human diet for cell multiplication of bones and soft tissue.
- The 'goitre' disease in human is due to deficiency of iodine.
- For good health, the requirement of vitamin 'A' per day is more than 2000 IU.
- The requirement of vitamin '13' per capita/day for good health is above 0.17 mg.
- For good health per capita/day requirement of vitamin 'C' is above 20 mg.
- Iron requirement per capita/day for good health is above 3.0 mg.
- Calcium requirement per capita/day is above 20 mg.
- Magnesium is implicated to have role in cardiovascular diseases.
- Zinc deficiency in human body leads to growth failure and poor development of body

growth.

- Chromium deficiency in body leads to impaired glucose tolerance.
- Magnese deficiency in body leads to abnormality in skeletal bone mineralization.
- Excess molybednum intakes in human body may increase the risk of gout.
- Selenium deficiency in human body is also implicated as a risk factor in cancer.
- Megaloblastic anaemia in living organism is due to deficiency of vitamin B_{12}.
- Inadequate intake of vitamin like riboflavin results in soreness of the tongue (glossaries), cracking at the angles of mouth (angular stomatitis), redness of the eye and burning sensation in eyes, scaliness of the skin in the region between the nose and the angles of the lips (seborroic dermatitis).
- Psychomotor development in children may be impaired in riboflavin deficiency.
- Vitamin A is incorporated in rhodapsin (eye pigment)
- Tapioca is the richest source of carbohydrate (38.1g) 100 g edible part) and calories followed by sweet potato.
- Chilli is the richest source of fiber (6.8 g / 100 g edible part).
- Giant chillies are the richest source of thiamine followed by peas.
- China is the largest producer of vegetables in world followed by India.
- India occupaies first position in cauliflower, second in onion and third in cabbage in the world.
- India shares 13.38 per cent of world production of vegetables.
- Vegetable crops, occupy only 2.8 per cent of the total cultivated land.
- The area and production wise largest vegetable growing states are west Bengal, Orissa and Uttar Pradesh.
- Vegetable crop varieties like in tomato (Pusa Red Plum), carrot (Pusa Yamadagni and Pusa Meghali), pumpkin (Arka Chandan), palak (Pusa Jyoti), beet root (Pusa Swarnima) and sweet potato (Pusa Sunehri) are richest source of carotene.
- Parsley is the richest source of vitamin C (281mg/ 100 g edible part).
- Sweet potato is the richest source of vitamin A (14190 11g/100g edible part).
- Protein-energy malnutrition (PEM), vitamin A deficiency, iodine deficiency disorders (IDD) and nutritional anemia- mainly resulting from iron deficiency or iron losses - are the most common serious nutritional problems in almost, all countries of Asia, Africa, Latin America and the Near East.
- RDA stands recommended dietary allowance.

A large number of vegetable crops are being cultivated in India in temperate, tropical and sub tropical regions. Most of the vegetables are quick growing, high yielding, and give very high remuneration. India is the world's second largest producer of vegetables next only to China. Vegetable crops in India occupy only 2.8 per cent (7.99 m.ha) of the total cultivated land producing 133.9 million tonnes of vegetables. India shares 12 per cent of world production of vegetables with a productivity of about 15 t/ha which is quite low as compared to many countries.

The present production is not sufficient to meet the requirement of 300 g of vegetables on an average per capita per day. At present our per capita availability is around 145 g / day. By the end of 2030 according to an estimate we need 151-193 million tonnes of vegetables to meet our requirement. According to the recommendations given by ICMR, an average man with vegetarian or non vegetarian food habit should consume 125 g leafy vegetables, 100 g of roots and tubers and 75 g other vegetables. Since the availability of vegetables per day per capita is very low, it is necessary that the vegetable production and consumption in India will have to be increased three to four fold. Area, production and productivity of leading vegetable producing states are given in the table 3.

Table 3: Production of vegetables in leading states of India (2009- 10)

States	Area (000' ha)	Production (000' tonnes)	Productivity (t/ha)
Uttar Pradesh	1020.1	22435.7	21.99
West Bengal	1302.7	21906.5	16.81
Bihar	836.0	13906.8	16.63
Orissa	694.2	8963.6	12.91
Tamil Nadu	263.7	7627.7	28.92
Gujarat	406.8	7255.5	17.83
Karnataka	441.2	7082.2	16.05
Maharashtra	451.8	6172.6	13.66
Andra Pradesh	331.3	5426.2	16.37
Assam	255.2	4569.9	17.90

Total	7984.8	133737.6	16.75

Source: Indian horticulture data base, (2009-10)

The vegetable industry contributes heavily to the national economy. Millions of farmers, business people (marketing) and industries (seeds, fertilizer, pesticides, herbicides, machinery manufactures etc.) are directly or indirectly dependent on vegetable cultivation.

Vegetables have great potential to contribute directly to the income, employment and nutrition. Due to varied geographical situation and favourable climatic conditions, India can develop into one of the leading countries exporting fresh vegetables and their seeds. During 2006-07, India exported fresh vegetables worth of Rs. 430.2 crores. Of all the fresh vegetables exported the share of onion is around 75 %. Other traditional vegetables which are presently exported are potato, gherkins, okra, bitter gourd, chilli, cauliflower and some root vegetables.

In addition to these traditional vegetables, non traditional vegetables which have export potential are asparagus, celery, sweet pepper, sweet corn, green pea, french bean and tomato. Cole crops and root vegetables are much more demand in temperate countries during winter. In India, these vegetables are grown in the open during winter and thus the cost of production is less as compared to those grown under protective cover. There is a lot of opportunity for exporting these vegetables to the European and North American countries from India.

Problems and prospects of vegetable production in India

Indian vegetable industry is developing in faster rate. Many aspects on the vegetable improvement and the production practices are developed still the following are limitations of vegetable farming in India.

Vegetables are highly perishable:

Fresh vegetables are like living organisms and as such undergo normal life processes even after harvest. They respire, loss of water occurs through transpiration and undergo chemical changes if not sold immediately after harvest. Deterioration of vegetables is also influenced considerably by temperature, atmospheric humidity and other factors. The losses

in leafy vegetables and fruit vegetables are much more than in root and tuber vegetable crops. Thus, a considerable quantity of vegetables produced in our country is wasted every year.

Ignorance on nutritive value of vegetables:

A majority of community is quite unaware about the nutritive value of different vegetable crops. Hence, inspite of available facilities for cultivation they are not giving much attention to vegetable gardening. In our country most of the population residing in villages are not educated who do not realize the importance of vegetable crop which are an important source of vitamins and minerals.

Illiteracy and lack of technical knowledge of scientific cultivation:

Authentic literature on vegetable cultivation is still not available to the farmers. Literature is very essential for selection of suitable varieties for different regions for different purposes, economic methods of cultivation including doses of nutrients, methods of controlling insect pests and diseases and the ways to get maximum return from these crops. At present ICAR-New Delhi, CFTRI-Mysore, State Agricultural Universities are publishing literature on vegetable crops but yet there is inadequate supply of the same to growers.

Lack of transportation facility:

Timely and speedy delivery of vegetables with minimum damage and deterioration enroute at the lowest cost are important aspects of transportation. Most of the Indian villages though there are proper facilities for growing vegetables, yet organized cultivation not taken place due to lack of proper transportation facilities,.

Lack of enough refrigeration and storage facilities:

The losses during the storage may be lesser if vegetables are stored properly under regulated conditions of temperature and humidity. In India this type of storage facility is available only in cities at higher rent. Hence a small grower cannot use it for harvested vegetables. Therefore, it could be advantageous if cold storage houses are constructed near production regions for storing the produce.

Non availability of sufficient quantity of quality seed in time:

There should be proper arrangement for supplying good vegetable seeds for both early and late crops. The vegetable seed industry is largely in the hands of private agencies and few of them have adequate facilities for scientific production. As a result, the seeds available in the market are often of doubtful origin and usually give indifferent performance. National

Seed Corporation, New Delhi started supply of improved and hybrid seeds of many vegetables directly and through its branches to cultivators and vegetable growers. However, still there is a great scope for evolving and standardizing new varieties of the best quality of vegetables in India.

Malpractice in marketing:

Marketing includes all the steps from the time the produce is ready for harvest till it is in the hands of the consumers. The main aim of marketing is that the producers should get a suitable price for their produce. At present due to more middlemen and the price meant for the produce is not received by the producer.

Problem of Insect pests, diseases and weeds:

Due to the tenderness of vegetables, the insect pest, disease and weed attack is more in vegetable crops than cereals/ fruit crops/forest trees.

Lack of irrigation facilities:

Light and frequent irrigation are very essential for vegetable growing. During summer it is not possible to grow vegetables if irrigation facilities are not available. Perennial and large season vegetables are grown if better irrigation facilities are available.

Lack of research, technical guidance and sufficient capital:

Before 1970, there was no co-ordinated scheme in the country but at present All India Co-ordinated Improvement Project on potato, vegetables and tuber crops are running at country level and conducting research work on important vegetable crops. Generally vegetable growers in our country have not well developed as yet and can not afford heavy expenditure in vegetable growing. Due to lack of capital they are not using better chemicals, fertilizers and labour saving equipments. Due to these facts they are not getting better yields and quality.

Questionnaire

I. Select the most appropriate answer of the following questions:

1. Deficiency of proteins results in

a. Beriberi b. Kwashiorkar c. Rickets d. Anaemia

2. Night blindness is due to the deficiency of

a. Vitamin a b. Vitamin b c. Vitamin c d. Vitamin d.

3. Which of these mineral elements present larger quantities in vegetables compare to food materials.

a. Ca, Fe and P b. K, n and p c. Mg, s and an d. N, k and mn.

4. Lack of vitamin c in our body leads to

a. Scurvy b. Ulcer c. Rickets d. Indigestion

5. The average productivity of vegetables in India

a. 15T/ha b. 25T/ha c. 10T/ha d. 20 t/ha

6. As per ICMR, what is the percapita requirement of vegetables per day?

a. 300G b. 500G c. 200G d. 400 g

7. In the world, indicate the position of our country in respect of area, production of vegetables

a. Ist b. II nd c. IIIrd d. IVth

8. ---------- is also known as anti sterility vitamin

a. Vitamin C b. Vitamin E c. Vitamin K d. Vitamin B

9. Pea is the richest source of

a. Carbohydrate b. Protein c. Vitamin d. Fat

10. ---------- is the richest source of vitamin A

a. Carrot b. Tomato c. Potato d. Sweet potato

11. The AICVIP was started in

a. 1968 b. 1988 c. 1986 d. 1970-71

12. Out of the total cultivated area in India, vegetable crops occupy----------

a. 0.5 per cent b. 2.2 per cent c. 5 per cent d. None of the above

13. According to ICMR report, the per capita vegetable requirement in India is ----------

a. 500g b. 400g c. 200g d. 300g

14. Which one of the following vegetables is the richest source of protein?

a. Pea b. Fenugreek c. Pointed gourd d. Cucumber

15. Yellow coloured vegetables are rich source of ----------

a. Vitamin E b. Vitamin C c. Vitamin A d. Vitamin B

II. Say true or false

1. According to dieticians, an individual should consume about 200 g of leafy vegetables.
Ans: False
2. 250 g of root and tuber vegetables and 100 g of other vegetables daily recommended for a balanced diet.
Ans: False.
3. Vegetable crops occupy only about 2.2 per cent of the total cultivated area of the country.
Ans: True

4. Total area and production of vegetables in India is 7.98 m. ha and 129.43tons respectively.
Ans: True.
5. Leguminous vegetables are rich source of vitamins.
Ans: False

III. ANSWER THE FOLLOWING QUESTIONS

1. Define the term ‘vegetable’
2. Why vegetables are considered as protective food?
3. Enlist the advantages of vegetable production?
4. Mention few vegetables which are rich source of the following minerals/vitamins.

a. Calcium
b. Iron
c. Phosphorus
d. Carbohydrate
e. Vitamin a
f. Vitamin b
g. Vitamin c
h. Vitamin d
i. Vitamin e

j. Vitamin k
k. Roughage

Lecture 2.

EXPORT POTENTIAL, STANDARDS, SPECIFICATIONS, HANDLING AND VALUE CHAIN FOR EXPORTS

- Introduction.
- Some specific requirements for the export of vegetables.
- Period of Requirement.
- Producing Pockets.
- Growing pockets of some vegetable crops.
- Export Policy.
- Problems in Export.
- Suggestions for Improvement.
- Rules and Regulations for Vegetable Export and Processing Business Firm Name Registration.

Introduction

India is the world's second largest producer of vegetables, but hardly 2 per cent of the produce is processed. About 25-30 percent of the production is wasted due to lack of adequate processing and infrastructure facilities. Besides meeting domestic requirement, the country is meeting the adhoc demands of various foreign markets from the vegetables being produced every year and exports sizeable quantity of vegetable and processed products after completing domestic requirement of vegetables. In 2000-2001, the country exported other fresh vegetables to the tune of Rs 190.84 crore in the preceding year, representing a growth of 32.89 per cent (Verma *et al.,* 2002). India, over the years has been regularly exporting in a variety of fresh vegetables. Sri Lanka, UAE and USA together accounted for more than 50 per cent of the total exports of fresh vegetables in 2000-2001. Onion accounts for 60 per cent of total foreign exchange earning among fresh vegetables. Among other vegetables, 60 per cent share goes to okra, 20 per cent to green chilli and 20 per cent bitter gourd, French bean, capsicum and other mixed vegetables. The non -traditional items meet the requirement of Indian expatriates in South East Asia and Gulf countries and to some extent in the UK go to European countries where growing conditions are not ideal during November. There is a great demand for vegetable products for export because vegetables have shown to earn 20-30 times more foreign

exchange per unit area than cereals. India exports sizeable quantity of vegetables and processing products. In the year 2000-2001, dried and preserved vegetables worth Rs 738.29 crores were exported. Besides this, 70821.96 metric tonnes of other processed fruits and vegetables costing worth Rs 206.94 crores were also exported in the same year. Currently onion accounts for 70 per cent of the total foreign exchange earned through export of fresh vegetables. Among other vegetables, 60% share goes to okra, 20% to green chillies and 20% to bitter gourd, french bean, capsicum and other mixed vegetable. In global vegetable markets, Thailand, Jordan, Syria, Lebanon, Kenya, Zimbabwe, Guatemala, China, Argentina, Indonesia, Egypt. Turkey, Iran, Cyprus, Australia, NewZealand and Holland are the main competitive countries, which export vegetables to different countries.

In India, Vegetables are grown in the open and thus their cost of production is less as compared to those grown under protected condition. There is a lot of opportunity to export these vegetables to the European and North American countries from India. Presently our share in world export market is very negligible. If we are to make our presence felt in the export market, considerable development is required in infrastructure and export from India. Vegetable crops have vast potential for export and processing industries in 2006-07. About 2.75 lakh tonnes of fresh vegetables worth Rs. 43002.06 lakh were exported. During the IXth plan period, export target of fresh vegetables has been fixed to the tune of 7 lakh tonnes (6 lakh tonnes of onion and 1 lakh tonnes of other vegetables like okra, bitter gourd, chilli, garlic, bottle gourd, melons, sweet pepper, beans etc).

Different processed products of vegetables, particularly, paste, sauce ketchup (tomato products), pickles (cucumbers, carrot, mixed vegetables), saurkraut (lactic acid fermented product of cabbage), dehydrated products (onion, potato, pea) and frozen vegetables (sweet pepper) have steady export demand.

The export of horticultural products and foreign exchange earnings during 2000-2001 are given in Table 1.

Table 1:Export of Fresh and Processed Vegetables

Products	1998-99	Quantity in MT 1999-2000	2000-2011	Value in Rs. lakh	1999-2000	2000-2001
Fruit & vegetable seeds	6062.37	8179.84	12299.44	6633.92	8394.10	6750.85
Fresh onion	215693.61	260475.27	343253.69	17604.71	20270.12	27621.89

Other fresh vegetables	64654.62	115656.37	133992.01	10233.34	14414.62	19084.96
Fresh vegetables	280348.23	376101.64	477245.7	27838.05	34684.74	46706.85
Dried & preserved vegetables	145049.54	235637.73	286927.2	38305.25	58989.61	73829.36
Other processed fruit & vegetables	34322.15	39152.26	70821.26	10811.15	11723.12	20694.29

Export of major vegetables from India (2007- 08)

Vegetables	**Quantity (tons)**	**Value (Rs in lakhs)**
Onion	1008606.48	103577.89
Tomato	134845.15	15290.78
Potato	78450.77	4142.68
Peas	814.64	270.85
Brinjal	338.10	191.74
Sweet potato	346.81	35.48

- Vegetable Having Export Potential: The Agricultural and Processed Food Products Export Development Authority (APEDA) has identified traditional vegetables like onion, potato, okra, bitter gourd, chilli and non-traditional vegetables like asparagus, celery, sweet pepper, sweet corn, baby corn, green peas, French bean, cucumber and gherkin and cherry tomato having good export potential. Among other vegetables, potato, okra, tomato, baby corn, cucumber & gherkins, chillies, French beans, capsicum, bitter gourd & bottle gourd are being exported. Vegetables are also being exported in processed form. The total export of vegetables in processed form is over Rs. 231 crores annually.
- Importing Countries: Onions and traditional vegetables are being exported to Malaysia, Singapore, Gulf Countries, Sri Lanka, Bangladesh, Pakistan and Nepal. Nontraditional vegetables are exported to European countries and Australia in addition to Gulf countries and South East Asian countries. Onions and garlic are transported by ships and other vegetables by air. Kuwait Airways, Saudi Airways, Air India and TWA are the important airlines, which transport vegetables.

- Variety and Quality Requirement: The requirement of foreign markets in terms of

varieties and qualities differ from domestic requirements. The requirement also differs between different foreign markets. European markets, Japan, Australia, USA etc., require different qualities and varieties than Gulf countries and South East Asian countries. For example, in case of onion, European and Japanese markets require yellow/brown coloured mild pungent onions of big size, whereas, gulf countries and South East Asian countries require light red to dark red coloured strong pungent onions of varying sizes. South East Asian countries and Sri Lanka also demand small rose and multiplier onions.

Parbhani Kranti, Arka Anamika, Varsha hybrid, Varsha Uphar varieties of okra; Awsari, Panvel, G 4 and Pusa Jwala varieties of chilli; Pusa Navbahar variety of cluster bean; Contender, Premier, Tweet Wonder, Astrel and Monel varieties of French bean; Varad bottlegourd, MBTH-1 bittergourd, Agrifound Dark Red, Agrifound Light Red, Arka Niketan, Baswant 780 and N-2-4-1 varieties of common big onion in red types, Granex 33, Spanish Brown, Tana F-1 in yellow types, Agrifound Rose, Arka Bindu in small rose type, Agrifound Red, CO, & CO_4 in multiplier type of onion; Sugarbaby in watermelon; Great Lake in Lettuce; Nantes and Zino Carrot; Agrifound Parvati & G-282 in garlic are some of varieties of different crops, which are in good demand. Some of the specific requirements of size, colour, shape etc., are given in Table 2.

Table:2 Some specific requirements for the export of vegetables

Crops	Specific requirement
Okra	Green, tender and 6-9 cm long.
Chillies	Green and 6-7cm long
Cluster bean	Green tender and 7-10 cm long.
Butter gourd	Green 20-25 cm long having short neck.
Bottle gourd	Green 20-25 cm ling having short neck
Bottle gourd	Light green straight cylindrical in shape and 25-30 cm long
Gherkin	Green small sized having 160-300 fruits/kg in premium grade
Tomato	Round, medium size reed colour in middle east, cherry tomatoes in European
French bean	Straight 10-12 cm long, round green pods in bush beans, flat beans, flat beans having 12-13 cm length and pods are also in demand in European markets.

Big onion	4-6 cm in diameter, light to dark red colour, round shape, strong pungency in gulf markets and South East Asian markets 3-4 cm in diameter, light red and round shape in Bangladesh. Yellow/brown colour, 7-8 cm in diameter, round or spindle shape in European and Japanese markets.
Small onion	Dark red, 2-3 cm in diameter and round shape
Multiple onion	2.5-3.5 cm in diameter and round shape
Garlic	white, round, 5cm or above in diameter bigger cloves of 10-12 mm and above with 10-15in number. For Bangladesh and srilanka 4-5 cm size bulbs are also acceptable.
potato	White, oval 4.5 to 60 cm in size. Bangladesh demands red types and that Iran & Iraq demand patotoes with yellow flesh.

Source: **Pandey and Singh (2000).**

- **Period of Requirement**: The quantity of different vegetables required, though, differs in different months in view of local production particularly in South East Asian countries; the demand is round the year. In European markets, the demand is from November- December to April-May, when there is no local production or even stored produce is not available. India having varied agro-climatic conditions can produce and supply the vegetables to different markets from one to the other parts comfortably round the year if necessary infrastructure facilities are created for pre-cooling and transport etc.

- **Producing Pockets**: As mentioned above, although, it is possible to produce vegetables in one or the other parts round the year due to ports being near and also good infrastructural facilities created, the production is presently limited in certain pockets for meeting the demands of the foreign markets. The details of some of the crops and area of production are mentioned in

Table 3.Growing pockets of some vegetable crops:

Okra	Nasik, ozar saikheda, Dindhori, Kolhar, Naraingaon and Sholapur in Maharashtra,
Chilli	Pen, alibaugh and chol inraigad district dindhori, and Niphad

	and itaatpuri Taluka in Nasik district of maharastra.
Watermelon	Panval near Mumbai and mlaharashtra state.
Bottle gourd and bitter gourd	Nasik and Pune district in Maharashtra
Gherkin	Nasik in Maharashtra state
Capsicum	Nasik , Pune ans Satara district un Maharashtra.
Baby corn	Bangalore in Karnataka, Nasik and Pune in Maharashtra.
French bean and	Dindhori in Nasik District, Wai in Satara Distrct and Naraingaon in Pune,
Cluster bean	Dhule and Ahmednagar.
Onion (big)	Nasik Pune and Satara district in Maharashtra Periyar and Coimbatore district in Tamil Nadu, Bhudaun in Uttar Pradesh,and Patna, Biharsharif in Bihar, Bhavnagar and Rajkot in Gujrat
Onion (small)	Kolar and Bangalore in Karnataka and cuddapah in Andhra pradesh
Onion (multiple)	Anna, Madurai, Salem and Coimbatore district of Tamilnadu.
Garlic	Indore and mandsaur in Madhya Pradesh, Ooty in Tamil Nadu, Jamnagar and Rajkot in Gujarat and kullu in Himachal Pradesh.
Tomato	Nasik and Pune in maharashra and Bangalore in karnataka
Potato	Jallandher and Ludhiana in Punjab Kurudshetra and Karul in Haryana Ooty in Thamil Nadu and Indore in Madyapradesh.

- competing countries: Thailand, Jordan, Lebanon, Syria, Zimbabwe, Guatemala, China, Argentina, Indonesia, Egypt, Turkey, Iran Cyprus, Australia, New Zealand and Holland re the other countries which export different vegetables to different countries details of some of the exporting counties and items being exported are given in table 4.

Name of the countries	Vegetables exported
Thailand	Brinjal, Baby corn, Chillies okra, multiple onion garlic and yellow

	onion.
Holland	Onion, Baby corn, Capsicum, Cole crops , Tomato cucumber lettuce, root crops and tomato
Spain	Onion and garlic.
Australia	Onion, beans, cote crop, cucumber and root crops.
Iran	Onion.
Turkey	Onion.
Egypt	Onion and garlic.
China	Onion and garlic and other European vegetables
Argentina	Yellow onion.
Indonesia	Multiplier onion and bigger clo^{y}ed garlic.
Kenya	Beans, peas and okra.
Guatemala	Asparagus.
Morocco	Gherkin.
Jordon	Assorted vegetables.

Source: **Pandey and Singh (2000).**

- **Export Policy**: Fresh vegetables export other than onion is allowed freely. Under this category any person may export vegetables to any country except to a country where export is prohibited by law enforced from time to time. Government has also started the policy of giving cash incentives of 10-20 per cent depending upon the kind of vegetable being exported. Export of onion up to 20 kg per consignment is allowed by air as a part of assorted vegetables. Onion export has been canalized through National Agricultural Cooperative Marketing Federation of India (NAFED) under the present policy of export. In this system, the exporters are required to register with NAFED and get NOC for export. Other vegetables are exported on consignment basis under OGL (Open General License).

Problems in Export:

Inadequate Air Cargo Space: Except onion and tuber vegetables, all other items are transported by air. Non-availability of sufficient air cargo space at a time has been a major constraint in increasing the export.

Higher Air Freight: Air freight of vegetable export from India to Gulf countries and UK etc. is

very high compared to Kenya, Jordan, Lebanon etc. This is one of the major bottlenecks in increasing the export.

Restriction in the Export: Many times because of failure of a particular crop and increased local demand, the export has to be restricted. This does not allow regular export due to which we loose many foreign markets.

Non-Availability of Suitable Varieties: In onion, we do not have production of yellow onions which are in demand in European and Japanese markets. Bigger clove garlic is also not available in adequate quantities, which are now demanded by almost every country.

Absence of Cultivation of Suitable Crops/Varieties Exclusively for Export as Fresh or For Processing: Presently, there is no exclusive production of suitable varieties for export as fresh or processing. This increases cost which affects export adversely.

Improper Packing of the Produce: In many vegetables, open mesh jute bags are still being used, whereas, preference is there for open mesh plastic woven bags. The corrugated fiber board boxes being used at present also do not have required strength and thus rare damaged in transit. No proper space handling / storage of material at ports/airports. Cold storage facilities at all ports or airports do not exist. Adequate handling space also does not exist. This results in damage to stock.

Inadequate Research & Development Backup: Not much export oriented Research & Development programmes are being taken up in vegetables. The quality of the produce is, therefore, not uniform as per the requirement of foreign markets. Lot of labour is thus wasted in sorting and grading of the produce.

Suggestions for Improvement: In order to meet the international requirement without affecting the domestic supply, there is a need for a well thought out strategy for the coming years so as to produce quality crops at competitive price and remain regularly in the market. Followings are the suggestions for improvement:

Export policy should be long term and consistent. Frequent changes in export policy should be avoided in view of likely adverse affects on foreign markets and growers.

Exclusive production of different vegetables for different seasons in suitable pockets should be arranged so as to continue supply throughout the year at a competitive price without affecting domestic supply.

Enough quality control measures should be made for weight, mixtures, size, disease etc. We must export the quality product only in order to remain in the market regularly.

Regular assessment of international market for products originating from the local areas. Suitable diversification of export both in terms of countries and commodities for increasing the quality and also value.

Suitable pockets for growing different vegetables economically round the year should be identified and agro techniques from export angle for production of quality produce of different crops should be standardized. Organic farming as well as integrated pest management should be introduced. Exclusive production of suitable crop/varieties for export as fresh and in processed form should be introduced.

Production and distribution of quality seeds of different crops may be arranged in adequate quantities by different seed producing agencies.

Pre-cooling units and cold storage for fresh vegetables should be established for prolonging the shelf life and minimizing the losses in post harvest handling.

Ventilated and temperature controlled transport system should be introduced and highest priority for loading and transportation of perishable items should be given.

Cold storage and transit ventilated storage facilities as per the need of different crops should be created at all ports/airports where from vegetables export is being taken.

Rules and Regulations for Vegetable Export and Processing Business Firm Name Registration: If anyone is doing any business like clinic, pharmacy, agri-business with specific name than any other person cannot harm him in any way by keeping your firm name if registered. The party has right to use in the court of law. Firm registration is done under Indian Registration Act, 1958.

Trade Mark/Trade Name: A trademark means identification of your goods. It is a symbol, which a person uses in the courses of trade in order to that the purchasing public from similar goods of other traders may distinguish his goods. Registration of trademark done under Trade Mark and Merchandise Act, 1958.

Patent: A patent granted under Patent Act, 1970 centers upon the patentee, where the patent is for an article or a substance, the exclusive right by him self his agents or licensees to make use, exercise, sell or distribute such articles.

Agmark: Under Agmark registration, vegetable producers are covered: Vegetable oil cakes, dried edible mushroom, table potato, Kanchan (Bathua), seed potatoes, table potatoes (export), water chestnut, curry powder, chillies powder, celery seeds etc.

FPO: Under FPO registration, vegetable processed products are covered: Dehydrated vegetables, tomato products, ketchup and sauces etc.

Quality Labelling Produce: Still, vegetable growers and specialists have not equipped themselves with the qualitative aspects of production and pre and post harvest core, which play a very vital role in the export of vegetable produce. This requires government intervention and also sizeable investment in research and development. It is also necessary to familiarize the growers and the exporters with the technologies to qualitative aspects.

While promoting vegetable exports in India quality should be the watchword, we must provide such quality as would be the consumer' S delight. It is no longer sufficient, if we ensure stomach's satisfaction. In the export world, the sum is fast transforming from customer satisfaction to consumer delight. And to achieve to this, the entire outlook in agricultural industry and business should be radically transformed to adopt the proven three pronged commitment, consistency and competence; commitment to lift agricultural from its present state of stagnated growth to achieve buoyant agrarian economy; consistency in terms of supply of quality products and competence to sell India’s products at competitive rates by increased productivity an adoption of innovative and appropriate technology and expertise.

Tomato:

Tomato has been identified as a potential vegetable for export by the Agricultural and Processed Food Products Export Development Authority (APEDA), New Delhi**.** The specific requirement of tomato for export in Middle East are round, medium size and red colour, while cherry tomato is preferred for export to European countries. Tomato is being exported from the areas like Nasik and Pune in Maharashtra and Bangalore in Karnataka.

Processed products of tomato especially puree and pastes have great demand in export. Tomato is exported from India, but due to lack of suitable varieties/ hybrids exclusively for exports, our tomato do not compete in foreign market. For encouraging export potential of tomato and its products there is an urgent need for development of suitable varieties, proper packing procedure and long term and consistent export policy. Pre cooling units and cold storage for fresh tomato should be established for prolonging the shelf life and minimizing the losses in post harvest handling.

CHILLI

India has emerged today as the foremost producer and exporter of chillies contributing to almost one fourth of the world production. The export of chillies and chilli products from India have been steadily increasing both in volume and value from 8,227 tonnes and Rs.9,66,54,000 in 1984-85 to 51,891,72 tonnes and Rs.209,61,00,000 in 1996-97 respectively Indian chillies are exported mainly to Sri Lanka, USA, Canada, UK, Saudi Arabia, Singapore, Malaysia and Germany. Important products such as chilli dry, chilli seed, chilli fresh, chilled, chilli crushed, pigments are exporting from India.

The total export of chillies from India is on an average of only 4 per cent of total production. This is mainly because of domestic consumption. China has emerged as a principal exporter and the main competitor in international market. Exports of chilli from India fluctuate widely because of varying factors such as availability of produce for internal use and international market. These are an increasing demand for organic food colours which offers good potential for developing exports.

Chillies are exported in the form of fresh chillies, dry, green chillies, pickles, chilli powder and also oleoresin both colour as well as pungent. The Directorate of marketing and

inspection under the ministry of agriculture has prescribed grades for the internal as well as export markets known as AGMARK grades for chillies. The specifications are based on colour, pod length, stalk less pods, broken chillies, loose seeds, damaged and discolored pods, foreign matter, per cent of moisture etc.

OKRA

Okra has tremendous export potential as fresh vegetable. It accounts for 70 percent of the 30 percent exchange earnings, other than onion, from export of vegetables. Major targets have been our neighboring countries in the gulf and south East Asia, particularly Singapore, Mauritius, Malaysia, Sri Lanka, Bangladesh and Middle East countries which are upcoming potential markets for export of vegetables from India. For fresh fruits export, bhendi fruits should be green, tender, 6-9 cm long. Among them the suitable varieties for export are Pusa Sawani, Parbhani Kranti, Varsha Uphar and Pusa A-4. Although bhendi is grown for export in different parts of the country, the major exporting areas are Nasik, Ozar, Saikheda, Kolhar, Dindori and Sholapur in Maharashtra.

Water melon

There is no proper survey of the foreign markets taken up regarding the quality requirements. Further, no new market has been explored. There is a need to have research and development activities of export oriented types in each crop. In 1997-98, 3,593 mt melons were exported from India which was valued at Rs.1.60 lakh.

Cucumber

India has varied agro-climatic condition making the cultivation of whole range of vegetables possible from temperate to tropical. In 1997-98, the cucurbits and gherkins are exported in quantity of 10766 mt which valued Rs.1784 lakhs. The fruits exported should have good keeping quality.

Bottle gourd

India is an important supplier of fresh vegetables to South-East Asia and Gulf countries. Bottle gourd has great export potential. The fruits exported should be light-green to dark green colour having length of 30-100cm and should be straight. They should have good packing ability in carton boxes. The varieties Pusa Summer, Prolific Long, Pusa Hybrid 3 and Samrat have good export potential. Research is needed to survey other countries for their requirement and production of such marketable produce to the consumers according to their liking to meet their requirement.

Questionnaire

I. Match the following:

A	B
Exporting country	Name of the vegetable
1.Thailand	(4)Onion
2.Holland	(8)Yellow onion
3.Spain	(5)Cole crops
4.Iran	(1) Okra
5.Australia	(2)Carrot
6.Guatemala	(10)Beans
7.Moracco	(6)Asparagus
8.Argentina	(3)Garlic
9Jardan	(7)Gharkin
10.Kenya	(9)Assorted vegetable

II. Say true or false

1. Onion accounts 50 per cent of the total foreign exchange earned through export.

Ans: False

2. Other than onion, okra & chillies ranks second and third position in export.

Ans: True

3.The export qualities of tomato producing areas are Nasik &Pune in Maharastra and Bangalore in Karnataka.

Ans: True.

4.The total export of chillies from India is on average only 10 per cent of total production.

Ans: False

5. Okra accounts for 70 per cent of the 30 per cent exchange earnings, other than Onion, from export of vegetables.

Ans: True

6. Suitable area for growing bhendi for export purpose is located in AndraPradesh state.

Ans: False

7. China is the largest exporter of chilli.

Ans: False.

Lecture 3.

Classification of vegetable crops

- Introduction
- Botanical classification:
- Parts used
- Method of culture.
- Life cycle.
- Thermo classification.
- Photoperiod
- According to growing season
- Methods of raising.
- Hardiness.
- Rate of respiration.
- Forcing
- Soil reaction
- Rooting depth

Introduction

There are more than 240 plants in the world which are used as vegetables. Hence, their classification is essential to understand the nature of vegetable crops and their commonness or distinctness requirement for commercial production. The classification is mainly to show the relationship between the individual vegetables and to avoid repetition while describing their cultural operations. Any method of classification systematizes to some extent the preparation and presentation of the material and eliminates unnecessary repetition of some of the principles of culture.

Vegetable crops have been classified into various groups, but the classification based on the cultural practices has been proved to be the best adoptable in the field conditions, since it is very convenient to a growers. No single method of classification would serve the purpose for different groups like agronomists, breeders, taxonomists and so on. For convenience the following methods of classification are suggested.

I. Botanical classification:

Class: *Spermatophyta*

Division-I*:* *Gymnospermae:* Ovules naked, not enclosed in ovary

Division- II: *Angiospermae:* Ovules in an ovary

All vegetables belong to the group ***Spermatophyta*** and sub division II *Angiospermae.* Botanical classification is most useful from breeder's point of view and helps in identification of vegetables. It provides information on morphological and cytological similarities and dissimilarities, floral biology and other details of crop improvement. The botanical names along with the family of common vegetable crops are given below.

Monocotyledonae (one seed half):	
1)Amaryllidaceae (Alliaceae)	
Onion	*Allium cepa*
Garlic	*A. sativum*
Leek	*A. porrum*
2) Araceae	
Colocasia	*Colocasia esculenta*
3) Graminae	
Sweet corn	*Zea mays*
4) Liliaceae	
Asparagus	*Asparagus officinalis*
5) Dioscorecaeae	
Yam	*Dioscorea alata*
Dicotyledonae (Two seed half):	
1) Aizoaceae	
New Zealand spinach	*Tetragonia expansa*

2) Araliaceae	
Udo	*Aralia cordata*
3) Chenopodiaceae	
Beet	*Beta vulgaris*
Spinach	*Spinacia oleracea*
Palak	*Beta vulgaris* var.bengalensis
4) Convolvulaceae	
Sweet potato	*Ipomoea batatas*
5) Cruciferae (Brassicacaeae)	
Cabbage	*Brassica oleraceae var. capitata*
Cauliflower	*Brassica oleraceae var. botrytis*
Brussels sprout	*Brassica oleraceae var. Gemmifera*
Chinese cabbage	*B. Campestris var.pekinensis*
Turnip	*B.campestris var. rapa*
Mustard	*B. juncea*
Raddish	*Raphanus sativus*
6) Cucurbitaceae	
Pumpkin	*Cucurbita moschata*
Summer squash	*Cucurbita pepo*
Cucumber	*Cucumis sativus*
Ridge gourd	*Luffa acutangula*
Sponge gourd	*Luffa cylindrica*
Snake gourd	*Trichosanthes cucumerina*
Bottle gourd	*Lagenaria siceraria*
Water melon	*Citrullus lanatus*
Winter squash	*Cucurbita maxima*
Bitter gourd	*Momordica charantia*

7) Compositae (Asteraceae)	
Lettuce	*Lactuca sativa*
Globe artichoke	*Cynara scolymus*
Jerusalem artichoke	*Helianthus tuberosus*
8) Euphorbiaceae	
Tapioca/cassava	*Manihot esculenta*
9) Leguminosae (Fabaceae)	
Cluster bean	*Cyamopsis tetragonoloba*
Indian bean/Hyacinth bean	*Dolichos lablab*
Lima bean	*Phaseolus lunatus*
Kidney/snap/French bean	*P.vulgaris*
Cow pea	*Vigna sinensis*
Winged bean/Goa bean	*Psophocarpus tetragonolobus*
Sword bean	*Canavalia gladiata*
Methi/fenugreek	*Trigonella foenum graecum*
10) Malvaceae	
Bhendi	*Abelmoschus esculentus*
11) Solanaceae	
Potato	*Solanum tuberosum*
Tomato	*Solanum lycopersicum*
Sweet pepper	*Capsicum annuum var grossum*
Brinjal	*Solanum melongena*
Hot pepper	*Capsicum annuum var annuum*
12) Umbelliferae	
Carrot	*Daucus carota*
Coriander	*Coriandrum sativum*
Celery	*Apium graveolens*

II. Parts used:

Stem: Asparagus, Potato, Kholrabi

Leaves: Methi, Palak, Coriander, Amaranthus, Spinach, Cabbage

Fruits: Tomato, Brinjal, Okra, Peas, Beans, Watermelon, Pumpkin, Chillies

Flower: Cauliflower, Broccoli, Globe artichoke

5)Underground portions:

1) Roots: Beetroot, Radish, Carrot

2) Tuber: Potato

3) Bulb: Onion, Garlic

4) Corm: Yam

5) Rhizome: Turmeric, Ginger

6) Immature seed: Peas, Beans

III. Method of culture

By this method it is possible to generalize the cultivation practices based on their culture and climatic requirements.

Sl. No.	Group	Vegetables
1	Perennial vegetables	Asparagus, Artichoke, Chow chow, Moringa, Ivy guard, Pointed gourd, Spine gourd
2	Greens	Spinach, New Zealand spinach, Kale, Chard, Mustard, Collards, Amaranthus
3	Salad crops	Celery, Lettuce, Cress, Parsley
4	Cole crops	Cabbage, Cauliflower, Broccoli, Brussel's sprout Chinese cabbage, Knol-khol
5	Root crops	Beet root, Carrot, Parsnip, Turnip, Raddish
6	Bulb crops	Onion, Leek, Garlic, Shallot, Welsh Onion, Chive
7	Tuber crops	Potato, Sweet potato, Cassava, Elephant foot yam
8	Peas and beans	Pea, Bean, Broad bean, Lima bean, Winged bean, Cowpea
9	Solanaceous crops	Tomato, Brinjal, Chilli, Pepper
10	Cucurbits	Cucumber, Watermelon, Pumpkin, Gourds
11	Fibre crop	Okra
12	Pot herbs green	Spinach, Kale
13	Other root crops	Colocasia, Dioscorea, Arrow root

IV. Life cycle:

Annuals: Vegetables which complete their life cycle in one season.

Eg: Broad bean, Lima bean, Water melon, Musk melon, Indian spinach, Chinese cabbage, Cress etc.

Biennial: Those végétales which complète their life cycle in two seasons. Eg. Cabbage, cauliflower, turnip, carrot, etc.,

Perennial: Those végétales which complète their life cycle in more than two seasons. Eg. Artichoke, chicory, asparagus, chow chow, coccinia etc.,

V. Thermo classification:

On the basis of temperature, vegetable crops may be grouped into cool and warm season crops. In cool season crops, the edible parts are mainly root, stem, leaf and immature flower parts. Whereas, in warm season crops edible part is mainly fruit with exception of pea and broad bean which are cool season crops. The cool season crops grow well when the monthly mean temperature does not exceed 21^0 C. They thrive best if the monthly mean temperature is 15-17^0 C. The warm season crops on the other hand grow best when the monthly mean and average maximum temperature are 5^0 to 6^0C higher than for the cool season crops. The average monthly minimum temperature should not be below 9^0C to 10^0C for the warm season crops.

Cool season vegetable crops	***Warm season vegetable crops***
Cole crops	Beans(mostly)
Root crops	Solanaceous vegetables
Bulb crops	Gourds
Lettuce	Okra
Methi	Cassava
Pea	Summer squash
Potato	Sweet potato

Winter squash	Yam

VI. Photoperiod

Short day vegetables*:* Soybean, Sweet potato

Long day vegetables: Flowering is induced by period longer than critical units. eg; Spinach, beet, Chinese cabbage, Lettuce, Radish etc.

Day neutral vegetables: Flowerings induced by a period of 10-18 hours of even continuous illumination. eg: Tomato, Squash, Pumpkin, Asparagus, Pepper etc.

VII. Growing season.

Kharif: Cucurbitaceous vegetables which complete their life cycle during rainy season.

Rabi: Root crops, Cole crops, Potato, Lettuce etc., which grow from October to February

Summer: Melons etc., which grow from February to May.

VIII. Methods of raising:

Direct sown crops: Okra, Carrot, Radish, Beans, Peas, Garlic.

Transplanted crops*:* Tomato, Brinjal, Chillies, Cabbage, Cauliflower.

Vines and cuttings*:* Sweet potato, Cassava, Pointed gourd, Coccinia.

Bits of tubers and corms: Potato, Yams.

IX. Hardiness:

Vegetables which can tolerate frost are known as hardy and vice versa are known as tender. The degree of frost tolerance makes the crop hardy, semi hardy and tender.

Hardy vegetable crops	Semi hardy vegetable crops	Tender vegetable crops
Asparagus	Beet root	Amaranthus
Broccoli	Carrot	Okra
Brussels sprout	Cauliflower	Chilli
Cabbage	Celery	Tomato
Garlic	Globe artichoke	Cluster bean
Knol khol	Lettuce	Cowpea
Leek	Palak	Cucurbits
Onion	Potato	Snap bean
Peas		Sweet potato
Radish		Tapioca
Spinach		Yams
Turnip		

X. Rate of respiration

After harvest, the rate of respiration of the parts harvested enhanced depending on the climatic conditions. The vegetable having the lowest rate of respiration possess the longest storage ability.

Respiration rate of vegetables

Very high	High	Moderate	Low	Very low
Asparagus	Bean	Beet	Cabbage	Onion
Broccoli	Lettuce	Carrot	Sweet potato	Potato
Pea	Lima bean	Celery	Turnip	Pumpkin
Spinach		Cucumber		Ashgourd

XI. Forcing:

Cool forcing vegetables: Asparagus, Beetroot, Cauliflower, Celery, Lettuce, Onion, Pea, Raddish, Spinach

Warm forcing vegetables: Bean, Cucumber, Brinjal, Muskmelon, Pepper, Tomato

XII. Soil reaction (pH):

Slightly tolerant (6-6.8 pH)	**Moderately tolerant (5.5 to 6.0pH)**	**Highly tolerant (5.0-5.5 pH)**
Asparagus	Carrot	Potato
Onion, Cauliflower	Cucumber	Sweet potato
Broccoli, Leek	Brinjal, Garlic	Water melon
Cabbage,	Pea, Chilli, Radish	Chicory
Lettuce, Muskmelon	Pumpkin, Tomato	Rhubarb
Celery	Turnip, Parsely	

XIII. Rooting depth:

Shallow rooted (30-40 cm)	**Moderately deep rooted (50-60 cm)**	**Deep rooted (80-100 cm and above)**
Broccoli	Beet	Artichoke
Brussels sprout	Carrot	Asparagus
Cabbage	Cucumber	Cluster bean
Cauliflower	Brinjal	Cow pea
Garlic, Leek, Lettuce	Muskmelon	French bean
Onion,Potato,Radish	Pea, Pepper	Lima bean
Spinach	Summer squash, Turnip	Pumpkin, Sweet potato, Tomato, Water melon

Questionnaire

I. Select the most appropriate answer of the following questions:

1. A stem vegetable is

a. Carrot b. Knol-khol c. Sweet potato d. Radish

2. All Cole crops belongs to the family----------

a. Cucurbitaceae b. Cruciferae c. Umbelliferae d. None of the above

3. AVRDC is situated in

a. Tokyo b. Taiwan c. Tasmania d. Turkmenistan

4. Which of the following is a biennial vegetable?

a. Muskmelon b. Tomato c. Onion d. Chilli

5. Which of the following is fruit vegetable crop?

a. Sweet potato b. Okra c. Potato d. Spinach

6. Which one of the following soil is best for vegetable cultivation?

a. Sandy b. Sandy loam c. Clay loam d. Clay

7. Which one of the following vegetable produces maximum seeds per fruit?

a. Tomato b. Brinjal c. Chilli d. Potato

II. Say true or false

1. All the vegetables come under the sub community spermatophyte.

Ans: True

2. Based on their temperature requirements, all vegetables are roughly placed in two groups viz., winter and summer vegetables.

Ans: True gymnospermae gymnospermae

3. No vegetables belongs to the division gymnospermae

Ans: True.

4.Cabbage is deep rooted vegetable.

Ans: False

5. Carrot completes its life cycle in one season.

Ans: False.

6. Perrinnial vegetables complete their life cycle in more than two seasons.

Ans: True

7. Vegetables which are tolerant to frost are known as hardy vegetables.

Ans: True

8. The vegetable having lowest rate of respiration possess longest shelf life..

Ans: True

III. MATCH THE FOLLOWING

1.	Amaryllidaceae	Water melon **(5)**
2.	Chenopodiaceae	Knol khol **(4)**
3.	Convolulaceae	Beet root(**2)**
4.	Cruciferae	Onion **(1**)
5.	Cucurbitaceae	Lettuce (**6)**
6.	Compositae	Winged bean (**8)**
7.	Euphorbiaceae	Bhendi (**9)**
8.	Leguminosae	Carrot **(10)**
9.	Malvaceae	Sweet potato (**3)**
10.	Umbelliferae	Tapioca (**7)**

Lecture 4.

Types of vegetable gardening

- Home or Kitchen garden / Nutrition garden.
- Commercial vegetable gardening.
- Market gardening.
- Truck gardening.
- Vegetable forcing.
- Vegetable growing for processing.
- Vegetable seed production garden.
- Floating garden.

Vegetable gardening can broadly be classified into the following types on the basis of production and utilization of the products. The popular and commonly used classification of types of vegetable garden was suggested by Thompson and Kelly.

I. Home or Kitchen garden/Nutrition garden:

Vegetables are grown in areas surrounding the house for fresh supply to kitchen for family consumption. The main purpose of kitchen or home gardenis to provide the family daily requirement with fresh vegetables rich in nutrients and energy. There is to be more or less continuous supply of a variety of vegetables throughout the year according to the season. It also provides recreation and exercise especially for ladies. A model kitchen/nutrition garden is depicted in fig. 1. In addition to the above, home garden can reduce the family expenditure and improve the standard of living.

Fig.1: Layout of model kitchen garden

Table 1.Cropping pattern of kitchen/nutrition garden

Plot No.	Vegetables and period	Vegetables and period	Vegetables and period
1	Cabbage (October-February)	Cowpea (March- June)	Fenugreek (August-September)
2	Okra (September – December)	French bean (January - March)	Carrot (June –July)
3	Chilli (June-May)	Garlic (june-December)	Radish (June-July)
4	Peas (September – November)	Tomato (December – March)	Okra (April –June)
5	Carrot (September – November)	French bean (December - April)	Cucumber (May –July)
6	Capsicum(September – December)	French bean (January - April)	Cucumber (May – August)
7	Beet root(September – December)	Cabbage (December – March)	Cluster bean (April –July)
8	Potato (November-February)	Amaranthus (November – April)	Cowpea (May –April)
9	Sweet potato(August – September)	Brinjal (January - February)	Carrot (June –July)
10	Palak (September – November)	Capsicum(January – February)	Radish (June –August)

Types of kitchen garden

a) Home garden having fruits and vegetables

b) Home garden having only vegetables

Kitchen gardens vary according to the size of the residential plot.

Eg: 1) Large size kitchen garden

2) Medium size kitchen garden

3) Small size kitchen garden

4) Terrace garden: In cities/towns where only little space is available, one can grow vegetables in the pots, drums and other containers placed on terrace or roof.

Advantages:

1) Kitchen garden is the best means of recreation and exercise

2) Kitchen garden is lowering down the vegetable bill: In kitchen garden, there is no transportation charge and middlemen's share which greatly add to the price paid by the consumers in purchasing vegetables from the market.

3) It secures enough vegetables within the means of all classes at very cheap rate

4) The cost of raising the vegetables in the kitchen garden through one's own labour is far less than what a family spends on vegetables in the market.

5) Vegetables grown in the kitchen garden are nutritious, fresh and are not liable to infection with germs occurring in unsanitary markets.

6) Better utilization of available surrounding land, kitchen waste and kitchen water.

Planning and management:

Land: Land size depends on number of persons to be supplied with vegetables. An area of 250 sq.m can supply vegetables for a family of five members.

Location: As far as possible the kitchen garden should be located near the house especially in the back of the kitchen room. The soil should be preferably loam or sandy loam, well drained with rich in organic matter and nutrients.

Arrangement of crops:

Perennials and fruit crops should be on one side or at one end of the garden, such a way that they should not obstruct field preparation and intercultivation. Cucurbitaceous and other vine vegetables should be grown near the fence. Quick growing plants should be planted in continuous rows as per our plan of supply of vegetables throughout the year.

Manuring: FYM or compost is best suited for kitchen garden. For best growth and development of crops chemical fertilizers are also used in addition to kitchen waste.

Interculture: As and when required, take up weeding, staking, thinning, earthing up etc., for good growth and development of vegetable crops.

Irrigation: Plants should be irrigated regularly

Control of pest and disease: Plant protection measures based on the need are taken up at appropriate intervals to control respective pest / disease.

Harvesting: Generally harvesting is done at right stage in order to get the quality products .according to requirement.

II. Commercial vegetable gardening:

The vegetables are grown on large scale for sale in the market. This is further divided into following types.

i) Market gardening	Canning
ii) Truck gardening	Freezing
iii) Vegetable forcing	
iv)Vegetable growing for processing	Dehydration
	Pickling and fermentation
	Vegetable seed production

v) Vegetable seed production garden

Market gardening:

The main objective of market gardening is to produce vegetables for the local market. At present due to development of transport facilities, growers are sending their produce even to distant markets where prices are more attractive and profitable. Now vegetables are brought to the mandies from distant villages by trucks. Timely and proper irrigation facilities, good seed, enough nutrition, abundant labour supply and easy transportation facilities are essential for market gardening.

The places where market garden is practiced, the land value is very high. So it becomes necessary to secure large returns per acre to realize some profit on the investment. For market gardening, crops like peas, cauliflower, cucumber, tomato, chillies, onion etc., are grown.

Truck gardening:

It is the method of growing special vegetable crops in relatively larger quantities for distant markets by the employing of extensive methods. In this method of gardening, in

general more extensive and less intensive method of cultivation than market gardening is followed.

In recent years the development of national highways and efficient motor truck facilities have improved this gardening considerably. The main feature of truck garden is given below.

a) Such farms are located far away from the centre of consumption preferably by the side of rail route or metallic roads.
b) Price of land and labour is comparatively lower
c) Only few crops of semi perishable nature are grown on large area. Eg: Onion, Green chillies.
d) Cost of transportation is high.
e) Mechanization is followed partly or wholly.
f) The cost of cultivation is less.

Vegetable forcing:

It is the method of growing the vegetables out of their normal season in net houses, green houses, glass houses and under other artificial growing conditions. In Indian condition vegetable forcing is not possible because the consumers cannot afford the prices of such vegetables.

The following are the characteristics of this type of farming.
a) Cost of production is higher than other method of vegetable production.
b) Various structures viz., green house, cold frames etc are required for forcing vegetables.
c) The cultivation is most intensive.
d) It requires special technical knowledge.
e) Environment is controlled artificially.
f) It is a sort of specialized demand oriented programme. Few vegetable crops such as tomatoes, cucumbers, peas, asparagus etc are grown in this type of farming.

Vegetable growing for processing:

The main objective of this type of gardening is to produce the vegetables for supply to processing factories. These gardens are situated around the factories and grow the kind of varieties required by the factories. This type of gardens in India are very limited due to lack

of processing factories. But, the prospects of future development are quite bright as the processing industries are growing up fast.

The main features of this type of garden are as given below.

a) Cultivation is less intensive with low cost of production

b) Market is assured.

c) Vegetables are grown on contract basis.

d) Specific kinds of varieties of vegetables are cultivated.

Suitable crops for various methods of preservation

i) Canning: Tomatoes, Peas, Beans, Okra, Pointed gourd, Sweet corn, Asparagus

ii) Freezing: Peas, Sweet corn, Lima beans, Asparagus, Cauliflower, Spinach.

iii) Dehydration: Onion, Potato, Cauliflower, Peas, Cauliflower, etc.,

iv) Pickling and fermentation: Turnip, Cucumbers, Cabbage, Cauliflower, Carrot, Chilli, and Radish.

Vegetable seed production garden.

The main objective of this type of gardening is to produce quality seeds on large scale under the inspection of an organization. Climate, soil, diseases free conditions are factors influencing the location of seed growing areas. The owner of garden should have thorough knowledge of the crop, its growth habit, mode of pollination, isolation distance required and time of rouging etc. the knowledge about curing, threshing, cleaning, grading, packing and storage is also essential. Nucleus/ breeder's seed is produced by the breeder. Foundation seed is multiplied at research stations or seed corporation farms.

The certified seeds are multiplied by the farmers under the inspection of seed certification agency. This is an expanding industry in India and also profitable to the growers.

Following are main characteristics of this type of gardening.

i) Vegetables are produced mainly for seeds under strict supervision of specialists.

ii) Vegetables are produced on contract basis in suitable climatic conditions.

iii) The practices such as isolation, frequent rouging of off types is essential to maintain the purity of the seed.

iv) Highly skilled labour is employed.

v) High investment for control of pests and diseases.

III. Floating garden:

In this type of gardening the vegetables are grown in water on a floating base like boat. These floating gardens can be seen in Dal lake of Kashmir valley**.** In such areas where land is submerged in water, this type of gardening can be followed. A floating base is made from the roots of typha grass or any other similar type of material. The floating base is kept in the water and seedlings are transplanted on leaf compost made out of the local vegetation growing in the area. According to the need of the crop, inter cultural operations can be done by sitting in boats. Most of the summer season vegetables are supplied from Dal Lake to Srinagar**.**

Questionnaire

I. SELECT THE MOST APPROPRIATE ANSWER OF THE FOLLOWING QUESTIONS:

1. Type of vegetable gardening followed on the of Dal lake of Kashmir valley is ----------

i). Floating garden ii). Hydroponics. iii). Kitchen garden iv). None of the above

2 _____ gardening is to Produce vegetables for local market.

i) Market gardening ii) Truck gardening iii) Vegetable forcing iii) Vegetable processing

3 _____ gardening is to Produce vegetables for distant market.

i) Market gardening ii) Truck gardening iii) Vegetable forcing iii) Vegetable processing

4 _____ gardening is to Produce vegetables out of their normal season.

i) Market gardening ii) Truck gardening iii) Vegetable forcing iii) Vegetable processing

5 _____ gardening is to Produce vegetables for supply of processing factories.

i) Market gardening ii) Truck gardening iii) Vegetable forcing iii) Vegetable processing

6. Which is the vegetable suitable for dehydration?

i) Onion ii) Turnip iii) Carrot iii) Chillies

7. Which is the vegetable suitable for canning?

i) Asparagus ii) Cauliflower iii) potato iii) Cucumber

8. Which is the vegetable suitable for Freezing?

i) Asparagus ii) Cauliflower iii) potato iii) Cucumber

9.What is the colour of the used for identification of breeder seeds?

i) Blue ii).White iii) Red iii) Golden yellow

10. Floating gardens are find in

i) Karnataka ii).Kerala iii) Himachal Pradesh iii) Jammu & Kashmir

II. Say true or false.

1. In floating gardening, a floating base is made from the roots of Typha grass.

Ans:True

2. The popular and commonly used classification of types of vegetable garden was suggested by H.C. Thompson and W.G. Kelly.

Ans: True

3. An area of 500 sq. m. nutrition garden can supply vegetables for a family of five members.

Ans: False

4. Truck garden is one fo the example of commercial vegetable gardening.

5. Cost of transportation is high in market garden.

Ans: False

III. ANSWER THE FOLLOWING QUESTIONS

1. Define nutrition garden.

2 What are the advantages of kitchen garden?

3 Differentiate between market garden and truck garden.

4. What are the salient features of vegetable forcing garden?

5. Describe the planning and management of kitchen garden.

Lecture 5.

Origin, area, production, economic importance, and description of varieties and hybrids of Tomato

- Area and production.
- Economic importance and uses.
- Description of popular varieties and hybrids.
- Varieties resistant to leaf curl.
- Hybrids
- Varieties suitable for different purposes.
- IAHS Bangalore released hybrids.

TOMATO

Botanical name:	*Solanum* **l***ycopersicum.* Mill
Family:	Solanaceae
Chromosome No.:	2n = 24
Origin:	Peru or Mexico

Area and production

The estimated world production of tomato is about 127.92 million tones and area of about 47.19 lakh ha. China ranks first with production of 33.64 million tones leaving USA to second place. The area and production of tomato in our country was about 6.34 lakh ha and 124.33 lakh tones respectively in 2009-10. The leading tomato growing states are UP, Karnataka, Maharashtra, Haryana, Punjab and Bihar.

Economic importance and use

Tomato is producing a very good source of income to small and marginal farmers and contributes nutrition to the consumers. Tomato is a rich source of minerals, vitamins and organic acid. There are various types of flavouring compounds found in fruits, which enrich the taste.

The total sugar content is 2.5 % in ripe fruit and amount of ascorbic acid varies from 16 to 65 mg/100 g of fruit weight. 100 g of edible portion of tomato contains 94.1 g of water, 1.0 g of protein, 0.3 g of fat, 4.0 g of carbohydrates, 0.6 g of fibre, vitamin A (1100 I.U), vitamin B (0.20 mg), vitamin C(23 mg), malic acid (150 mg), citric acid (390 mg), oxalic acid (3.5 mg), potassium (268 mg), and phosphorus (27 mg)

Several processed items like paste, puree, syrup, juice, ketchup, drinks etc are prepared on large scale. Some times, it is called poor man's orange. Tomato is very good appetizer and its soup is said to be a good remedy for patients suffering from constipation. It is used for treating chronic dyspepsia, bronchitis, asthma and also used as a blood purifier. Three flesh colours in tomato namely red (lycopene pigment), yellow (carotenoid) and tangerine (prolycopene) were found.

Description of popular varieties and hybrids

A large number of tomato determinate and indeterminate varieties have been evolved by various organizations of the country. According to the growth habit, tomato is characterized by two types of plant.

Determinate type:

Inflorescence occurs more frequently in almost every internode until terminal ones are formed and elongation ceases at this point, in otherwords, it may be defined as self topping and the main stem terminates with a flower cluster.

Indeterminate type: Inflorescence cluster occurs at every third internode and main axis continues to grow indefinitely.

Important varieties/hybrids:

Arka Saurabh:

This variety was developed in IIHR Bangalore by selection from the breeding line V 685 introduced from Canada. Plants are semi determinate in growth; fruits are thick

fleshed, firm round, medium large in size, deep red colour. Fruits have good transport quality, which is good for both fresh market and processing. The average yield is 30.8 tonnes per ha.

Arka Vikash:

An improved variety developed through selection from a variable population of American variety "Tip Top" introduced at IIHR Bangalore. Plants are indeterminate; fruits are medium size with uniform deep red colour. It is recommended for cultivation in both hills and plains. The variety does well in moisture stress conditions and gives an average yield of 30.3t/ha.

Sioux:

Plants are indeterminate, medium to large round fruits with yellow stem end, sub acidic in flavour, suitable for short distance market. This variety was released by IARI.

Pusa Ruby:

A very popular variety developed at IARI, New Delhi through hybridization of Sioux X Improved Meeruti. Plants are indeterminate, spreading, less branched, hardy with an height of 80-85 cm. fruits are flattish- round, small to medium sized uniform red, slightly lobed and mild acidic. This is an early variety having 25-30 fruits per plant.

Pusa Early Dwarf:

It was developed by NBPGR, New Delhi through hybridization of Improved Meeruti X Red Cloud. Plants having determinate growth habit are typical dwarf with compact fruiting. Fruits are medium large in size, uniform red, ribbed, obscure furrow with 5-6 locules. It is suitable for rainy season.

Pusa Uphar:

The variety developed at IARI, plants are indeterminate, erect thick stemmed with dark green foliage, 2-3 fruits per cluster, fruits are medium size, round shaped with deep red skin colour. Average yield is 35-40t/ha and this variety is suitable for processing.

CO 3: Plant habit is determinate, which is a mutant variety of CO1 developed by TNAU, Coimbatore. Plants are erect, thick and main stem has strong primary branches with dark

green foliage. Fruits are round globular in shape, medium in size, bright red colour and possess high Vitamin C and gives an average yield of 38.1 t/ha.

Hissar Anmol: Developed at HAU, Hisar through hybridization of Hissar Arun X Lycopersicon hirsutum f. glabratum. It is resistant to leaf curl virus. Plants are determinate, flattish round, medium in size with red colour.

Hisar Lalit: This variety has been developed through hybridization of HS 101 X Resistant Bangalore *at HAU, Hisar*. It is a semi determinate, which bears fruits in medium to large in size, round in shape. This variety is resistant to root knot nematode.

Pant Bahar: Developed at Pantnagar from AC 238 line. Plants are bushy with light green foliage with relatively thin stem, fruits are ready for harvest in 78 days. Fruits are flattish round medium in size and red in colour. This is resistant to verticillium and fussarium wilt and has good storage and processing quality.

Pant T3*:* Developed at Pantnagar through pure line selection. Plants are semi determinate, round hairy stem. Fruits ripen in 60 days, uniform red in colour and suitable for processing. Its average yield is 19.2 t/ha

Punjab Chhuhara: This variety was developed at PAU, Ludhiana through hybridization of EC 55055 215 X Punjab Tropic. Plants are dwarf, bushy, determinate and uniform red colour at maturity. This variety is suitable for long transportation.

Punjab Kesari: Developed through hybridization followed by pedigree selection at PAU, Ludhiana. It is recommended for cultivation in both plains and hills. Plants are determinate bushy and this variety is susceptible to late blight fruit borer and root knot nematode.

Pusa Sheetal: It is developed through hybridization of two low temperature fruiting type introductions, Balka (Introduced from Bulgaria) X Jeemnoroshnese (Introduction from

USSR). Plants are determinate growth habit. Fruits are flattish, round in shape, uniform red colour. The average yield is 36.3t/ha.

VC 48-1: This is a bacterial wilt resistant variety developed at Assam Agricultural University. Plants are determinate, very vigorous and possess good foliage.

NTDR-1: This variety is developed at UAS, Bangalore. It is a nematode resistant variety.

Maega (L-15): This variety released through hybridization between NTDR1 X AVRDC at UAS Dharwad. Fruits are medium in size, flattish round and it can grow in high temperature conditions. Average yield is 25-30t/ha.

Arka Alok (BWR-5)

A pure line selection from IIHR 719-1-6(CL-114-5-1-0) from AVRDC, Taiwan Plants determinate Fruits on the lower clusters square round, large(120g) and in later cluster oblong, medium (80g) firm fruits with light green shoulder. Resistant to bacterial wilt. Bred for fresh market Suitable for kharif and Rabi seasons. Duration 130 days. Yield 46 t/ha.

Arka Abha (BWR-1)

A pure line selection from IIHR 663-12-3-SB-SB (VC-8-1-2-1) from AVRDC, Taiwan. Plants semi determinate. Fruits oblate, with light green shoulder Fruits have stylar end scar with average fruit weight of 75g. Develops deep red color on ripening. Resistant to bacterial wilt caused by Rastonia solanacearum. Bred for fresh market Suitable for both kharif and rabi Duration 140 days Yield 43 t/ha.

Arka Ahuti (Sel-11)

A pure line selection from IHR 143-3-7-SB-1(Ottawa 60 from Canada) Plants semi-determinate. Fruits oblong with 2-3 locules. Thick fleshed fruits have light green shoulder, ripens to dark attractive red, TSS 5.2% Bred for processing- tomato puree. Suitable for kharif and rabi seasons. Duration 140 days Yield 42 t/ha.

Arka Meghali A pedigree selection (F8) of the cross Arka Vikas x IIHR 554 Plants semi-determinate. Narrow dark green leaves with good canopy. Fruits medium (65g.), oblate with light green shoulder. Deep red fruits. Suitable for fresh market. Bred for rainfed cultivation Suitable for kharif season. Duration 125 days. Yield 18 t/ha

Arka Ashish: It is ready for harvesting in 130 days. Fruits are egg shaped red in colour and all fruits can be harvested at once. Suitable for processing. It is resistant to powdery mildew and crop can be grown both in rainy and winter season. Average yield is 38 t/ha.

Arka Abhijit

A F1 hybrid of the cross 15 SBSB x IIHR 1334 Plants semi-determinate. Dark green leaves with good canopy. Fruits medium (65-70g.), round with green shoulder. Deep red, firm fruits. Suitable for fresh market Highly resistant to bacterial wilt. Duration 140 days Yield 65 t/ha.

TOMATO - Arka Ananya It is a high yielding F1 hybrid with combined resistance to ToLCV and BW Plants semi-determinate with good foliar cover. Foliage dark green. Fruits round, firm (5.0 kg/cm2), medium (50-65g) with light green shoulder. First fruit maturity 55-60 days. Develops deep red color on ripening Yields 76 tons/ha. in 140 days. Suitable for summer and rainy seasons.

Arka Rakshak High yielding F_1 hybrid with triple disease resistance to ToLCV, BW and early blight. Fruits square round, large (90-100g), Deep red, firm fruits Suitable for fresh market and processing. Yield 75-80 t/ha.in 140 days.

Arka Samrat : High yielding F_1 hybrid with triple disease resistance to ToLCV, BW and early blight. Fruits oblate to high round, large (90-110g), Deep red, firm fruits Suitable for fresh market. Yields 80-85 t/ha. in 140 days

Arka shreshta A F1 hybrid of the cross 15 SBSB x IIHR 1614 Plants semi-determinate.Light green leaves with good canopy. Fruits medium large(70-75g.), round

with light green shoulder. Deep red firm fruits. Suitable for both fresh market and processing. High yielding F1 hybrid with bacterial wilt resistance. Suitable for rabi season Duration 140 days Yield 76 t/ha.

Arka Vikas (Sel.22) A pure line selection from an American variety Tip-Top. Plants semi-determinate. Narrow dark green leaves with good canopy. Fruits medium large (80-90 g), oblate with light green shoulder which develop deep red on ripening. Bred for fresh market Adapted to both rain fed and irrigated conditions. Suitable for both kharif and rabi seasons Duration 140 days. Yield 35-40 t/ha.

Pusa Gaurav: Developed through hybridization of GlamourXWatch, Determinate with light green foliage, oblong, yellowish red fruits, Yield 40 t/ha.

Azad T-2, Azad T-3, Azad T-5: Developed at CSAUAT, Kanpur, determinate, red round fruits, resistant against fruit borer and nematodes and leaf curl.

Pusa Sadabahar: Determinate, plants dwarf, accommodating more number of plants per unit area and prolific bearer. Suitable for growing under wide temperature range of 8^0 C to 3^0 C.

Pusa Rohini: Determinate, suitable for summer season, sowing in plains of North India, Fruits are round, medium. Yield 40-43 t/ha.

Narendra Tomato (NDT-5): Indeterminate, medium large, round, red at maturity, suitable for processing.

Sakthi: Developed at KAU Kerala, semi determinate, resistance against bacterial wilt.

Mukthi: Developed at KAU Kerala, determinate, resistance against bacterial wilt and fruit cracking and heat tolerant variety.

Kashi Amrit: Developed at IIVR, Varanasi, determinate, attractive red, round. Yield 62 t/ha.

Varieties resistant to leaf curl:

Three varieties such as **Sankranthi, Nandhi and Vybhav** are released at **UAS Bangalore** which are resistant to leaf curl virus and suitable for growing in summer season.

Sankranthi: Fruits are medium, round, medium duration (95-105 days). Yield is 40-45 t/ha.

Nandhi: Fruits are medium size, high yielding variety. Yield is 40-45 t/ha.

Vybhav: Suitable for distant transport. It is resistant to both leaf curl and bacterial wiltdisease.Yield is about 40-50 t/ha.

Arka Vishal: plants are tall; duration of the crop is 165 days. Fruits are large, red in colour and suitable to grow in rainy and winter season. Staking is required for growth and better development of plants. Average yield is 75 t/ha.

Arka Varadhan: Crop is harvested in 160 days after transplanting. Fruits are large deep red in colour, resistant to root knot nematodes and grown both in rainy and winter season. Staking is necessary for the plants. Average yield is 75 t/ha.

Pusa Hybrid-1: Developed at IARI New Delhi, determinate, round, medium size, suitable for long distance transportation. Fruit setting at high night temperature. Yields 32.5 t/ha.

Pusa Hybrid-2: Determinate, round, medium, field resistant to nematode, yields 55 t/ha.

Pusa Hybrid 4: Determinate, round, medium, yields 55 t/ha.

Pusa Divya : Indeterminate F1 hybrid, profusely branched, round, yield 35 t/ha.

Varieties suitable for different purposes:

Varieties for fresh market: Pusa Early, Dwarf, Pusa Ruby, Pusa 120, Pant T-3, Arka Vikas, Arka Saurabh, CO-3, Punjab Kesari, Pant Bahar

Varieties for distant market: Pusa Gaurav, Roma, Punjab Chhuhara, Pusa Uphar.

Varieties for processing: Pusa Gaurav, Rousa, Punjab Chhuhara, Pusa Uphar, Arka Saurabh.

Varieties resistant to abiotic stresses: Pusa Sheetal-low temperature; Pusa hybrid 1- High temperature; Pusa Sadabahar- high and low temperature regime.

IAHS Bangalore released hybrids

1) Rashmi: Tolerant to fusarium and verticillium wilt.

2) Rupali: For high temperature.

3) IAHS-88-2: Tolerant to fusarium, verticillium and root knot nematode.

4) Naveen: Fresh market.

5) IAHS-88-3

6) Karnataka Rajani

7) Vaishali

MAHYCO Seeds: MTH 4, Sadabahar, Gulmohar.

Novartis: Avinash 2. Yields 75 t/ha;

Bejo Sheetal pvt. Ltd- Meenakshi, Talstoi.

QUESTIONNAIRE

I. MULTIPLE CHOICE QUESTIONS

1. The centre of origin of tomato is ----------

a. Peru and Mexico b. Mediterranean c. China d. India

2. The genus to which tomato belongs is ----------

a. Lycopersicon b. Capsicum c. Solanum d. Physalis

3. Tomato variety CO-3 was evolved by ----------

a. X rays b. Gamma rays c. EMS d. MMS

4. Tomato variety Pusa Lal Meeruti was evolved by

a. X rays b. Gamma rays c. EMS d. MMS

5. ---------- is considered as poor man's orange in India, while love of apple in India

a. Capsicum b. Brinjal c. Tomato d. Water melon

6. Aroma of green leaf of tomato is due to

a. Sirigrini b. Glycoisocinate c. Capsaicin d. None of the above

7. Tomato fruit aroma is due to

a. Sulfonium b. Chlorophyll c. Carotenoid d. Polyphenols

8. The fruits of tomato is

a. Pome b. Pepo c. Drupe d. Berry

9. Tomato produces ----flowers in cluster on the stem

a. Proandry b. Protogynous c. Cleistogamous d. Hercogammy

10. Sioux and Marglobe varieties of tomato are introduced from

a. Asia b. USA c. Africa d. Europe

11. Severianin is a ----------variety of tomato

a. Highly seeded b. Parthenocarpic c Parthenogenesis d. None of the above

12. Pusa Divya hybrid, Punjab Upma and Pusa Upkar are the latest varieties of

a. Brinjal b. Chilli c. Capsicum d. Tomato

13. *Solanum lycopersicum* is a new botanical name of

a. Tomato b. Brinjal c. Chilli d. None of the above

II. Say true or false.

1. Punjab chhuhara variety of tomato is pear shaped and withstands long distance transportation.

Ans: True

2. Determinate cultivars bears flower at every third node.

Ans: False.

3.Arka Vikash is selected from an introduced variety of Tip Top

Ans:.True

4. Sankranthi variety is released by UAS, Bangalore which is resistant to leaf curl virus.

Ans: True.

5. Lycopine pigment is responsible for colour of the tomato.

Ans:, True

6. India ranks first in respect of area and production of tomato in the world.

Ans: False.

Lecture 6. Climate, soil requirement, seed rate, preparation of field, nursery practices, transplanting, spacing, planting systems, irrigation, growth regulators. nutrition and weed management, harvest, post-harvest handling, storage, marketing and seed production of tomato.

- Climate and soil.
- Seasons.
- Seed rate.
- Nursery.
- Preparation of field.
- Transplanting.
- Spacing.
- Nutrition.
- Irrigation.
- Weed control.
- Staking.
- Use of growth regulators and chemicals.
- Other intercultural practices.
- Harvesting and yield.
- Maturity standards and post harvest management
- Storage and marketing
- Seed production

Climate and soil

Temperature affects growth and development of tomato plants primarily by controlling biochemical processes. Temperature emerges as the major growth factor through its control on plant development including morphogenesis and product quality and induction of flowering stimuli. Temperature also determines climatic zones and controls plant distribution, growth cycles, and growth rates and ultimately yield. Tomato is a warm season crop. It is neither tolerant to frost nor to water logged condition. The

optimum ranges of temperature is 20-24^{0}C, mean temperature below 16^{0}C and above 27^{0}C are not desirable. Lycopene content is highest at 21-24^{0}C while the production of this pigment drops off rapidly above 27^{0}C. Tomato can be grown on variety of soils but better yield is obtained in well drained soil, fairly fertile, rich in organic matter with fair water holding capacity. For early crop, a sandy loam soil is the best, however, for higher yield heavy soils rich in organic matter are preferred. The best soil pH is 6-7.

Seasons

Seed sowing in the plains is done thrice during the year.

1) For rainy-autumn crop: The seeds are sown in the month of June and July.

2) For autumn-winter crop: Seeds are sown in the month of Sep-Oct.

3) For spring-summer crop: Seeds are sown in the month of Jan-Feb.

In hills the seeds sowing depend upon the elevation of the place. On lower hills, seeds are sown at Feb-March while on the higher hills in the months of March and April.

Seed rate

The seed rate depends upon the germination percentage of seed. Normally 300-400 g and 100-150 g seeds for open pollinated varieties and hybrids respectively are required for planting one hectare land.

Nursery

Approximately 200m^2 area will be sufficient for raising the seedlings to plant one hectare. Generally nursery beds are prepared in the size of 7.5 m long, 1-1.2 m width and 10-15 cm height. Well decomposed farmyard manure is properly mixed in to top soil of the bed at the rate of 3 kg/ m^2. A fertilizer mixture of 0.5 kg NPK of 15:15:15 per bed is mixed in the soil at least 10 days before sowing the seeds.

For raising healthy seedlings, seeds should be treated before sowing with captan or thiram @ 2g/kg of seed is essential. The seeds are sown in a bed either broadcasted or in row, at a distance of 7.5 cm between the rows. After sowing, the beds are covered with a thin layer of dry grass or compost, thereafter the beds are irrigated with a rose can.

Light watering is required daily in the evening. Every week, if required, a fungicide such as Mancozeb or Difolation 0.25% should be sprayed to reduce the post emergence damping off. The seedlings will be ready for transplanting after 4 to 6 weeks of seed sowing.

Now a day's various kinds of plastic seedling trays (Pro-trays) are used for raising seedlings. These trays provide congenial environment for growth and development of seedlings.

1. Uniform, vigorous and healthy planting materials can be raised for better growth, development and yield.
2. Economy of seed rate which cuts down cost of cultivation particularly for hybrids.
3. Favourable growing conditions can be provided through convenient protection against biotic and abiotic stresses.
4. Efficient time management for preparation of main field.

Preparation of field

The field is first ploughed with soil turning plough followed by 4-5 ploughings with country plough or harrow. Leveling should be done after ploughing and bring the soil into fine tilth and also provide better drainage facilities. At the time of soil preparation, raising the planting bed above ground level facilitates drainage during rainy season.

Transplanting

Seedlings should be hardened before transplanting by withholding watering for 4-5 days so as to reduce the available moisture to 20 per cent Hardening can also be achieved by adding 4000 ppm NaCl to the irrigation water or by spray of 200 ppm cycocel+$ZnSO_4$ (0.25%) + 25 mm proline at time of transplanting. The tomato seedlings are transplanted on flat beds or on side of ridges. In the initial stage, seedlings are transplanted at the side of the ridge and later earthing up is done to keep plant in the middle of the ridge.

Spacing

In tomato, plant spacing is dicided on the basis of growth habit of the variety and purpose such as fresh marketing or processing. The closer the spacing, the higher is the yield but this reduces fruit quality. There is especially reduction in the size and more incidence of insect pests and diseases. Different spacings are followed such as 60cmx45cm, 75cmx60cm and 75cmx75cm on flat and raised beds. In some areas 100cmx60cm spacing is also followed. The plant population of 35,000/ ha is considered to be optimum for producing fruit yield of 40 tonnes/ha.

Nutrition

The quantity of nutrient applied in the field depends upon several factors such as cultivar, soil and growing condition, irrigation and season. A crop grown in spring summer will require more nitrogen as compared to crop of winter season. Early maturing varieties will require less nitrogen as compared to long duration ones. Adequate supply of nitrogen increases, fruit size, fruit quality, keeping quality, colour and taste. Acidity is also increased by excess nitrogen. High level of phosphorous throughout root zone area is essential for rapid root development and for better utilization of water and other nutrients. Adequate amount of potassium is required for growth, yield and quality. Removal of primary nutrients from the soil is 0.33 kg N, 0.11 kg P and 0.44 kg K per 100 kg yield.

Recommended dose of fertilizers for varieties are given below

Sl. No.	**Place**	Nitrogen (kg/ha)	Phosphorous(kg/ha)	Potassium(kg/ha)	FYM (t/ha)
1	New Delhi	60	60	0	25
2	Coimbatore	100	80	50	25
3	Bangalore	115	104	64	25
4	Chaubatia	100	90	-	-

Well rotten 38 tons of FYM and 250 kg of each NPK per hectare is the recommended dose for hybrids .Half dose of nitrogen and full dose of phosphorus and

potassium should be applied as basal while half dose of nitrogen may be applied as top dressing after 25-30 days of transplanting. The application of Zn, Cu and B significantly increased the number of fruits per plant, yield and quality. Application of 20-30kg of Borax and 0.5% Zn is beneficial for yield and good quality of fruit.

Irrigation

Tomato plants require adequate moisture throughout their growth period. First irrigation is required soon after transplanting. Too much of water at the time of transplanting and before fruit set have been found detrimental causing blossoms off. Irrigate the crops at an interval of 3-4 days during summer and 10-15 days during winter to maintain the soil moderately wet. During winter, the plants are not irrigated at the time of ripening of fruit. A long spell of drought followed by sudden heavy irrigation may cause cracking of fruits. Furrow irrigation is most widely used to irrigate tomato crop in India. Drip irrigation of tomato crop increases the yield by 50 per cent and saved water by 30 per cent as compared to furrow method. Nowadays sprinkler irrigation is also being popularized which is found to be more economical. Irrigation following a period of moisture stress during fruit development leads to blossom end rot. Development of moisture stress in foliage results different physiological consequences. Viz. (1) Decrease in stomata opening (2) Reduction in photosynthesis and transpiration. (3) Dehydration of protoplasm (4) Reduction of cell division and cell enlargement. (6) Decrease in total dry matter production and growth.

Weed control

The normal method of weed control is to give two hand hoeing in the first and third fortnight after transplanting and an earthing up operation during the seasonal fortnight. The application of pre emergence herbicides like metribuzin at 0.35kg/ha, fluchloraline 1.25kg/ha controls the weed population and increases the yield of tomato. Recently the use of pendimethalin @1.0kg/ha as pre emergence application at three days after transplanting was found very effective in suppressing the weeds.

Staking

In case of indeterminate varieties, the yield and quality of fruit is improved by staking the plants with wooden sticks/polythene threads. Staking not only increases the yield and improve its quality but also reduces the infection by fungal diseases.

Use of growth regulators and chemicals:

Use of plant growth regulators in tomato has been found beneficial for earliness, yield, quality, cold and high temperature, and fruit setting and to develop resistance to TLCV (Tomato Leaf Curl Virus). Growth regulators activate the root growth, increase fruit set and yield. They also affect the physiological process hasten maturity and better quality of fruits.

Various growth regulator substances recommended for various purpose are summarized in the table.

Chemicals	Common name	Doses(mg/litre)	Effective
2,Chloroethyl phosponic acid	Ethephon	200-500 whole plant spray	Flowering induction, better rooting and setting of plants
2,Chloroethyl trimethyl ammonium chloride	cycocel	500-100	Flower bud, stimulate pigment formation and increase fruit set
2,4 Dichlorophenoxy acetic acid	2,4-D	2-5 seed treat whole plant spray	Increase fruit set, earliness and parthenocarpy
3 Indole butyric acid	IBA	50-100	Increase fruit set
3 Indole acetic acid	IAA	Foliage spray	Increase fruit size and yield

Naphalene acetic acid	NAA	Spray oil	Higher fruit set, yield
Parachlorophenoxy acetic acid	PCPA	50 foliar spray	Higher fruit set under adverse climatic condition
6-4Hydroxy methyl 8 methyl gibberlin	GA	50-100 foliar spray	Elongate shoot growth and increase fruit yield

Other Intercultural practices

Mulching

Mulches are used to increase or reduce the temperatures suppress weed growth and conserves soil moisture. Organic mulches like straw can reduce the soil temperature during summer season however, plastics are used to increase the soil temperature during winter season for maintaining the optimum temperature which is required for good growth, flowering, fruiting and quality of tomato.

Pruning

Pruning and training is followed in indeterminate tomato varieties. Pruning is the removal of unwanted growth of plants, improves the size, shape and other qualities of fruits. Pruning breaks the apical dominance, eliminates the crown set and enhances the plant vigour. Apart from pruning in indeterminate tomato, early and total yield and quality are increased to greater extent by training. The plants are trained with wires, strings or stacks.

Harvesting and yield

In indeterminate cultivars, fruit are harvested in 70-100 days after planting. In determinate cultivar fruits are harvested at 70 days depending upon the environmental condition. According to the use of fruits they are harvested in following stages.

Green stage: About a fortnight before turning (Development of a trace of redness at the stylar end of the fruit), the fruits will develop normal colour of the vine though they are still green yet they may be fully developed. These fruits are picked and sent to distant markets.

Pink stage: At this stage, pink colour on the fruits varies from the trace at the bottom end to a considerable extent covering the surface. Though at this stage most of the fruits are red, yet they are not fully ripe. They are picked for local markets.

Ripe stage: At this stage the surface of most of the fruits is red and softening of the fruits begins. They may be picked for home or table use.

Full ripe stage: At this stage the fruits have maximum colour development and may feel soft to touch. They are ordinarily used within 24 hours of picking and are consumed or used for canning and pickling.

Fruits are normally picked at an interval of 4-5 days in summer whereas for winter crop picking should be at weekly interval. The yield varies greatly according to varieties or season. On an average yield of open pollinated varieties ranges from 20-25 t/ha. Hybrid varieties may yield up to 50t/ha or more under normal conditions.

Maturity standards and post harvest management

Optimum maturity depends upon the marketing and other processing purpose. The maturity stage of tomato fruit is classified by USDA as mature green, breaker, turning, pink, light red and red. Red ripe tomatoes are preferred for local market, for processing, fruits at the fully matured green, turning red and pink are preferred for long distance market and storage. The Bureau of Indian standards has specified four grades, *viz*. super A, super, fancy and commercial.

Storage and marketing

Fruits at mature green stage could be stored successfully at 12-13^{0}C in PE bags of 100 gauge thickness for 4-5 weeks. Cool chamber storage extended the shelf life of tomatoes during summer season. Usually bamboo basket and wooden boxes of various size and shapes are used for packing tomato. Wooden boxes are generally used for packing for long distance markets. Use of PE bags for pre packing of tomato could reduce the physiological loss in weight and TS shelf life. Tomatoes can be stored in low temperature and evaporative cool storage. In India tomatoes are not commercially stored in cold storage. Pre cooling of tomato after harvest and prior to storage and transportation are reported to prolong their storage life.

Seed production

For seed production, it is essential to produce a healthy crop and plant should be true to type. It is essential to maintain isolation distance of 50-100 m with other varieties. Crop should be inspected the off type and diseased plants are removed. Natural cross pollination is 3.84per cent alternate rows of 60 cm and 1.74 per cent in 240 cm distance in autumn crop. Usually these following methods have been employed to extract seeds from the slimy mass of tomato.

Fermentation method: Ripe fruits are crushed in non metallic box by hand. No fruit juice should be allowed to drain out. Entire mass is kept for 24-72 hours depending upon high and low temperature. Seed will settle down at bottom. Remove fermented mass and clean the seed 8-10 times in clean water then dried in shade.

Alkali treatment method: Fruit is cut into halves and scoop out the slimy mass containing seed. Treat with 300 g washing soda in 4 litre of boiling water in equal volume. When mixture is cooled down allow to stand overnight. Next day seeds are washed thoroughly and allowed to dry.

Acid treatment method: Slimy mass treated with hydrochloric acid @ 75 ml per 12 kg of mass. Seeds are separated from slimy mass within 15 to 30 minutes. The acidified

liquid is then decanted /removed and seed is separated and dried in shade. In this method seed germination is affected.

Questionnaire

I. MULTIPLE CHOICE QUESTIONS

1. For distant transportation, tomato fruits are picked at

a. Immature green stage b. mature green stage c. turning stage d. Red ripe stage

2. For processing tomato the fruits are picked at ----------

a. Immature stage b. Pink stage c. hard ripe stage d. Over – ripe stage

3. In tomato, for fruit setting in adverse condition spray

a. 2,4-d b. PCPA c. Ethrel d. Cycoel

4. Lycopene development in tomato is adversely affected when temperature is above ----------

a. 30^0 C b. 25^0 C c. 20^0 C d. 10^0 C

5. The best soil reaction pH for tomato cultivation is ----------

a. Below 5 b. 8.0 and above c. 6.0-7.0 d. 7.0-8.0

6. Tomato seed sufficient to raise crop of one hectare area is ----------

a. 500-800g b. 400-500g c. 200-300g d. 800-900g

7. The red colour in tomato is due to pigment

a. Anthocyanin b. Quercetin c. Lycopene d. Xanthophyll

8.The chemical used for hardening of seedlings in the nursery is

a. Cycocel b. MH c. TIBA d. Hcl

9_____ is used to induce fruit set.

a. 2,4-D b. IBA c.PCPA d. All of these

10. Long dry spell followed by heavy irrigation causes

a. Blossom end rot b. sunscald c.Silvering d. Cracking

II. Say true or false.

1. Pruning and training of tomato plants is a common practice in determinate cultivars.

Ans: False

2. Tomato seed sufficient to raise one hectare area is 500-900gms gms.

Ans: True

3. Tomato fruits for canning are picked when they are at pink stage.

Ans: False

4. Tomato does best in a soil that has a soil reaction with pH from 6.0 to 7.0

Ans: True

5.Isolation distance for seed production of certified and breeder seed is about50 &100 meters respectively.

Ans: True

6 Acid method of seed extraction is best than other methods of seed extraction.

Ans: False. .

Lecture 7.

Physiological disorders of tomato

- Blossom end rot.
- Fruit cracking.
- Sun scald.
- Puffiness.
- Cat face.
- Unfriutfulness.
- Low temperature injury.
- Delayed ripening and colour development.
- Gold fleck.
- Silvering.
- Pithy stem.
- Green back.
- Blotch or Blotchy ripening.
- Bronzed fruit or bronzing.

Blossom end rot

Brown water soaked discoloration appears at the blossom end of the fruit where the senescent petals are attached while the fruit is still green. The spots enlarge and darken rapidly and the affected portion of the fruit becomes sunken, leathery and dark coloured. This disorder may occur due to

i) Sudden change in the rate of transpiration specially in moisture stress condition

ii) Continuously high evapotranspiration regime and a large leaf area

iii) Increasing level of nitrogen content in the fruits

Control

1) This disorder is decreased by increasing the frequency of irrigation

2) Judicial fertilizer application. Increase in the level of phosphate fertilization application decline the incidence of this disorder.

3) Liming decreases the incidence

4) Single foliar spray of 0.5% calcium chloride ($CaCl_2$) at the time of fruit development.

Fruit cracking

Two types of fruit cracking are seen. Radial cracking, where surface of the mostly full ripe fruits cracks radially from the stem end of the fruit and concentric cracking, where surface of mostly mature green fruits cracks concentrically around the shoulder of the fruit. Radial cracking is more common and causes greater loss than concentric cracking. Cracking may occur due to

i) Irrigation or rainfall after long dry spell

ii) Exposure of fruits to sun due to pruning and staking

iii) Boron deficiency

iv) Genetic factor which is reported to be inherited polygenically

Control

1) Irrigation at regular intervals

2) Pruning and staking during summer season should be avoided

3) Picking of fruits before fully ripe stage which reduces radial cracking

4) Spraying seedlings before transplanting with 0.3-0.4% borax solution and repeating the sprays at the time of fruiting, 15 days after second spray and at fruit ripening stage

5) Growing resistant varieties like Sioux, Roma, Punjab chuhara, pusa ruby, Arka saurabh, Pant T_1 etc.

Sun scald

Exposed portion of either green or nearly ripe fruits get blistered and water soaked due to extreme heat of scorching sunshine. Rapid desiccation in the blistered portion turns the sunken areas white or grey in green fruits and yellow in pink or red fruits. Sun scalding may cause inhibition of fruits softening, production of tough tissues and differential fruit ripening. This problem is common in plants that have lost considerable foliage. For this reason, training and pruning in tomato aggravate this disorder because foliage cover over the fruit is reduced in these cultural practices. Cultivars with heavy foliage cover are least affected by this disorder.

Control

1) Protection of plants from defoliation by diseases and insect pests
2) Training and pruning in summer months should be avoided

Puffiness

Outer wall of the grown up fruits (two-third normal size) continues to develop normally but growth of the remaining internal tissues (Placenta, mesocarp)is retarded resulting in partially filled fruit which is light in weight and lacks in firmness. Cross section of the affected fruit shows emptiness or pockets. The differential tissue growth leading to this disorder occurs due to

i) Non fertilization of ovules

ii) Embryo abortion after normal fertilization

iii) Necrosis of vascular and placental tissue after normal development of the fruit

iv) High temperature and high soil moisture are the primary factors responsible for this disorder. Application of boron reduces puffiness and improves fruit shape.

Control

1) Over irrigation should be avoided
2) Less nitrogen should be applied
3) Boron should be applied by spraying 0.3-0.4% borax solution

Cat face

Distortion of the blossom end of the fruit gives rise to various ridges, furrows and indentation in a localized area of the fruit. Catface is named due to these ridges and indentations. Abnormal growing conditions during formation of the blossoms appear to cause death of the cells of the blossom end of the ovary which turn dark to form a leathery blotch at the end of the fruit. Unlike blossom end rot, the patch does not progress and thus gives rise localized affected area.

Unfruitfulness

Temperature particularly a night temperature has profound effect on fruit setting in tomato. High day temperature (above 32^0C) and high night temperature (above 20^0C) is not congenial to fruit set. On the other hand fruits normally fail to set at or below 13^0 C. Both high and low temperature adversely affects fruit set mainly by reducing pollen viability and pollen germination on stigma. For this reason, low fruit set is a problem during summer cultivation in eastern India, especially in West Bengal where temperature remains above critical limit and during winter cultivation in northern India where temperature falls far below the critical level in winter.

Control

1) Growing high temperature tolerant varieties like HS-102, Punjab Kesar, Punjab Chuhara, Hot set etc.
2) Growing low temperature tolerant varieties like Pusa Sheetal, Cold set, Ostenkinskiz etc.
3) Application of growth substances like parachlorophenoxy acetic acid (PCPA) 50 ppm at full bloom stage or 2,4 D, 1-2 ppm prior to anthesis.

Low temperature injury

Tomato is sensitive to frost. As the maturing fruits are exposed to near freezing temperature accumulation of the sugar in the fruit juice lowers the freezing point slightly. As a result, the fruits become soft, water soaked and dull coloured. Low temperature injured plants become darken, desciccated and wither.

Delayed ripening and colour development

The rate of ripening and colour development are affected by temperature and it slows down with the approach of 25-26^{0}C and development of red colour is suppressed above 30^{0}C. Similarly, at temperature below 10^{0}C, ripening and colour development get hindered. Hence, delayed ripening and colour development is a major problem during both high and low temperature condition at the time of fruit ripening.

Control

1) In spring summer and early autumn winter growing condition the plants should be sprayed with 250 ppm ethrel at turning stage of the fruits which ripening and gives early yield.
2) In winter, when temperature is not favourable for ripening and colour development, the matured green fruits may be harvested and dipped in 500 ppm ethrel solution for 3-4 hours. After treatment, the fruits are heaped under straw covering which hastens ripening.

Gold fleck

In the fruit surface around the calyx and fruit shoulder, tiny yellow spots often appear which are called gold flecks. These gold flecks appear due to deposition of calcium oxalate.

With high incidence, fruits become non attractive and their shelf life also get reduced. Incidence of this disorder is increased due to

i) Higher supply of phosphatic fertilizers

ii) Higher supply of calcium fertilizers

iii) Increased magnesium concentration in the fruits

iv) Summer shading lowers the incidence of this disorder

Silvering

This disorder affect stems, leaves and flowers. In the stem silvering, grey-green stripes of varying number and width appears. Discrete grey green patches of varying size also appear on the leaves. This disorder may be caused due to exposure of plants to low temperature ($<21^0$C) for some time.

Pithy stem

Large air spaces are formed in the pith accompanied by the increase in abscisic acid levels in the leaves. Water uptake is prevented due to this disorder.

Following types of colour variations due to ripening disorders are seen in tomatoes

a) Green back: It is hard green or yellow area surrounding the calyx when the rest of the fruit is ripe. It can be eliminated by controlling the rise of the day temperature, application of shading and use of resistant varieties.

b) Blotch or blotchy ripening: Yellow, green or waxy areas occur at random over the surface of ripe fruits. This can be controlled by controlling the rise of temperature above 75^0 F and high levels of potash also eliminate this trouble.

c) Bronzed fruit or bronzing*:* It occurs as a shock reaction to infection with TMV (Tobacco mosaic virus), but only fruit developing at the time of infection is affected. Greater the loss of quality. This can be eliminated by breeding varieties resistant to TMV.

Questionnaire

I. MULTIPLE CHOICE QUESTIONS

1.Blossom end rot in tomato is caused by the deficiency of ----------

a. Calcium b. Magnesium c. Boron d. None of the above

2. Puffy fruit in tomato is caused by

a. Viral attack b. Physiological disorder c. Bacterial attack d. None of the above

3. The physiological disorder caused by boron deficiency in tomato is ----------

a. Puffiness b. Cracking c. Blossom end rot d. Silvering

4. In tomato, locular Jelly may not fill the locular cavity which may lead to ----------

a. Cracking b. Puffiness c. Cat facing d. Sun scald

5. Boron deficiency in tomato causing in

a. Browning b. Cat facing c. Puffiness d. Fruit cracking

6. Distortion of blossom end of the fruit leads to formation of ridges, furrows and indentations which is known as

a. Browning b. Cat facing c. Puffiness d. Fruit cracking

7. Gold fleck is due to deposition of

a. Calcium oxalate b. $MgSO_4$ c. Boron d. Zinc

8. Delayed ripening of fruits overcome by application of

a. Borax b $ZnSO_4$ c. NAA d. Ethrel

9. Fruit cracking occurs when the soil is deficient in

a. Boron b Zn c. Mg d. Calcium

10.Silvering disorder may be caused due to the exposure of plants to

a. Low temperature b High temperature c. High humidity d. Low humidity

II. II. Say true or false.

1. Leaf curl is the most serious virus disease of tomato in India.

Ans: True.

2. Cracking of the skin of tomato fruits has been associated with deficiency of calcium.

Ans: False

3. If tomato fruits are exposed to intense sunlight, it may cause a disorder known as cracking.

Ans: False.

4. Puffiness is due to abortion of Embryo

Ans: True.

5. Blossom end rot occurs when increasing Nitrogen content in the fruits.

Ans: True.

Lecture 8. Origin, area, production, economic importance and description of varieties and hybrids of Brinjal

- Area and production.
- Economic importance and uses.
- Description of popular varieties and hybrids.
- Long varieties.
- Round varieties.

BRINJAL

Botanical name : *Solanum melongena*
Family : Solanaceae
Chromosome No. : 2n = 24

Origin : India

Common name : Eggplant, Aubergine

Area and production

In India it is well distributed in Orissa, Bihar, Karnataka, West Bengal, Andhra Pradesh, and Maharashtra and UP. Brinjal covers 8.14% of total vegetable area and produces 9 per cent of the total production.

Table: Area, production and productivity of brinjal in India

Year	Area (000'ha)	Production (000'MT)	Productivity (MT/ha)
2001-02	502.4	8347.7	16.6
2002-03	507.3	8001.2	15.8
2003-04	516.4	8477.3	16.4
2004-05	526.5	8600.8	16.3
2005-06	553.3	9136.3	16.5
2006-07	568	9453	16.64
2007-08	561	9678	17.25
2008-09	600	10378	17.30
2009-10	612	10563	17.26

Source: APEDA, Ministry of commerce and Industry

Economic importance and uses

It is an annual crop cultivated all over India.. The fruits are available practically throughout the year. Brinjal fruits are a good source of calcium, phosphorus, iron and vitamins particularly 'B' group. Analysis of 100 g of edible fruit contains 91.5g of water, 6.4 g of Carbohydrates, 1.3g of Protein, 0.3g of fat and 0.5g of mineral matters. Its green leaves are the main source of vitamin C (38-104.7mg/100g).

Dark purple brinjal has more vitamin C than those with white skin. Bitterness in brinjal is due to presence of glycoalkaloids. Generally, high amount of glycoalkaloids (20mg/100g) produces a bitter taste and off flavour.

Brinjal is reported to stimulate the intrapeptic metabolism of blood cholesterol. Leaf and fruit, fresh or dry produce had marked drop in blood cholesterol level. The de-cholestrolising action is attributed to the presence of poly unsaturated fatty acids (linoleic and linolenic) which are present in flesh and seeds of fruit in higher amount (65.1%). The presence of Mg and K salts also helps in de-cholestrolising action. Dry fruit is reported to contain goitrogenic principles. Aqueous extracts of fruit inhibit choline esterase activity of human plasma.

Brinjal has got much potential as raw material in pickle making and dehydration industries. It is supposed to contain certain medicinal properties and white brinjal is said to be good for diabetic patients. The fruits are employed as a cure for toothache. It is also an excellent remedy for those who suffering from liver complaints. It is very popular in southern Europe, France and Italy and USA.

Description of popular varieties and hybrids

In brinjal a large variation in plant types, fruit colour, shape and size are available. Two main types namely round and long are cultivated throughout India. The following are important cultivars grown in India.

I. Long varieties

Pusa Purple Long:

It is a selection from a local variety 'Batia' grown in Punjab, Delhi and western UP. It is early maturing cultivar becoming ready for picking in 100 to 110 days. Fruits are glossy, light purple in colour, 25-30 cm long, smooth and tender. The average yield varies from 250-275quintals/ha. It is moderately resistant to shoot borer and little leaf disease.

Pusa Purple Long **Pusa Purple Cluster** **Pusa Kranti**

Pusa Purple Cluster:

It is a very early maturing cultivar becoming ready for picking in 75 days after transplanting. Fruits are small, dark purple in colour and borne in clusters. On an average, each fruit weigh about 21 g with bearing of 50 fruits per plant. This cultivar is resistant to bacterial wilt and little leaf disease.

Pusa Kranti:

This cultivar is dwarf and spreading habit. Fruits are oblong with attractive purple colour. This cultivar is good for both spring and autumn planting under north Indian conditions. The average yield varies from 25-30 t/ha.

Krishnanagar Green long: It is a very popular variety in south India. Fruits are long, green and fleshy with scanty seeds. The average yield varies from 25-30 t/ha.

Arka Sheel: The fruits are medium long, with deep shining purple colour. The duration of this is 150 to 160 days. The yield varies from 35 to 40 t/ha.

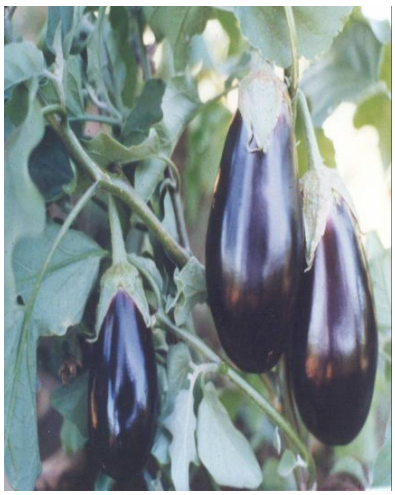
Arka Nidhi **Arka Shirish** **Arka Kusumakar**

Arka Kusumakar*:* The finger shaped fruits are borne in clusters. Plants are dwarf in stature. Fruits are small, light green in colour and yield is 45 t/ha in 110-120 days.

Arka Neelkanth

Arka Keshav

Arka Anand



Arka Navneeth

Arka Anand :It is a high yielding F1 hybrid with resistance to Bacterial wilt. Suitable for Kharif and Rabi. Avg fruit weight is 50-55 gm. Yields 60-65 t/ha in 140-150 days.

Arka Keshav (BWR-21) :Derivative of the cross Dingrass Multiple Purple X Arka Sheel through pedigree method.Tall & branched plants bearing long fruits in clusters. Red purple glossy fruit skin with green calyx. Green leaves with purple leaf base and purple veins when young. Light purple green stem. Fruits tender with slow seed maturity with no bitter principles.Resistant to bacterial wilt. Duration 150 days. Yield 45 t/ha.A

Arka Navneeth: A F1 hybrid between IIHR 22-1 and Supreme Green angular leaves. Large oval fruits with deep purple shining skin. Calyx green, thick and fleshy. Average fruit weight 450gm.

Free from bitter principles with very good cooking qualities. Duration 150-160 days.

Arka Neelkanth (BWR-54) .Derivative of the cross Dingrass Multiple Purple X Arka Sheel through pedigree method. Tall & compact plants Bearing small fruits in clusters. Violet blue glossy fruit skin with green purple calyx. Dark green leaves with purple leaf base and purple veins when young. Purple green stem Fruits tender with slow seed maturity with no bitter principles. Resistant to bacterial wilt. Duration 150 days. Yield 43 t/ha.

Arka Nidhi(BWR-12) Derivative of the cross Dingrass Multiple Purple X Arka Sheel through pedigree method. Tall & compact plants Bearing medium long fruits in clusters, Blue

black flossy fruit skin with green purple calyx. Dark green leaves with purple leaf base and purple veins, when young. Deep purple green stem. Fruits tender with slow seed maturity with no bitter principles. Resistant to bacterial wilt. Duration 150 days. Yield 48.5 t/ha.

Arka Shirish (IIHR 194-1) Pure line selection from IIHR 194-1, a local collection from Karnataka Tall plants, green leaves with white flowers Fruits green, extra long. solitary bearing habit. Duration 140-150 days. Yield 39 t/ha.

H -4: It has been released from HAU, Hissar. The fruits are long, thick with deep shining purple in colour. The average yield is 25 t/ha.

Punjab Barsati: It is released from PAU, Ludhiana. Fruits are 18-20 cm long and 4-6 cm in diameter. The average yield 350-400q/ha.

Pant Smart: Released from GBPUAT, Pantnagar. Plants are tall and vigorous, medium long fruits borne in clusters. Purple green in colour, resistant to bacterial wilt and tolerant to shoot and fruit borer.

Azad Kranti: Erect plant, narrow leaf, long fruits, dark purple in colour and fruit weighs 62g. The average yield is 30t/ha.

II. Round varieties

Pant Rituraj: Semi erect plant. Fruits are round, dark purple in colour. Resistant to bacterial wilt and yields 40t/ha.

Pusa Purple Round: Fruits are purple in colour and each fruit weighing about 400-500g. It is highly resistant to little leaf virus diseases. Average yield varies from 25 to 30 t/ha.

Manjri : It is a selection from a local material recommended by the Department of Agriculture, Maharashtra state. The fruits are medium sized, round with purple colour. Average yield 27.5-30 t/ha.

Krishnanagar Purple Round: The fruits are large sized, round and dark purple in colour. Average yield varies from 250-30 t/ha.

Punjab Bahar: The fruits are round with deep shining purple colour. The average fruit weighs 200-300g and yield varies from 35-40t /ha.

Hybrids:

Pusa Anmol: It is a hybrid cultivar evolved from a cross between Pusa Purple Long and Hyderpur at IARI. It produces early and increased yield of about 80% over Pusa Purple Long.

Pusa Hybrid-5: Plants vigorous, fruits long, glossy, attractive, dark purple in colour. Fruit weighs about 100g. Average yield is about 52t/ha.

Pusa Hybrid-6: plants semi erect, vigorous, glossy, attractive purple colour.

Azad hybrid: Iti is cross between Azad B1 and Kalyanpur-3. Plants semi erect, branched, early fruiting and round, yields about 45 tonnes/ha. Less prone to shoot and fruit borer infestation.

Hisar Shyamal (H-8): Aushey X BR112. Plants erect, early, round fruits, tolerant to bacterial wilt.

Arka Navneet: IIHR221XSupreme. Fruits round to slightly oval in shape. Big size (400 to 500g). Yields about 65-75t/ha.

F1 hybrids: Commercially marketed by IAHS in India are Long 13, Suphal and Round 14. Some of the F1 hybrids released by MAHYCO Seed Company are MHB-1, MHB-9 and MHB-20 (Kalpatharu).

Vijay hybrid: It has been released from Vegetable Research Station, Kalyanpur. The fruits are long, thick and deep purple in colour. It takes about 102 days for harvesting the edible matured fruit. The average yield is 400 q/ha.

Pusa Kranti: (Pusa Purple Long X Hyderpur) X WG (Wynad Gaint). It is a medium duration variety, fruits are long, dark purple in colour and bears 35t/ha.

Pusa Bhairav: PPL X 11a-12-2-1. Fruits are long, purple in colour and bears in clusters. Average yield is 30 tonnes/ha. Resistant to phomopsis blight and fruit rot.

Questionnqire

I. MULTIPLE CHOICE QUESTIONS

1. Bitter taste in brinjal fruit is due to ----------

a. Anti Vitamin E factor b. CN glycosides c. Solasodine d. Trypsin inhibitors

2. Brinjal belongs to the species

a. Khasianum b. Sisymbrifolium c. Melongena d. None of the above

3. Brinjal is a native of ----------

a. Africa b. South America c. India d. Korea

4. Brinjal variety MDV 1 was evolved by ----------

a. X-rays b. Gamma rays c. EMS d. MMS

5. Flower in brinjal may be

a. Long styled b. Medium styled c. Pseudo –short-styled d. All of the above

6. Flowers in Brinjal are

a. Hermaphrodite b. Staminate c. Pistillate d. Solitary and hermophrodite

7. ---------- is also known as Egg plant

a. Tomato b. Brinjal c. Chilli d. Okra

8. Brinjal borne ---------- types of flower on the basis of length of style

a. 4 b. 5 c. 3 d. 6

9. ----------colour Brinjal is good for diabetic plant

a. Purple b. Green c. White d. Black

10. Basic chromosome number in Brinjal is ----------

a. 12 b. 8 c. 10 d. 12

11. ---------- is variety of Brinjal resistant to phomopsis blight

a. Pusa purple long b. Pusa bhairav c. Pant Rituraj d. Pant Samarat

II. Say true or false.

1. Three types of flowers have been described in Brinjal

Ans: False

2 Bitterness of brinjal is due the presence of Glucoalkaloides.

Ans: True.

3. Pusa purple long is a selection from local variety Batia. grown in Punjab.

Ans: True

4. Arka Neelkanth is resistant little disease.

Ans: False

5. Pant Samarat is resistant to Bacterial wilt disease and tolerant to shoot and fruit borer pest.

Ans: True

Lecture 9. Climate, soil requirement, seed rate, preparation of field, nursery practices, transplanting, spacing, planting systems, irrigation, growth regulators, nutrition and weed management, physiological disorders, harvest, post harvest handling, storage, marketing and seed production of brinjal

- Climate and soil.
- Seasons.
- Seed rate.
- Nursery.
- Preparation of field.
- Spacing and transplanting.
- Nutrition.
- Irrigation.
- Weed control.
- Mulching
- Use of growth regulators and chemicals.
- Physiological disorders /constraints.
- Harvesting and yield.
- Marketing.
- Storage and post harvest handling.
- Seed production

Climate and soil

Brinjal is susceptible to severe frost. A long and warm growing season with temperature range of 21-27^{0}C is most favourable for its successful production. Climatic conditions especially low temperature during the cool season cause abnormal development of the ovary (Splitting) in flower buds which then differentiate and develop into deformed fruits during that season. Late cultivars, however, withstand mild frost and continue to bear some fruits. The brinjal grown in warm season shows luxurious growth and starts bearing

from the initial flowers, while in cool season its growth is poor and slow and fruit size, quality and production are adversely affected.

Soil

The brinjal can be grown practically on all soils from light sandy to heavy clay loam soils are good for an early crop, while clay loam and silt loam are well suited for higher yield. Generally silt loam and clay loam soils are preferred for brinjal cultivation. The soil should be deep, fertile and well drained. The soil pH should not be more than 5.5 to 6.0 for its better growth and development.

Seasons

Brinjal can grow under a wide range of climatic conditions. The sowing and transplanting time varies according to agro climatic condition of the region. Under the harsh climate of North India two sowings are normally done 1. June-July for autumn- winter crop 2. November for spring summer crop. Sowing time in other parts of the country is from June-September and again in December-January. In hilly regions sowing of seed is done from March- April and seedlings are transplanted in May.

Nursery

Raised beds should be prepared (7.5×1.2×10-15cm) and seeds are sown in rows of 7.5 to 10cm apart. The beds are prepared well and levelled and one centimetre thick layer of farm yard manure is to applied and mixed properly. The seeds should be covered properly by a mixture of FYM and soil. As soon as the sowing is completed the bed should be covered with a thin layer of dry grass and kept moist till the seeds germinate. To avoid fungal diseases, the seeds should be treated with captan or thiram at the rate of 2g/kg of seed. For safe guarding, the seedlings should also be sprayed with mancozeb at a concentration of 2g/litre. About 250-375 g seed is sufficient to cover one hectare of land with 30,000-45,000 seedlings. The seedlings are ready for transplanting in about 4-5 weeks.

Preparation of land

Soil is prepared to fine tilth by giving 4-5 ploughings. Well rotten organic manure (25t/ha) is incorporated into the soil well before the final preparation.

Spacing and transplanting

The planting distance depends on the fertility status of the soil, growing season and cultivar. Usually, the spacing for the bushy, non spreading type should be 50 to 60 cm in both ways and for spreading cultivars row to row distance should be 75 to 90 cm and that for plant to plant 60 to 70 cm either in flat beds or ridges. Three spacing's are generally recommended i.e. 60×45, 75×60cm and 75×75 cm depending upon the size and spread of the plant besides duration of bearing period. Highly vigorous bushy and late bearing cultivars are given, wider spacing as compared to dwarf upright and early types. Stocky, healthy seedlings which are free of disease and shoot and fruit borer infestation and have attained a height of 10-12cm with 3-4 leaves are to be selected and transplanted. A light irrigation should be given immediately after transplanting.

Nutrition.

It is a heavy feeder of nutrients and requires more nutrients for better yield and quality. It removes 0.29, 0.08 and 0.50 Kg NPK for every 100 Kg fruit yield. As already mentioned 25 tonnes of FYM should be added 25 to 30 days before transplanting. NPK application is done in the form of inorganic fertilizers. Apply 25% of nitrogen as in the form of top dressing 6 weeks after transplanting and the remaining 25% N should be added in to soil 10 weeks after transplanting.

Table 1. Recommendations of NPK levels in some states of India

State	NPK (kg)
Andra pradesh	100-60-60
Madhya pradesh	100-60-25
Orrissa	125-80-110
Punjab	125-62-30
Karnataka1	125-10-50
Tamil Nadu	100-50-30
Uttar pradesh	100-50-50
West Bengal	120-50-50

Micronutrients

The deficiency of micronutrients in brinjal has not been noticed in field. But some workers have studied the effect of their application. The application of minor elements had no effect on vegetative growth of the plant. However, Cu increased the number of flowers and fruits, Zn improved the weight of fruits and Mn showed similar but less pronounced effect on flowering and fruiting.

Irrigation

It requires several irrigation for successful cultivation. Timely irrigation is essential for fruit set and its development. Usually the crop is irrigated weekly once for higher yield. Proper drainage facilities should be provided in rainy season to remove excess of water from the field. Drip irrigation is beneficial for decreasing water use and weed control.

Weed control

It is essential to keep weeds under control from the initial growth itself. Shallow inter cultivation is given to remove the weeds. Three to four hoeings are normally followed for effective control of weeds, proper aeration and good growth of the plants. Orabanche is one of the serious weed affecting solanaceous crops in some areas. It is a root parasite and should be controlled effectively. A pre-planting treatment of 1.0 kg ai/ha of fluchloralin followed by one hand weeding at 30 days after transplanting is effective.

Mulching

The most beneficial effect of mulching is that it conserves soil moisture and controls weeds. Mulching in brinjal crop with black polyethylene film reduces weed growth, accelerates crop growth, induces early bearing and increases yield.

Use of growth regulators and chemicals.

Application of 2, 4-D (2ppm) at flowering induces parthenocarpy, increases fruit set, advances fruit maturation and significantly increases total yield. Spraying of 4 CPA(Para-chlorophenoxy acetic acid)(20ppm) and N-metatolyphthalamic acid (0.5%) promotes fruit set in brinjal. NAA (60ppm) alone or in combination with BA(30ppm) applied on open flowers improved fruit set and ascorbic acid, GA_3, IAA and thiourea advances the flowering by 4-5 days. Spray of mixtalol (long chain C24-C34 aliphatic alcohols) on Cv. Arka Navneet has given beneficial effect with single spray of 4 ppm solution.

PHYSIOLOGICAL DISORDER/CONSTRAINTS

1. Calyx withering

This disorder occurs between mid-February and mid - April. The affected fruits become reddish brown in colour and lacking in normal luster and thus marketability of fruits is hampered. The affected fruits have much higher calcium and nitrate content than healthy ones.

2. Poor fruit set

In brinjal, four types of flower, according to length of style, are recognized irrespective of the variety namely, long styled, medium styled, pseudo short styled and short styled. Pseudo short and short styled flowers do not normally set fruit but their numbers in a plant are normally higher than long and medium styled of lower which produce fruits.

In brinjal, flowers are normally borne solitarily as well as in clusters. The solitary flowers are mostly long or medium styled whereas mixtures of short styled, pseudo short-styled and medium /long styled flowers are found in the cluster. Obviously ratio of short styled flowers to long/medium styled flowers in cluster in much high (3-4:1). So, fruit set depends on the plant. Natural drop is also a problem in brinjal which may be as high as 50% in medium styled flower and 30% in long styled flower.

Control: True short styled flowers are actually sterile flowers which cannot be induced to set fruits. However, application of growth substances on pseudo short styled, medium styled and long styled flowers produce higher percentage of fruit set.

1. Spraying the plant with 2 ppm 2, 4,-D at flowering stage when few flower clusters appear.
2. Spraying with 60 ppm NAA or 500 ppm PCPA (Parachloroacetic acid) at full bloom stage.

Harvesting and yield

Brinjal fruits are harvested when they have developed a good colour and marketable size, are still immature, tender and have not lost culinary qualities. The fruits are harvested with stalk at joint where they are attached to the branch. Normally the plucking can be done at 7 to 10 days depending upon the variety. Yield of brinjal vary according to the region,

cultivar and duration of the crop. Early crop normally yields 20-30 t/ha. While long duration crop yields 35-40 t/ha. Many F1 hybrids yield about 40-80t/ha.

Marketing

After harvest, the fruits are kept in shade and diseased and damaged fruits are sorted out. In early stage the size of fruit will be small and hence the fruits can be packed in baskets and taken to the market, but during later stage or at peak of the pickings, the fruits are packed in gunny bags and taken to the market. The attractive bright, glossy appearance having freshness and optimum size of the fruit are qualities for good market price.

Storage and post harvest handling

Brinjal green fruits had longest shelf life of 4 weeks based on the PLW discoloration, spoilage and CO_2 injury during storage at 8-10^{0}C under controlled atmosphere with initial concentration of 5% CO_2 . The fruits can also be stored for 7-10 days in fairly good condition at 7.2-10^{0}C with 85-95% RH.

Seed production

An isolation distance of 100 to 200m for certified and foundation seed plots respectively should be maintained between two cultivars. During crop period at least 3 times plants should be rouged off. First rouging should be done before flowering and on the basis of foliage characters, the off types has to be removed. Second rouging is done at the time of flowering on the basis of flower characters and off types are to be removed. Final rouging is to be done at the fruiting on the basis of fruit characters and off types.

At all the stages disease/pest affected plants should be removed. At ripening, the fruits become light yellow in colour and at this stage they are harvested and seeds are extracted properly. The fruits are cut into pieces and washed in clean water and the seeds settled down in the bottom of the pot are collected. The seeds should be dried completely and kept in cool place.

Questionnaire

I. MULTIPLE CHOICE QUESTIONS

1. Optimum temperature requirement for successful production of brinjal should be

a. 15 -20^0 C b.21- 27^0 C c. 30-35^0 C d. 10-15^0 C

2. Ideal soil PH for growth and development of brinjal is

a. 5-5.5 b. 5.5-6 c. 6-6.5 d. 6.5-7

3. Seed requirement for raising one hectare crop of brinjal

a. 250-375g b. 400-500g c. 500-750g d. 750-1000g

4. Brinjal seedlings are transplanted at a spacing of

a. 60x30-45 b. 75-90x60-70cm c. 50-60x50-60cm d. None of the above

5. Average yield of brinjal is _____ t/ha in F1 hybrids.

a. 10-20 b. 20-30 c. 40-80 d. 50-60

6. Chemical used for controlling root knot nematodes in brinjal is

a. Aldrin b. Nemagon c. Chloropyriphos d. None of the above

7. NPK requirement of brinjal is _____kg/ha.

a. 100:50 :50 b. 200:100:100 c. 125:19:50 d. None of the above

8. Spraying of _____ controls poor fruit set in brinjal.

a. GA3 b. MH c. CCC d. 2,4-D

9. _____ method is followed for extraction of seeds

a. Fermentation b.Acid c. Alkali d. None of these

10. Little leaf of Brinjal is due to

a. Fungus b. Bacteria c. Mycoplasma d. Root knot nematode

11. Little leaf disease of Brinjal is transmitted by an insect vector

a. Aphid b. leaf hopper c. butterfly d. None of the above

II. Say true or false.

1. Orabanche is the serious weed in cultivation of brinjal

Ans: True

2 .Flochloralin weedicide is used for control of weeds in brinjal cultivation.

Ans: True

3. Isolation requirement for brinjal 500 & 800 Meters for breeder seed and certified seed respectively.

Ans: False.

4. Average yield of open pollinated varieties is 50 tons per hectare.

Ans: False.

5. Application of NAA induces parthenocarpy in brinjal.

Ans: False.

Lecture 10.

Origin, area, production, economic importance and description of varieties and hybrids of chilli and capsicum

- Area and production.
- Economic importance and uses.
- Varieties of chilli.
- Bell pepper varieties

CHILLI AND CAPSICUM

Botanical Name	**:** *Capsicum annum* var.*annum* *Capsicum annum var.grossum*
Family	**:** Solanaceae
Chromosome number	**:** 2n=24.
Origin	**:** Central and South America
Common name	**:** Chilli (Hot pepper), Capsicum (Sweet pepper & Bell pepper)

Area and production

At present chilies and capsicums grown all most all states of the country. The major chilli growing states are Andra pradesh, Karnataka, Maharastra, Orissa, Tamil Nadu, Madhya Pradesh, West Bengal and Rajasthan. Within a span of over four centuries, it has spread to an area of around 0.8 million ha. The area and production keeps varying depending on price fluctuations and the weather conditions.

Area has been varying between 0.982 and 0.816 million ha and production 61,82,000 and 86,200 tonnes of dry chilli. Andra Pradesh has been leading both in area and production contributing on average of 25 per cent of the total area and over 40 to 50 per cent of the total production. Chilies have adapted very well to the Indian condition so that, India is considered as secondary centre of origin.

Table: Major Chilli growing states in India

State	Area (000 ha)	Production(000 tonnes)
Andhra Pradesh	**249.40**	**400.60**
Karnataka	**161.00**	**97.40**
Maharashtra	**132.7**	**68.40**
Orissa	**94.5**	**75.60**
Tamil Nadu	**86.5**	**45.70**
West Bengal	**55.10**	**44.40**
India	**962.10**	**862.01**

Source : Directorate of Economics &statistics, Ministry of Agriculture, Govt of India.

Capsicum also known as Bell pepper is restricted to cooler regions of the country and periphery of cities with cooler weather. As such capsicum growing around cities like Bangalore, Belgaum and Mysore (Karnataka), Nilgiris (Tamil Nadu), Pune, Thane (Maharashtra), Ranchi (Jharkhand), Darjeeling (West Bengal), Himachal Pradesh and Jammu & Kashmir and hills of Uttar Pradesh.

Economic importance and uses.

Chilli is mainly used in culinary purpose for adding flavour, colour, and pungency. Dry chilli, powdered or ground into a paste and even green chillies are used for curries, sambars, rasam and other savory dishes to impart pungency, colour and flavour to food items. It is widely used in the manufacture of curry powder, curry paste and all kinds of pickles and preparing sauce, soups, salads etc.

In food and beverage industries chilli is being used in the form of oleoresin which permits better distribution of colour, flavour in food. Capsaicin, the pungent principle, is used in the preparation of balms, whereas the colour extracts (caratenoids pigments) find use as colour additives in food industry, poultry and prawn feed industry. Raw green as well as fried one are used as such for eating.

Capsicum is mostly consumed raw in green mature forms unlike in Europe and US where they are consumed in red ripe form in salads, cooked, mixed and stuffed vegetables.

Varieties of chilli

- **K-1:** It is a selection from Assam type chilli i.e. B72A. Plants are tall compact. The fruits are 6.6cm long and are shiny red with a capsaicin content of 0.35 mg/g. It yields 1900 kg of dry pods per ha in a crop duration of 215 days which is 20 per cent higher than local varieties.

K-2: It is released from TNAU. This is a hybrid derivation of K1 and sathur samba. Plants are tall, compact, fruits measure 7.3 cm long with a capsaicin content of 0.49 mg/g. Fruits are bright red and crop matures in 210 days. It yields about 1500kg of dry pod per ha.

- **Co-1:** Developed at TNAU, Coimbatore. It is a selection from a Samba type from sathur Samba. The plants are erect, medium tall and compact. Fruits measure 7.3 cm long with a capsicin content of 0.72 mg/g. It yields 2100 kg of dry chilli /ha in a duration of 210 days.

- **Co-3**: Released by TNAU, Coimbatore. It is a selection from Sri Lankan introduction. Plants are dwarf less spreading. Suitable for very close planting. It yields about 15-18 tonnes of green or 3.5 tonnes of dry pod/ha.

- **PMK 1:** Developed at TNAU, Coimbatore. It is a cross between CO2 X Ramanathapuram gundu. Suitable for rainfed condition, yields about 2.3 t/ha of dry chilli. Capsaicin content 0.36 mg/g.

- **G-4 (Bagyalaxmi):** This variety known for its high yielding potentiality. Plants are tall, dense and fruits are 8.8 cm long. Fruits are bright red and contain 0.52 mg capsaicin per gm of fruit.
- **G-5 (Andra Jyothi):** It is a cross between G-2 and Bihar variety (1331) which is tolerant to thrips. Plants are tall, dense and the fruits are red measuring 5.1 cm length and 6.3 cm in girth. The capsaicin content is 0.65 mg/g of fruit.

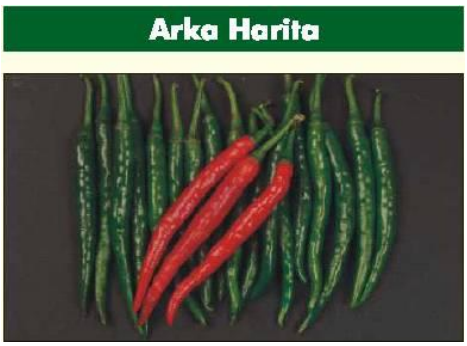
- **NP 46A:** This variety is evolved at IARI. Plants are dwarf, dense, spreading type. The cultivar is less seeded and contains 0.53 mg capsaicn per gm of fruit.
- **Pusa Jwala:** Released at IARI, New Delhi. This is derived from a cross of NP 46A and puri red. The plants are dwarf and spreading in habit. Fruits are long red and contain capsaicin of 0.48 mg/g of fruits.

Pant C-1: GBPUAT: It is evolved from a cross between NP46A X Kandhari. It is tolerant to leaf curl and mosaic virus. The plants are erect and 50-60 cm tall. Fruits are green when immature and red when ripe. Fruits are erect, 6-7 cm long and are highly pungent.

- **Pant C-2:** It is a selection from cross involving the same parents as that of pant C-1 plants are tolerant to leaf curl & mosaic and yields about 1400 kg dry chilli/ha.

- **Arka Abir:** released through pure lime selection. It is suitable for colour extraction.

- **Sindhur:** It is selected from CA960. The fruits have deep red thick pericarp. They measure 8.2 cm in length with capsaicin content of 0.81 mg/g fruit.
- **JCA154:** This is pickling cultivar from JNKV Madhya Pradesh. Fruits are dark green when unripe and bright red when ripe. Fruits mature in 115-120 days.
- **Pusa Sadabahar:** This is a multipurpose chilli cultivar. It can be consumed green and used for preparation of red powder and manufacture of oleoresin. Fruits bear in cluster of 6 to14 that facilitate bunch harvesting. It is developed through the cross between Pusa jwala X IC 31339 (*C.Frutescense*). Fresh fruit yield 75-100 q/ha and dry yield 15-20q/ha.
- **X-235.** It is cross between G4 X Anther mutants. Early maturing plant spreading with short internodes. Leaves small dark green. Flowers with yellow anthers as markers. Fruits are 5-6 cm long and pointed tip.



Arka Lohit **Arka Harita**

- **Arka Lohit:** released by IIHR, Bangalore. It is a selection from IHR 324, plants are tall, spreading, foliage light green. Tolerant to moisture stress, suitable for rainfed condition. Fruits are dark green with a capsaicin content of 0.21 per cent fruits are highly pungent , yield potential is 3.5 t/ha of dry or 20 to 25 t/ha of green chilli in 180 days.
- **Arka Harita** High yielding chilli F1 hybrid developed by using MS line. Plants tall (1m) & spreading (90cm.). Fruits medium long (10 cm) with width 1 cm. Fresh yield 31 t/ hectare and dry yield 6 t/ ha in 150-160 days. Fruits are dark green and turn red. Tolerant to powdery mildew and viruses.

- **- Arka Meghana**. High yielding chilli F1 hybrid developed by using MS line. Plants medium tall (81.3 cm) & spreading 69.5 cm. Fruits long (10.6 cm) with width of 1.2 cm. Very early, taking 24 days for 50% flowering. Fresh yield of 33.5 t/ ha and dry yield of 5 t/ ha in 140-150 days. Fruits are dark green and turn deep red.Tolerant to powdery mildew and viruses.

Arka Suphal **Arka Sweta**

- **Arka Suphal PMR 57**:Indeterminate with a plant height of 80-90 cm Dark green Foliage Fruits straight, smooth with pointed tip, 7-9 cm long Fruit colour green changing to deep red Yield: 25t green and 3 t dry chilli/ ha Resistant to powdery mildew and field tolerant to viruses.

- **Arka Sweta** High yielding chilli F1 hybrid developed by using MS line. Plants medium tall(95cm)&spreading(82.5cm). Fruits long (13.2 cm) with 1.3 cm width. Fresh yield 38.4t/ ha and dry yield of 6 t/ ha in 140-150 days. Fruits are light green, turns red.

Arka Meghana

- **Samrudhi:** Released by UAS, Bangalore suitable for growing under rainfed conditions.

- **Jwala Sakhi:** It is evolved by cross involving vellanotchi X Pusa jwala. Fruits sulphary green, long, succulent yields 19.6 t green chilli in 125 days. Tolerant to little leaf and leaf spot.

- **Jwala Mukhi:** It is developed at KAU, vellayani by using same parents of Jwala sakhi. Plants dwarf, fruits long (9.6cm) succulent, dark green with light pungency yield 22.5 t/ha of green chilli in 137 days, tolerant to little leaf and leaf spot.

Bell pepper varieties:

- **California Wonder:** It is an introduction from USA. Plants vigorous, upright, prolific, fruits are 3-4 lobbed smooth with medium thick sweet flesh.

California Wonder **Chinese Giant**

- **Chinese Giant:** plants are vigorous and prolific bearer, fruits are 3-4 lobbed sweet flesh and skin is dark green in colour.
- **World Beater:** Plants are upright, productive, fruits 3-4 lobbed flesh thick mild and sweet.
- **Yolo Wonder**: Large fruit, 3-4 lobbed, medium thick flesh mild & sweet.

Bharat: This is F_1 hybrid released by IAHS Bangalore. Plants are vigorous, fruit dark green, 4 lobed yields 20-25t/ha. It is resistant to TMV.

Arka Mohini

Arka Gaurav

Arka Basanth

- **Arka Gaurav:** Selection from golden California wonder of USA. Plants indeterminate with upright bearing habit, thick flesh, 70 to 80 g fruit weight, tolerant to bacterial wilt, yield 20t/ha.

- **Arka Basant**: Indeterminate plant habit with yellow green foliage.Thick fleshed, 2-3 lobed conical fruits Average fruit weight 50-80 g Fruits erect, cream coloured, which turn orange red on ripening.Yield potential of 16 t/ha Duration of 150 days

- **Arka Mohini**: Determinate plant habit with dark green foliage. Thick fleshed, 3-4 lobed dark green blocky fruits. Average fruit weight 180-200 gms Fruits pendent, which turn red on ripening. Yield potential of 20 t/ha Duration of 160 days

- **Pusa Deepti:** IARI, katrain. It is a F1 hybrid, high yielding, resistant to anthracnose and fruit rot.

- **KT 1:** It is evolved at IARI sub station katrain. It is high yielding F1 hybrid resistant to anthracnose and fruit rot disease.

Questionnaire

I. MULTIPLE CHOICE QUESTIONS

1. California wonder is an important variety of ----------

a. Hot pepper b. Sweet pepper c. Black pepper d. None of the above

2. The chillies are rich in vitamin

a. A b. C c. A&C d. None

3. The green chillies contain ----------which has medicinal value

a. Capsicin b. Resin c. Coumarin d. Rutin

4. The highest production of chillies in ----------

a. Maharashtra b. Tamil Nadu c. Andhra Pradesh d. Arunachal Pradesh

5. The largest area in chillies is in ----------

a. Maharashtra b. Tamil Nadu c. Andhra Pradesh d. Andaman

6. The pungency in chillies is due to ----------

a. Cucurbitaein b. Resins c. Coumarin d. Capsicin

7. The red colour in fruits at the ripening stage in chillies is due to the pigment ----------

a. Capsanthin b. Quercetin c. Anthocyanin d. Catechol

8 The chilli has originated from

a. India b. Brazil c. Tropical America d. China

9. ---------- is botanically known as *C. fruitescens*

a. Black pepper b. sweet pepper c. Hot pepper d. None of the above

10. MDV-1 is a variety developed through

a. Pure line selection b. Mutation breeding c. Mass selection d. Pedigree method

11. ---------- variety of chilli is cross of NP46A x Pure red

a. Pant C-1 b. Pusa Jwala c. Pusa Sadabahar d. None of the above

12. Bharat is the first hybrid of capsicum released by

a. MAHYCO b. IAHS c. Sugrow d. Namdhari

II. Say true or false.

1. Among the most important states of India, only four viz, Andhra Pradesh, Maharashtra, Karnataka and Tamil Nadu account for three fourths of the total area under chilli.

Ans:. True.

2. Chillies are rich in vitamins, especially in vitamins A& C.

a. Ans:True.

3.Chilli is cross pollinated crop.

a. Ans: False.

4.USA is considered as secondary center of origin of chilli.

a. Ans: False.

5.In chilli, Dharwad and Belgaum are major growing districts in Karnataka.

a. Ans: True.

Lecture 11. Climate, soil requirement, seed rate, preparation of field, nursery practices, transplanting, spacing, planting systems, irrigation, growth regulators, nutrition and weed management, physiological disorders, harvest, post harvest handling, storage, marketing and seed production of chilli and capsicum

- Climate and soil.
- Seasons.
- Cropping system.
- Nursery practices
- Preparation of field.
- Spacing and transplanting.
- Nutrition.
- Irrigation.
- Weed control.
- Use of chemicals and growth regulators.
- Protected cultivation.
- Physiological disorders /constraints.
- Harvesting and yield.
- Storage
- Marketing
- Value added products.
- Seed production

Climate and soil

Climate

Chilli performs well in warm humid tropical and subtropical regions. It is being cultivated from sea level to almost 1000 m above MSL.Optimum temperature range of 15-35^{0}C is requires for chilli cultivation. Comparatively milder climate conditions are preferred for sweet or bell pepper. A soil temperature of 10^{0}C or less retards crop growth. Prevalence of low temperature during fruit ripening is likely to delay colour development of fruits. Temperature beyond 40^{0}C result in poor fruit set as well as severe fruit drop. As a rainfed

crop, chilli performs well in regions receiving rainfall of 600-1200 mm spread over four to five months. Areas receiving < 600mm of rainfall require a few protective irrigation for better crop yields. Successful crop of bell pepper can be raised only under irrigated condition providing shade to sweet or bell peppers through poly or net houses during summer and only shade nets and open during other seasons is beneficial.

Soil

Chilli can be grown in wide range of soils but well drained loam soil rich in organic matter is best suited for chilli cultivars. As a rainfed crop chilli can be grown successfully in medium to heavy textured soils like clay loams provided proper drainage to prevent water stagnation. Chilli crop will not withstand water logged conditions for more than a day. A good crop of chilli can be raised on red sandy and sandy loam soils, as an irrigated crop, with copious amount of organic manuring and fertilizer application is necessary to get optimum growth of the plant. Though chilli is grown on soils with as pH range of < 5.0 like the acid laterite soils of coastal areas and heavy rainfall (mountain) regions to soils of > 8.0 pH like the Alluvial soils of north India and black cotton soils of the Deccan plateau, it performs best at a soil pH of about 6.5. Saline and sodic soils hinder crop growth and fruit development. Most extensive cultivation of Chilli can be seen on vertisols covering the states of Andra Pradesh , Karnataka, Maharashtra and Tamil Nadu. Bell pepper performs best on red and alluvial soil with slightly acidic pH and having good drainage and aeration.

Seasons

In many parts of the country it is grown in all the three main cropping seasons. During monsoon the crop is mainly grown for dry red chillies while in other seasons it is mostly for green chillies. Crop grown in summer season most likely affected by complex virus diseases. Chilli cannot be grown during winter in North India as the temperature is quite low, which the crop cannot with stand. Capsicums are known to perform better in winter or rabi season and when they grown in summer, yields are very low due to poor crop growing and fruit set and also severe diseases, especially virus in hills.

Cropping system

With the pressure on cultivated land increasing one way to best production is to increase the crop productivity and the other alternative is to improve the land productivity per unit area and time through multiple cropping. Multiple cropping is the technique of growing

more than one crop either together or in a sequence in a year or in an appropriate time span on the same piece of land. Rotating wide spaced crops with narrow spaced crops which will reduce weed intensity, as in wide spaced crops the inter cultivation is effective. Inclusion of chilli or tobacco are known to reduce weed intensity as the inter cultivations are done both ways and for long period in these crops. Incidence of fruit rot, bacterial & viral diseases can be minimized by raising chilli crop in rotation with cereals and pulses. Sorghum yields are higher when raised after chilli crop, Chilli and paddy are common rotations followed in Andhra Pradesh and Tamil Nadu. Sequential intercropping systems involving capsicums were found to be more remunerative than simple crop sequence in the North India. Soybean was found to be quite compatible as mixed crop with chilli in Karnataka. Chilli and cotton intercropping is very popular in transitional tract of Karnataka. The highest yields, in nutritional terms, were obtained with intercropping beetroots, knol-khol and peas with capsicum. For dry regions of southern Karnataka, finger millet could be grown successfully as mixed crop with chilli. Chilli crop grown for green fruits can be intercropped with Ragi under rainfed conditions on red clay loam soils.

Nursery practices

Layout and maintenance of nursery is similar to tomato. About 1250 gm of seeds are required to raise seedlings to plant one ha of land. Approximately 50-60 thousand seedlings will be sufficient to cover one ha of field. To ensure healthy seedlings it is better to cover the beds with 40 mesh nylon nets which protect the seedlings from feeding by virus carrying vectors. Clipping of capsicum as well as chilli seedlings about 10 days prior to transplanting helps in better establishment of transplanted seedlings and also accelerate the growth of auxiliary buds resulting in better branching.

Preparation of field

The soil is brought to fine tilth by repeated ploughing and harrowing. Tillage consists of breaking up the hard, compact soil to certain depth by tillage operations like ploughing, hand digging to bring the soil to pulverized mass known as tilth. Twenty five tonnes of FYM/ha can be incorporated into the soil.

Spacing and transplanting

Seedlings are transplanted 4-6 weeks after sowing. Chilli planting at a closer spacing gives higher yield and a spacing of 20X20cm gave higher yields in Uttar Pradesh. A closer spacing of 30X30 cm was found good in Tamil Nadu. In Karnataka 75 X 45 cm distance between rows and plants is being practiced to get higher yields.

Bell pepper plant population appears to be the most important single factor for getting higher yields. Maximum fruit yields are got at a spacing of 45 X 45cm. A spacing of 60X30 with 55,000 plants/ha gave highest yields of 12.3t/ha in capsicum cv. California Wonder. In Karnataka 60 X 45cm spacing is recommended for higher yields.

Nutrition

Chilli and capsicum respond well to application of fertilizers both under irrigation and rainfed condition. The nutrient requirements are mentioned below.

Chilli			**Capsicum**
Nutrients	**Irrigated (kg/ha)**	**Rainfed (kg/ha)**	**Irrigated (kg/ha)**
N	175	100	150
P	75	50	75
K	75	50	50

Good fertile soils with humus are most desirable for growing capsicum. Heavy application of N fertilizers may increase vegetative growth and delay maturity. For rainfed crop 50% of Nitrogen and full dose of P & K applied as basal dose and remaining 50% should be applied 4 weeks after transplanting. While under irrigation nitrogen should be split into three split equal doses and applied at an interval of three weeks. Nitrate form of nitrogen is preferred by capsicum hence it is suggested that for bell pepper nitrate should be supplied at least at double the rate of ammonical nit rogen.

During cooler seasons higher ratios of ammonia to nitrate and in summer almost equal ratio of these two forms was found to favour capsicum production. Pepper plants grown

under nutrient film techniques (NFT) and exposed to solar radiation preferred NO_3 as the source of nitrogen while imposing shade made the plants to perform well with ammonical and nitrate forms 1:4 ratio. Capsicums were found to respond to inoculation with VAM fungus *Glomus irraradices*. Azospirillum as a seed treatment and soil application increased vegetative growth in capsicums.

Irrigation

Since chilli is largely cultivated as a rainfed crop, the crop suffers during its various growth phases by moisture stress due to drought spell. Soil moisture stress affects the plant growth and production of chilles. Decreased nitrogen utilization and decreased yield were observed at lower irrigation regions. Phosphorus uptake was severely affected by soil water stress. Moisture stress also resulted in severe flower drop in chilli. The soils with available water holding capacity of 100 to 160 mm per metre depth of soil are ideal for cultivation of chillies. The crop raised in kharif season is mainly for ripe red chilli purpose. In semi arid regions of the tropics, it is observed that providing supplemental irrigation whenever dry spell exceeds 8 to10 days period almost doubles the chilli yields on red loam soils. Irrigation requirement depends on season of cultivars and soil type.

Capsicums are mostly grown during rainy and winter seasons although as it not common to see them being cultivated during summer season. Even during monsoon season whenever dry spell exceeds 7-8 days providing supplemental irrigations are necessary. When the capsicums are grown as irrigated crops, normally furrow method of irrigation is followed.

Weed control

Weed intensity is generally more in red soils than in black soils in the same locality. Weed intensity is high when the crop is grown during kharif season than in Rabi or summer months. Though cultural methods of weed control is widely followed, with the increase in labour wage and scarcity of laborers and some times increased rains preventing these operations, using herbicides or combination of both herbicide and cultural operations are becoming more popular. A large number of herbicides have been tried, both for transplanted and direct sown chilli crop. Among the herbicides tried, dephenamide, trifluralin, EPTC, Nitrofen had given good results in chilli crop. Various mulches such as saw dust, gravels, crop residues, plastic films etc are used to control weed population.

Use of chemicals and growth regulators

Chilli plant growth is known to be improved by spraying of different growth regulators. Among several growth regulators available in the market, application of CCC and NAA (planofix) at flowering had the most beneficial effect on plant growth.

Name of the Chemical	Concentration	Effects
NAA (Planofix)	10ppm	Increased number of branches
NAA	10-100 ppm	Increased Fruit set
Triacontanol	1 ppm	Improved growth
Ethrel	300-500ppm	Increased branching
CCC	500-2000 ppm	Increased branching
CCC	20-200 ppm	Increased Fruit set
GA	50-200 ppm	Increased Branching

Protected cultivation

Capsicums can be successfully grown either for fruits or for seed production using naturally ventilated poly cum net houses for off season cultivation in areas where temperatures do not exceed 37-38^{0}C. Using misters or foggers to maintain slightly higher RH and marginally reduced temperature, fruit yields in the range of 30-35 t/ha and seed yield of > 1 kg/100 m^2 are obtained.

Physiological disorders/constraints

Blossom end rot: A disorder of sweet pepper where water soaked spots first appears on the blossom end of fruit. The spots soon become light brown and papery as the lesions dry out. The causes and control measures are similar to tomato. i.e. for controlling the disorder we should follow judicious and timely irrigation and the crop should be grown in the soil having good water holding capacity.

Sun scald: A disorder of sweet pepper, it occurs when the fruits are exposed to scorching sunlight. This disorder arises as a soft, light coloured area in fruit that becomes slightly wrinkled. Plants having enough foliage are less prone to this disorder.

Skin cracking: A disorder of sweet pepper where cracking occurs around the shoulder of fruits. It is often associated with fluctuations in temperature and humidity. High day temperature and average RH increases the incidence of cracking.

Flower and fruit drop: It is one of the major constraints in chilli cultivation. Flower and fruit drop may occur due to (1) Low humidity and high temperature condition which result in excessive transpiration and water deficit in the plant and cause abscission of buds, flowers and small fruits (2) decreasing light intensity (3) Short day and high temperature and (4) High temperature during early flowering stages.

Control

1. Irrigation at flowering and fruit set stage helps in reducing blossom end rot and fruit drop.
2. Foliar application of 50 ppm NAA at full bloom set stage effectively controls the drop.
3. Foliar application of 20 ppm NAA at first flower opening followed by two sprays at an interval of 30 days increases fruit set.
4. Application of Triacontanol (vipul 1ml/ 2 litre of water) also markedly reduces flowers and fruit drop.

Harvesting and yield

The crop is harvested for either green fruits or red ripe fruits by hand picking. The picking of green fruits continues for about 2 months at an internal of 10-12 days and they will be five to six pickings for green chillies and 3-4 for red ripe fruits. Drying of red ripe fruits for about 5-7 days in bright sun light is necessary before marketing or storage. When there is a good demand for green chillies one or two picking of green fruits can be done even of the crop is grown for red chillies.

The yield may be about 7 to 16 tonnes per hectare of green chillies and 12-20t/ha of non pungent sweet capsicums or bell peppers. In case of dry chillies the yield may be 0.5-1.0t/ha of rain fed & 1.5-2.5t/ha in irrigated crop. The yield of fresh green chillies is 3-4 times higher than that of fresh red ripe chillies and 6 to 10 times that of dry chillies. However the proportion of dry to fresh ripe chillies depends upon quality of seeds and the thickness of the inner wall, the pericarp of the fruit.

Storage

Green chillies and capsicum should be sold immediately after harvesting. Stored and transported at temperature ranging between 7^0C and 10^0C and RH 90-95%. If properly cooled and stored, the shelf life can be extended by 14-21 days. In case of dry chillies, pods should be properly dried after removing the plant parts and foreign matter. Later, they can be packed in clean, dry gunny bags and stored in cool dry places ensuring protection from dampness. Dry chillies could be stored better in craft pack at 27^0C and 65% RH where as for powder, polythene bag is effective than clear grass containers.

It is of great importance that colour and pungency in case of chillies and colour in the case of paprika are maximally preserved during storage. In trade there is preference for mechanically dried capsicums with around 10% moisture as those that are over dried suffer from loss of colour darkening and those with higher level are susceptible to infection and bleaching of colours during storage that have considerable influence on the stability of the colour, the temperature of storage and moisture content of samples. The light induced auto catalyzed degradation of carotenoids is also a factor in sun drying and storage.

Marketing

Though chilli is grown mostly in Kharif, harvesting of red ripe chilli commences in October-November in Karnataka to Feb-March in TamilNadu & Andhra Pradesh. The modes of transport to marketing centers are head loads, carts and trucks. These are important assembling and distributing to terminal markets of chilli in India. Some of the important assembling centers are Byadagi and Hubli in Karnataka. Güntoor and Warangal in AP, Madurai and Virudhanagar and Tamil Nadu. The distributing and terminal markets are Mumbai, Calcutta, Chennai, Guntur, Calicut, Patna, Kanpur, Nagpur, Delhi, Sholapur, Hyderabad, Vijayawada, Warangal & Solan. The present system of chilli marketing is through regulated market committee. The agricultural produce market committees are

operating market yards in all the major markets in AndraPradesh & Karnataka. Commission agents organize closed auctions in Tamilnadu and elsewhere in the country.

Value added products

The demand for value added chilli products like chilli powder, colour oleoresin and pungent oleoresin has been steadily increasing. In food beverage industries, chilli has acquired a great importance in the form of oleresin which permits better distribution of colour and flavour in food as compared to chilli powder. Oleoresin offers many advantages over straight spices, *viz,* cleanliness and uniform flavor. Oleoresin is used in preparation of processed products and also in a number of pharmaceutical formulations.

Seed production

Chilli is a self pollinated crop but cross pollution also takes place to some extent. The isolation distance between two cultivars may be kept 250-400 m apart to avoid cross pollination. Good healthy and well developed fruits should be selected for producing seeds. The off types and disease affected plants are taken out atleast thrice during crop period. First before flowering on the basis of flowers of external plant characters. Second at the time of flowering on the basis of flower characters and finally at the time of pod maturity on the basis of pod characters. Complete ripe pods are harvested and dried properly for 15-20 days in sunlight or 2-3 days in drier at 55^0C. Later on, the seeds can be extracted from the dry chillies. Simple mechanical seed extractor also used for extraction of seeds. Siever is used for separation of seeds fitted with wire mesh. This procedure brings down the extraction cost by 50 per cent and enhances germination per cent to 90 per cent.

The capsicum plant is generally cross-pollinated crop. The isolation distance between two cultivars should be kept 200m for foundation seed and 100 m for certified seed. Off types are removed as soon as these are observed. 3 to 4 rougings depending on the purity of the seed desired. Field inspections should be done at least twice or thrice. The fruit should be picked when red ripe and cut and crushed or macerated by machines. Seed is to be washed to make it free from and skin. After washing it should be dried and used for sowing. The seed yield is 105 to 225 kg/ha.

Questionnaire

I. MULTIPLE CHOICE QUESTIONS

1. Blossom end rot in chilli is due to ----------

a. Fungal disease b. viral disease c. Non parasitic cause d. None of the above

2. Bud, blossom and fruit drop in chilli, in general is due to

a. Deficiency of nitrogen b. humid climate c. Unfavourable temperature and water supply d. None of the above

3. About ____gm of chilli seeds are needed for planting of one hectare area.

a. 500 b. 1000 c. 1250 d. 1500

4. Chillies can be grown from sea level to an altitude of ----------

a. 1000m b. 2000m c. 3000m d. 4000m

5. CCC induces _____ in chilli.

a. Vegetative growth b. Number of branches c. Fruit set d. Fruit development.

6. Fruit drop in chilli is prevented by application of

a. NAA b. Ethrel c. CCC d. GA

7. Capsicum is generally _____ pollinated crop

a. Self b. Cross c. often cross d. none of the above

8. The most suitable time of transplanting sweet pepper is

a. March – April b. Mid February c. April – May d. None of the above

9. About _____ tons of dry chillies are obtained from one hectare irrigated area.

a. 1.0 b. 1.5-2.5 c. 4-5 d.7-8

10. The usual spacing followed for transplanting capsicum seedlings in northern India is ----------

a. 60x30 b. 75x30cm c. 45x45cm d. None of the above

II. Say true or false.

1. The isolation distance between two cultivars of capsicum should be kept 250 meters for certified seed

Ans: False.

2. Ideal temperature and relative humidity for storing dry chillies is about 27 ^{o}C & 65% respectively.

Ans: True.

3. Optimum PH requirement for cultivation of capsicum is 6.5

Ans: True

4. Application of growth regulator IAA to prevent fruit drop and flower drop in chilli.

a. Ans: False

5. In the nursery, seedlings are covered with nylon mesh to protect seedlings feeding from Vectors.

a. Ans: True

6. Seed yield of chilli is 800 kg / ha.

a. Ans: False.

Lecture 12. Origin, area, production, economic importance and description of varieties and hybrids of Okra

- Area and production.
- Economic importance and uses.
- Description of popular varieties and hybrids

OKRA

Scientific Name **:** *Abelmoschus esculentus*

Family **:** Malvaceae,

Chromosome number **:** 2n=72, 108,130

Origin **:** Asiatic region /Etthiopea/Africa.

Common names **:** Bhendi, Lady's Finger

Area and production

India is the largest producer of okra in the world. The major bhendi growing states are Uttar Pradesh, Orissa, Bihar and West Bengal.

Table: Area, production and productivity of Bhendi in India

Year	Area (000'ha)	Production (000'MT)	Productivity (MT/ha)
2006-07	396	4070	10.28
2007-08	407	4179	10.27
2008-09	432	4528	10.48
2009-10	452	4803	10.63

Economic importance and uses

Okra is more remunerative than the leafy vegetables. Fresh okra fruits are important and used as vegetable in India, Brazil, West Africa and many other countries. For year round consumption sun dried (Africa, India), frozen and sterilized (USA) fruits are also important market products. Tender green fruits are cooked in curry and also used in soups. The root and stem are useful for clearing cane juice in preparation of jaggery. Its ripe seeds are roasted, ground and used as a substitute for coffee in Turkey. Matured fruits and stems containing crude fibre are used in the paper industry.

Okra is rich in vitamins, calcium, potassium and other minerals. 100g consumable unripe bhendi fruits contain 10.4g dry matter, 3,100 calorie energy, 1.8g protein, 90mg calcium, 1.0mg iron, 0.1mg carotene, 0.07mg thiamin, 0.08mg riboflavin, 0.08mg niacin and 18 mg vitamin C. The dry seeds contain 13-22% edible oil and 20-24% protein. The seed cake is also used as an animal feed.

Description of popular varieties and hybrids

Pusa Makhmali: It is a pure line selection from local type collected from West Bengal. Fruits are light green tappered, attractive, 12-15 cm long with high yielding (8-10t/ha) potential but is susceptible to YVMV. It is suited for cultivation in hills and at virus free season.

Pusa Makhmali

Pusa Sawani

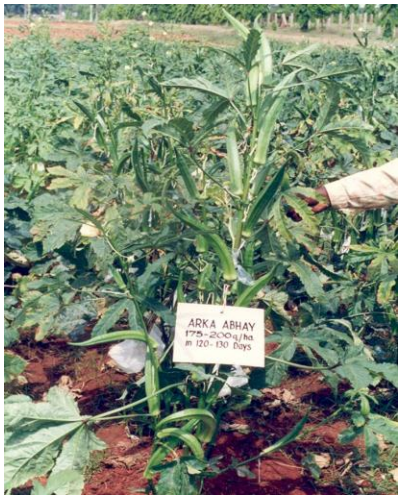
Pusa Sawani: Most popular variety known throughout the country. It is a hybrid derivative selection from the cross between IC 1542 and Pusa Makhmali. It bears smooth and dark green fruits having 5 ridges and takes 45-50 days from sowing to harvest. First fruit is borne on 5^{th} to 7^{th} node. It is suitable for cultivation in both spring summer as well as Kharif season since it is less sensitive to temperature fluctuations. Yield is around 12-12.5 t/ha.

Pusa A-4: This variety has been released as substitute for Pusa Sawani. The fruits are 5 ridged, attractive, dark green12-15 cm long having excellent shelf life. It is resistant to YVMV and tolerant to jassids and shoot and fruit borer. Yield ranges from 10-12 t/ha.

Co-1: It was developed at TNAU as single plant selection from a heterogenous population of Red Wonder. Plants are tall, leaves are light green and deeply lobed. The fruit starts from 5^{th} node. It has field tolerance to YVMV but is susceptible to fruit borer and powdery mildew. Suited well for cultivation in all seasons of the year.

MDU1: It was evolved at TNAU as an induced mutant from Pusa sawani. The fruit bearing starts from 4^{th} to 5^{th} node and takes 45 days to first picking. Fruits are light green about 20cm long and weigh about 29 g each at the time

Arka Anamika (Selection 10): This variety has been developed as a hybrid derivative selection from inter specific cross between *A. esculentum* and *A. tetraphyllus*. The plants are tall, upright, slightly pigmented on stem and lower leaves. It takes 55 days to first picking. The variety is excellent yielder in South but with a lower performance in northern states. It is resistance ot YVMV and yields around 12.5t/ha



Arka Abhay

Co-1

Arka Abhay (Selection): An interspecific hybrid between Abelmoschus esculentus(IIHR 20-31) x A.manihot spp. Tetraphyllus (Res. To YVMV) followed by backcross. Plants tall, well branched. Fruits lush green, tender and long. Fruits borne in two flushes. Purple pigment present on both sides of the petal base. Green stem with purple shade. Fruits free from spines having delicate aroma. Good keeping and cooking qualities. Resistant to yellow vein mosaic virus(YVMV) Duration 120-130 days. Yield 18 t/h

Punjab Padmini: It is released by PAU, Ludhiana as a hybrid derivative selection from inter specific cross between *A. esculentus* and *A. manihot ssp manihot*. The plants grow fast; 180-200cm. Pigmentation is visible on stem, shoots, petiole and basal lower veins of leaves. Fruits are 15-20 cm long, dark green and 5 ridged. It is resistant to YVMV and tolerant to jassids and cotton boll worm. It yields 10-12.5 t/ha green fruits.

Punjab -7: This variety was developed at PAU, Ludhiana as a hybrid derivative selection of a cross between *A. esculentus cv.* Pusa sawami and *A. manihot ssp. Manihot.* Plants are medium tall. Leaves are dark green with less serrated margins. Plant is sparsely hairy. Fruits are medium long, green, 5 ridged. It yields about 10t/ha.

Punjab-8(EM 58): It is an induced mutant derived from Pusa Sawani by treating seed with EMS 1%. The plants are tall. Fruits are medium long, thin, tender green and 5 ridged. It is resistant to YVMV and tolerant to fruit borer.

Parbhani Kranti: This YVMV resistant variety was developed at Marathwada Agricultural University, Parbhani from interspecific cross between *A. esculentus cv.* Pusa Sawani and *A. manihot*. Plants are single stem, tall with dark green foliage. The first fruit is borne on 5^{th} to 6^{th} node. The fruits are dark green, slender, 5 ridged with long beak. Average fruit yield varies from 8.5-9 t/ha.

Gujarat Bhendi 1: It was developed by Gujarat Agricultural University, Ahmedabad as a pure line selection. Plant height is 60 – 90 cm. The plants are erect, purple tinge on stem. Fruit starts from 4^{th} to 5^{th} node and fruits are 5 ridged, tender and green in colour. It yields 7 t/ha.

Gujarat Bhendi 1

Varsha Uphar (HRB 9-2): The variety has been developed by HAU, Hisar from the cross. Lam selection 1 X Parbhani Kranti. It is resistant to YVMV and field tolerant to leaf hopper. Plants are medium tall (90-120), fruits bearing starts from 4^{th} node. Fruits smooth, attractive, 18-20 cm long and 46-47 days to first picking. It is a prolific bearer with an average yield of 10 t/ha.

White Velvet: It is a very popular local variety in Karnataka.

Hisar Unnat (HRB-55): Developed by HAU, Hisar from the cross Selection 12-2 x Parbhani Kranti. It is resistant to YVMV, early (first picking in 46-47 days) and high yielding (12-13 t/ha) variety. Fruits 5 ridged 15-16 cm long on full maturity. It is suitable for growing during summer as well as rainy season.

Selection 2-2: This variety was developed at IARI from the cross (Pusa sawani x Best one) x (Pusa Sawani x IC 7194). The plants grow to an average height of 110 cm. It takes 50 days to first harvest. Fruits are green, tender, long (16-20 cm) and 5 ridged. It is popular in Maharashtra for fresh fruit exports.

Azad Kranti: It is released by C.S. Azad University of Agriculture and Technology, Kanpur. The plants are fast growing; fruits are shiny green, smooth, 5 ridged with long beak. It is tolerant to YVMV and gives good yield (12.5 t/ha).

Hybrid COBh H1: it is an VU selection / PA 4 (T). Plants are 110 to 120 cm tall, fruits are dark green, long and tender. About 21-29 fruits are borne per plant. Its is a high yielding and resistant to YVMV. Yield potential is 22.1 tonnes/ha. Crop duration is 120 days.

A number of private sector companies bred hybrids having resistance to YVMV are also being grown in the country. Varsha and Vijay from IAHS, Adhunik and Panhali from Century Seeds, Hybrid No. 6 and 7 from Mahyco, Nath Sobha from Nath Seeds etc. are few hubrids.

Questionnaire

I. MULTIPLE CHOICE QUESTIONS

1. Bhendi variety tolerant to salinity is ----------

a. Kalyanapur green b. Type -3 c. Pusa Sawani d. Pusa Dwarf

2. Arka Abhay is a variety of

a. Brinjal b. Chilli c. Tomato d. Bhendi

3. Mucilage, a sticky substance in okra, is generally extracted from --------

a. Flowers b. Buds c. Stem and root d. Leaves

4. Okra is ----------

a. Self pollinated b. Cross – Pollinated c. often – cross pollinated d. Both b and c.

5. Original home of okra is --------

a. India b. Africa c. America d. None of the above

6. Variety of okra resistant to yellow vein mosaic virus is ----------

a. Pusa Makhamali b. Pusa sawani c. Punjab No. 8 d. None of the above

7. Varsha upahar is a variety of ----------

a. Okra b. Cabbage c. Chilli d. Cowpea

8. ---------- belongs to family Malvaceae

a. Tomato b. Chilli c. French bean d. Okra

9. Okra fruits are excellent source of

a. Calcium b. Magnesium c. Manganese d. Iodine

10. ---------variety of okra is cross of pusa Makhmali x IC – 1542

a. Gujarat bhendi-1 b. Pusa Makhmali c. Pusa sawami d. Arka abhay

11. Cultivated okra is --------- in Nature

a. Polyploidy b. Tetraploidy c. Aneuploidy d. All of the above

II. Say true or false.

1. Roots and stem of okra is useful for clearing Sugar cane juice in preparation of jagarry.

Ans: True.

2. Okra is rich in iron element.

Ans:False

3. Dried and roasted seeds of Okra are used as substitute for preparation of tea

Ans: False

4. Leading Okra growing state in India is Maharashtra

Ans: False.

5.Bhendi is cross pollinate crop.

Ans: False

6. China largest producer of okra in the world.

Ans: False.

Lecture 13. Climate, soil requirement, seed rate and preparation of field, sowing, spacing, planting systems, irrigation, growth regulators, nutrition and weed management, physiological disorders, harvest, post harvest handling, storage, marketing and seed production of Okra

- Climate and soil.
- Seasons.
- Seed sowing.
- Seed rate
- Cropping systems
- Preparation of field.
- Spacing.
- Nutrition.
- Irrigation.
- Weed control.
- Use of chemicals and growth regulators.
- Physiological disorder
- Harvesting and yield.
- Storage and Marketing
- Seed production

Climate and soil

The crop is basically adapted to tropical climate and vigorous warm humid weather for best growth and production. It is susceptible to drought and low night temperatures. For seed germination optimum soil moisture and a temperature range between 25 and 35^{o}C is required, with fast germination observed at 35^{o}C. Seeds fail to germinate below 17^{o}C. At temperature above 42^{o}C flower buds in most of the cultivars may desiccate and drop causing yield losses. The optimum temperature range for growth is 20-30^{o}C. Sunlight is equally important for bhendi crop. A 50 $^{\%}$ reduction in sunlight during first three weeks after sowing has adverse effect on yield.

It can be grown in all kinds of soils ranging from sandy loam to clay. However, high yields can be obtained in loose friable, well manured loamy soils having better drainage. The soil optimum pH for okra ranges from 6-6.8.

Seasons

Sowing in plains is done in June-July for kharif and February-March for spring-summer crop. The best time is from May 25th to June 25th. The crop sown earlier in season will be less affected by YVMV than the July. In hilly region, the crop is sown from April to July.

Seed sowing

Seed is sown directly in the soil by seed drill, hand dibbling or behind the plough. Broadcasting is not recommended due to high seed rate as well as inconvenience in cultural operations and harvesting. Sowing on ridges ensures proper germination; economize irrigation and helps in drainage during rainy season.

Seed rate

The recommended seed rate per ha is 18-22 kg for spring summer crop and 8-10 kg for kharif crop. Higher seed rate could be used if the crop is to be sown early in January as it will augment germination loss due to low temperature. Higher seed rate and lower spacing could also be opted for spring summer crop to lower the field temperature and continued fruiting under frequent light irrigation.

Cropping systems/ planting systems

Okra could be used in different cropping systems. In sequential cropping, potato-carrot-okra, okra-potato-tomato and cauliflower-tomato-okra provides higher income per unit area. Under sequential intercropping system (Okra+French bean)-(Capsicum+onion)-(Muskmelon+radish) gave higher yield as compared with sole crops of okra-capsicum-muskmelon. Okra+radish and palak+French bean gave higher return than sole crop. Bhendi could give 300-500% crop land use efficiency as an intercrop in cassava and cucurbits. Growing in sequences like okra-cowpea-maize, maize-okra-radish reduced bacterial wilt in tomato and brinjal taken as succeeding crop.

Preparation of field

Soil should be worked well upto a depth of 20-25 cm and made into a fine tilth before seed sowing. The plant has well developed tap root system and is a heavy feeder and

as such the soil should be made rich in organic matter content. Application of 25 t/ha of FYM is needed for obtaining good crop. Solarisation during hot summer months helps to great extent in controlling weed pest population.

Spacing

A plant distance of 60 X 30 cm accommodating 5000 plants/ha is recommended for branching types, while 45 X 30 cm accommodating 66,000 plants/ha for non branching type. During spring summer season with less plant growth these spacing is kept at 45 x 20 cm or less. The seed should be sown at a depth of 2.5cm.

Nutrition

The quantity of manures and fertilizers depends upon the type of soil, but in normal condition 25 tonnes of FYM should be added at the time of last harrowing. In addition to this, 125kg N, 75kg P and 63 kg K/ha will be required in medium type of soils. Half of the nitrogen and full amount of P and K should be applied as basal dose while remaining half of the N should be given as top dressing 35-40 days after sowing the seeds. Positive effects of zinc up to 2% as soil application or 2mg/litre of foliar spray of molybdenum @20mg/l foliar spray have been observed on fruit yield and appearance.

Irrigation

During kharif, irrigate the crop as and when required. In summer season the crop should be irrigated at an interval of 5-6 days. Flooding of plants should be avoided. Drip irrigation increases considerable yield and saves 70-80% irrigation water.

Weed control

About two weedings are required till the crop canopy covers the soil surface. Use of weedicides has helped in reducing the numbers of weeding to zero during summer and one during kharif season. Fluchloralin @1.5kg a.i/ha as pre sowing soil incorporation and alachlor @ 2kg a.i/ha as post sowing gives control of weeds. The soil surface application of weedicides is effective for 4-5 weeks.

Use of chemicals and growth regulators

The highest average fruit set and yield were obtained with cycocel at 100 ppm as seed soaking for 24hrs on seed treatment by GA (400 ppm), IAA (200 ppm) or NAA (20 ppm) enhanced germination, ethephon (100-500ppm) reduced vegetative growth and weakened apical dominance, post harvest treatment with cycocel (100ppm) enhanced shelf life of fruits and with ascorbic acid (250 ppm) retention of chlorophyll was the best.

Physiological disorder

1. **Poor seed germination:** Seed germinate poorly when soil temperature remains at or below 20^0C. The problem occurs during early spring summer cultivation when seeds are to be sown at low temperature condition.

   Control:

   a. Soaking the seeds in water for 24 hours.
   b. Soaking the seeds in hot water at 45^0C for 1 ½ hours.
   c. Seed treatment with alcohol for half an hour.
   d. Water soaked seeds after tying in a piece of cloth are put into a heap of fresh cow dung overnight. Heats released due to decomposition of cow dung stimulate germination.

Harvesting and yield

The pods should be harvested when they are immature and green and have attained edible size. In general, harvesting every alternate day is advisable. Field is divided into blocks to ease harvesting at one or two intervals. Delay in harvesting causes fibrous and matured fruits of poor edible quality. Such fruits get very poor price in the market and ultimately poor income to the growers. Ten to fifteen pickings are done during the crop period. The best length at which the pods should be harvested is 8 to 10 cm. For distant market harvesting in the late evening and transporting the produce during coolness of night is practiced.

The yield depends upon the season, variety and cultural practices followed for the crop cultivation. An average yield of 8 tonnes green fruits per hectare during spring-summer and 12.5 tonnes during rainy season is ideal, though much higher yields have been harvested by individual farmers.

Storage and marketing

Fruits could be stored at 7-9^0C temperature and 70-75% RH for a couple of days without much loss in colour, texture of weight. The pods can be stored at room temperature for 2-3 days if water is sprinkled on the pods during day and once in night to keep them cool and fresh. Larger lots of harvested fruits suitably packed, reach the auction hall of vegetable market during night and are auctioned early in the morning. Transport of the produce to large or small mandis depends on the size of the lot and their requirement. Smaller producers form groups and come into contact with transporters. The producer pays the cost of transport and the commission agent charges some percentage of auction value from the wholesale purchaser who again pays 1% towards free of the mandi administration. The produce action

by lots packs or bags of known size. The purchased produce is again channelized to sellers in different areas directly to the retailers or sub agents of the area.

Seed production

It is often cross pollinated crop and to get seed isolation distance of 400 and 200 meters should be maintained for foundation and certified seeds respectively. Some cultural practices should be followed as recommended for normal crop. However, rainy season crop is good for seed. Pests and diseases are controlled strictly. Crop should be inspected thrice during the crop period. First before flowering on the basis of foliage characters, off types and disease plants should be removed. Secondly at the time of flowering and on the basis of flower characters, off types and diseased plants should be removed. Finally, at the time of pod ripening and on the basis of pod characters. When pods are brown, they should be considered for harvesting. Harvest them 4 to 6 days interval depending upon the maturity. Keep them in sun for drying and thresh them. Clean the seed and dry it up to 10% available

Questionnaire

I. MULTIPLE CHOICE QUESTIONS

1. First picking in okra can be done after

a. 30-35 days b. 45-50 days c. 60-65 days d. None of the above

2. Okra crop is sown at a spacing of

a. 75x45 cm b. 60x45cm c. 45x75 cm d. None of the above

3. Okra seeds fail to germinate below ----------^{0}C

a. 5 b. 10 c. 15 d. 20

4. Optimum pH range for better growth of okra is

a. 4.5-5.5 b. 6.0-6.8 c. 7.5-8.5 d. None of the above

5. Optimum temperature for okra seeds germination is ----------^{0}C

a. 20 b. 30 c. 15 d. 35

6. The most serious disease of okra is ----------

a. Yellow vein mosaic b. Powdery mildew c. Root rot d. None of above

7. The seed rat per hectare of okra for rainy season is ----------kg

a. 8-10 b. 10-12 c. 12-14 d. 14-16

8. The seed rate per hectare of okra for spring summer and winter crop is -------kg

a. 5-10 b. 10-15 c. 15-20 d. 20-25

9. Post harvest treatment with _____ enhances the shelf life of okra fruits.

a. GA b. Ethophan c. Cycocel d. NAA

10. Average seed yield of okra is about _____ q /ha.

a. 5-8 b. 10-15 c. 20-25 d. All of the above

II. Say true or false.

1. Optimum pH range for growth of okra is more than 7

Ans: False

2. Seeds of okra will not germinate below 30

Ans: False

3. Sowing in plains is done June –July for kharif and February – March. for spring –summer crop.

Ans:, True.

4.The recommended seed rate for ha is8 –10 kg for spring/summer crop and 18– 22 kg for kharif crop.

Ans: False

5.Yellow vein mosaic virus disease is less affected during Kharif season

Ans: False.

Lecture 14. Introduction on leafy vegetables. Origin, area, production, economic importance, description of varieties and hybrids, climate, soil requirement, seed rate and preparation of field, sowing, spacing, irrigation, nutrition , inter cultivation, harvest and post harvest handling of amaranthus

- Introduction on leafy vegetables
- Cultivated indigenous leafy vegetables
- Non cultivated naturally growing leafy vegetables
- Perennial greens
- Introduced leafy vegetables
- Amaranthus
- Importance and utility
- Varieties released from TNAU, Coimbatore
- IARI Varieties
- IIHR Varieties
- Climate
- Soil
- Season
- Seed rate and fertilizer recommendation
- Land preparation and sowing
- Irrigation and inter cultivation
- Harvesting
- Yield

Introduction on leafy vegetables

Among all vegetables, the leafy vegetables have a very high protective food value. They are rich in calcium, iron and other minerals and in vitamin A & C. Besides, they are soft fibrous matter provides the necessary roughage in the diet.

In India, leafy vegetables are generally considered inferior than other vegetables like peas, cauliflower and tomato which are more palatable and appetizing but fact remains that

leafy vegetables when properly prepared are equally palatable considering their extra nutritive value, the leafy vegetables deserve greater recognition.

There are varieties of leafy vegetables under cultivation in India. Certain plants which grow wildsuch as alternanthera,celosia portulaca etc. are also used as leafy vegetables. Among the several leafy vegetables Amaranthus is one of the most important warm season leafy vegetable.

The cultivation of leafy vegetables is well known in the state since time immemorial. The state has its credit on number of local edible leafy vegetables which are both cultivated and uncultivated.

Leafy vegetables could be grouped into:

1. Cultivated indigenous vegetables
2. Uncultivated naturally occurring leafy vegetables
3. Introduced leaf vegetables
4. Cultivated perennial leafy vegetables

1. Cultivated indigenous leafy vegetables

A. *Amaranthus tricolor*
B. *Amaranthus viridis*
C. *Amaranthus dubius*
D. *Atriples hortensis*
E. *Anethem rowa*
F. *Alterneathera sessiles*
G. *Hibiscus carbis*
H. *Coriandrum sativan*
I.*Portulaca grandiflora*
J. *Trigonella foenum gracum*

2. Non cultivated naturally growing leafy vegetables

A. *Alternanthera echinate*
B. *Amaranthus sessiles*
C. Amaranthus caudetus
D. *Amaranthus gangeticus*
E. *Amaranthus polygamus*
F. *Amaranthus spinosus*
G.*Centella asiatica*
H.*Celosia argentia*
I. *Coleus amboinicus*
J. *Jatropa prostrate*
K. *Oxalis carniculate*

3. Perennial greens

A. Subania grandiflora
B. *Moringa olerifera*
C. *Sauropus androgynus*
D. *Tamarindus indica*

4. Introduced leafy vegetables

- Spinach, Celery, Lettuce. Parsely, Basella, Ceylon (Talinium triangulare) etc,.

Amaranthus

Scientific name : *Amaranthus* Sp.

Family : *Amaranthaceae*

Chromosome number : 2n=32 or 34

Origin : India

Leaf type

Amaranthus tricolor/ganetious

Amaranthus tristis

Amaranthus lividus

Amaranthus blitum

Amaranthus durbius

Amaranthus viridis

Grain Amarath species

Amaranthus caudatus

Amaranthus cruentus

Amaranthus hypochondriacus.

Amaranthus edulis.

Importance and utility

Amaranthus is the most common leafy vegetable grown during summer and kharif season in India. It fits well in crops rotation because of its very short duration and large yield of edible matter per unit area. The estimation of the extent of its cultivation is not available. Green or leafy types are usually grown in kitchen and market garden. The grain amaranthus species are popular in the high lands of tropical and sub-tropical America. It is gaining importance in the Indian plains also, particularly in Gujarat and Maharashtra. Grain types are usually grown as mixed crops along with cereals, pulses and vegetables.

The leaves and tender stems of Amaranthus are rich in protein, minerals, vitamin A and C.100g of edible portion of Amranthus consists of Protein 4.0 g, Calcium 397 mg, Iron 25.5 mg, Magnesium 247 mg, Phosphorus 83 mg, Potassium 341 mg, Sulphur 6 mg, Vit C 99 mg and Vit A 9200 IU. Besides, the soft fibrous matter provides necessary roughage in the diet.

The fresh tender leaves and stem of amaranthus are delicious when cooked and consumed like other leafy vegetables. The tiny seeds of grain. Amaranthus are parched and milled for flour.Amaranthus flour compares favourably with other cereals in taste, nutritional value and yield.

The grain amaranthus is a rich source of protein and essential aminoacids like lysine, leucine and isoleucine which are required for growth of children.

Varieties released from TNAU, Coimbatore

Co.1 (*Amaranthus dubius*)

- Developed at TNAU
- Selected for tender leaves and mature stem
- Suited for early harvest
- Not suited for clipping of leaves
- 7-8 t/ha in 30 days
- Suited for late harvesting

Co.2 (*Amaranths tricolor*)

- Developed at TNAU
- Suited for early harvest
- Not suited for clipping of leaves
- 10-11 t/ha in 25 days

Co.3 (*Amaranthus tristis*)

- Developed at TNAU
- Suited for clipping tenders greens at weekly cultivars
- First clipping 20 days after spring green
- Ten clippings can be taken continuously
- Grain yields 10-12t/ha

Co.4 (*Amaranthus hypochondriacus*)

- Green cum grain type.
- Plants are dwarf

-Make rapid vegetative growth in 20-25 days.

-7-8 tonnes of green matter per hectare

-Grain yields 2 to 2.5 tons per hectare in 80 to 120 days

IARI Varieties:

Chhoti chaulai (*Amaranthus blitum*)

- Plant erect, dwarf, small green leaves
- Respond well to clippings/cuttings
- Suited for sowing in early summer

Badi Chaulai (*Amaranthus tricolor*)

- Plants have thick stem and longer leaves
- Well to clipping/cutting
- Suited for sowing at warm summer

Pusa Chaulai (*Amaranthus tricolour*)

- Stem medium thick, tender and leaves medium to large in size.

- Suited for sowing at early summer
- Yields 45 t/ha

Pusa Kiran

- Suited for growing in rainy season
- It gives yield of 35 t/ha

Pusa Keerthi

- Suited for growing in summer season
- It gives yield of 50 t/ha

IIHR Varieties

Arka Suguna

A pure line selection from an exotic collection from Taiwan (IIHR 13560) Light green, succulent stem and broad leaves.First harvest in 25-30 days after sowing and 5-6 cuts in 90 days. Moderately resistant to white rust under field conditions.Yield 25-30 t/ha.

Arka Samraksha

Arka Suguna

Arka Samraksha: It is a high yielding amaranth variety, with high antioxidant activity of 499mg (AEAC units) and minimum nitrate content of 27.3 mg and 1.34g of oxalates per 100g fresh weight of leaves. It is a pulling type amaranth variety with green leaves and stem, yields 10.9t/ha in 30-35 days duration.

Arka Varna

Arka Varna: It is a high yielding amaranth variety, with high antioxidant activity of 417mg (AEAC units), nitrate content of 37.6mg and 1.42g of oxalates per 100g fresh weight of leaves. It is a pulling type amaranth variety with green leaves and pink stem, yields 10.6 t/ha in 30-35 days duration.

Climate

Amaranthus species are widely distributed in temperate and tropical regions of the world. Different species differ in their day length (Photo period) requirements and respond differently to changes in photo and thermoperiodism. *A. caudatus, Amaranthus edulis* and *A.cruents* are short day (plants) species while *A. hypochondriacus* is reported to be day neutral. However it does well under warm situations temperature ranging from 22 to 30^0C. Grain Amaranthus is highly resistant to drought.

Soil

Amaranthus can be grown in a wide range of soil, however well drained loamy soils are best suited for this crop. Heavy soils with poor drainage and sandy soils with poor water holding capacity are unsuited for its cultivation. It can be grown in a pH range of 5.5.-7.5. However slightly acidic in nature are preferred.

Season: It can be grown throughout the year. However March to September are the best months to start the crop.

Seed rate & fertilizer recomendation

One hectare area requires around 2.5 kg seeds with recommended NPK is 100-50-50 kg inaddition to well decomposed 15-20 tons of FYM.

Land preparation and sowing

Prepare the land thoroughly by ploughing, harrowing and bring the soil to fine tilth. Incorporate entire quality of organic manure into the soil. Prepare the beds of convenient size. 3mx2m or 2mx1.5m with irrigation channels running between every two rows of beds. After the beds are ready apply entire dose of P and K along with 50% N and mix them well in the soil.

Sow the seeds thinly. On account of smallness of seed ,it should be sown shallow to a depth of 0.5-1cm .Since the seeds of Amaranthus are small in size, to achieve even distribution, mix the seed with fine sand or red soil before sowing. For line sowing spacing between rows is 20cm.

In grain amaranthus (*Amaranthus hypochondriacus*), the plants are thinned that have a spacing of 30cm x 30 cm on 25th day and they are allowed for flowering. The crop will be ready for harvest in 80-120 days depending on the variety and season. The dried spikes are threshed to separate grain which is used to prepare popped grain, green cakes, infant foods and the preparation like amaranthus malt.

Irrigation & inter cultivation

Provide light irrigation after sowing. Three days once or weekly irrigation is necessary, depending on soil and weather conditions. Top dress the crop with remaining 50% of N 20-25 days after sowing. Keep the land free from weeds.

Harvesting

Young seedlings are pulled out with roots, washed, tied into bundles and sent for marketing.

Crop will be reading for first clipping or cutting 25-30 days after sowing. The subsequent cuttings can be made at an interval of 6-10 days. It gives about 6-10 cuttings.

Yield

It is highly perishable hence leaves should be used same day of harvest. Average yield is 25 tonnes per hectare in leaf types whereas grain types yield is around 2 to 2.5 tonnes per hectare.

Questionnaire

A. Encircle the most appropriate answers:

1.---------- is basically known as amaranths tricolour.

a. Amaranths, b. Spinach beet, c. Spinach, d. None of the above.

2. Amaranths hypochondrias species of amaranths is of having.

a. Long day, b. Short day, c. Day natural, d. Both 'a' and 'b'

3. Amaranths is rich in

a. Vit. K, b. Vit-D, c. Vit- A, d. Vit-B.

4. Amaranths originated from

a. Brazil, b. India, c. Europe, d. None of the above.

5. Basic chromosome number in amaranths is

a. 20, b. 34, c. 17, d. 16.

6. Amaranths belongs to family.

a. Amarly Diaceae, b. Amaranthaceous, c. Lilaceae, d. Araceae.

7. Amaranths is a ---------- crop.

a. Self pollinated, b. Cross pollinated, c. Often cross pollinated, d. Heraphordate.

8. ---------- is a most serioud disease of amaranths

a. Black spot, b. While rust, c. Sun Scarching, d. Leaf curl.

9. Green yield of amaranths is about---------- q/ha

a. 40-60, b. 30-40, c. 60-80, d. None of the above

10. ---------- a grain type amaranths is widely grown in Gujarat and Maharashtra.

a. Jobner Green, b. Rajgarh, c. Pusa Harit, d. Pant Haritima.

11. Seeds of amaranths are deride up to---------- percent moisture and stored in moisture proof polyethylene bags.

a. 3-4, b.5-6, c.1-3, d.8-10.

B. Say true or false.

1.The grain amaranths species are popular in African countries.

Ans: False

2. Grain Amaranths is popular in north -indian states.

Ans: False

3 Lencine & Lencine essential amino acids are present in grain amaranths.

Ans: True

4. *A.edulis, and A.cruents*.species of amaranthus are short day plants.

Ans: True

5.Grain amaranths is highly resistant to frost.

Ans: False

6 Arka Suguna and Arka Arunima varieties of amaranths developed by IIHR, Bangalore.

Ans:.True

7. Chofi chaulai is a variety of *A- blitum*.species.

Ans: True

8. Quality of amaranths seeds required for one hectare areca is around 1.5 kg.

Ans: False

9.Grain amaranths is planted at a spacing of 15 x15.

Ans: False

10. Average yield of grain amaranths is 5 t/ha

Ans: False.

Lecture 15. Origin, economic importance, description of varieties, climate, soil requirement, seed rate and preparation of field, sowing, spacing, irrigation, nutrition and weed management, harvest and post harvest handling of basella

- Importance and utility
- Climate and soil requirements
- Varieties
- Seed rate
- Sowing
- Manuring
- Inter cultivation
- Plant protection
- Harvesting and yield.

BASELLA

Botanical name **:** *Basella alba*

Family **:** Basellaceae

Chromosome No. **:** 2n = 44, 48

Common name **:** Malabar night shade/poi/ Indian spinach

Importance and utility

The plant is a climbing vine with think fleshy stem and leaves. The different botanical forms are available *viz.*, *Basella rubra*, *Basella cannifolia*, *Basella cordifolia.* They are chopped and cooked as vegetables and has ornamental value. It is a rich source of vitamin A (3250 IU/100g), protein (1.2%) and rich source of iron (1.4mg/100g). The succulent leaves with petioles and tender leaves are cooked as vegetables.

Climate and soil requirements

Basella grows well in warm and moist climate. But it cannot tolerate extremes of temperature (optimum temperature is 25-32^{0}C). It can be grown successfully under partial shade.

It can be grown under wide range of soil right from sandy soil to clayey soils. Sandy loam with sufficient organic matter will be the best suited.

Varieties

There are no named varieties. Cultivars having dark green round oval leaves (Petiole and stem) with reddish petiole and stem and dark green cordate leaves are available.

Eclipse

Producing a crop in 55 - 60 days in warm areas. Very early cultivar producing small and compact plants that can be planted close together. The leaves are thick and medium to deep green in colour. Yields very well under warm humid conditions.

Red

The leaves, stems and flowers are tinged with red. The colour is lost when the plant is cooked and so it is best used in salads. *Basella alba* is a fast-growing, soft-stem vine, reaching 10 m in length. Its thick, semi-succulent, heart-shaped leaves have a mild flavour and mucilagenous texture. The stem of the cultivar *Basella alba* var.Rubra is reddish-purple.

Malabar Spinach (Red Vine)

Malabar Spinach (Green variety)

Malabar Spinach (Red Vine)

This is a unique variety that has red-purple vines and dark green leaves. This variety has relatively small leaves and vines. The vines grow much faster than the Green Vine variety. Many people also like to grow this variety as the backyard decorative plants due to the beautiful vine and flowers.

Malabar Spinach (Green variety)

This variety produces large dark green leaves and vines. This vegetable is very popular in Chinatown and Vietnamese markets. Young leaves and tips are excellent for stir-fry cooking.

Seed rate

One hectare area requires around 12-15 kg seeds.

Sowing

Basella is propagated by seeds as well as by stem cuttings. Usally stem cuttings are preferred and commonly followed cuttings of 40-45 cm long are planted before the onset of monsoon. Both direct seeding and transplanting after raising the seedling can be adopted. For trailing on the ground a spacing of 60cm x60cm can be adopted. If it is trained on trellis, a spacing of 60x30 or 60x20cm can be adopted. Rooted cuttings can be used for planting.

Manuring

A basal dressing of 20-25t of FYM and 60:60:40 kg of NPK/ha has to be applied before transplanting/sowing.

Inter cultivation

When the plants start trailing they should be trained on the support. Shallow cultivation in between the plants is done as when necessary. Frequent irrigation promotes quick growth of the plant, water stress induces early flowering.

Plant protection

Damping off, leaf spot and mosaic diseases are common in basella.

The seeds can be treated before sowing and soil can be sterilized before sowing. To the extent possible, it is advisable to avoid the use of any chemicals on the crop, since the leaves are edible part.

Harvest and yield

The first cutting starts from 45-60 days after planting. A quantity of 15-20 t/ha of green matter can be harvested from a hectare. Crop duration is 120-150 days. The leaves are tied in bundles of 15-20 and sprinkled with water. Use of polyethylene bags prolongs storage life.

Questionnaire

I. Encircle the most appropriate answer;

1.---------- is popularly known as malbar night shade, poi or Indian spinach.

a. Methi, b. Basella, c. Spinach, d. Spinach belt.

2. Basella is commonly grown in

a. North India, b. South India, c. Western India, d. Central India.

3. Botanical name of ---------- is Basella Alba.

a. Palak, b. Bari Chauli, c. Choti Chauli, d. Basella.

4. The origin place of Basella is

a. Europe, b. China, c. America, d. India.

5. Basic chromosome number in Basella is

a. 10, b. 20, c. 12, d. 14.

6.Basella is a ---------- plant in nature.

a. Erect, b. Spreading c. Semi- erect, d. Climbing.

7. Basella sowing is usually done in South India during.

a. June-July, b. August-September, c. October-November, d. December-January.

8. In order to raise one-hectare crop of Basella, about---------- kg seed per hectare will be required

a. 4-5, b. 5-10, c. 12-15, d. 45-60,

9. Basella leaves become ready for harvesting ------- days after sowing the seeds.

a. 3-40, b.20-30, c.12-50, d.60-75.

10. Basella belongs to family----------

a. Alliaceous, b. Amaranthaceous, c. Basellacea, d. Chemopodiiacea.

11. The total yield of Basella is -------- quintal per hectare.

a. 5-60, b.60-70, c. 100-150, d.150-200.

II. Say true or false:

1. Basella is a cool season plant.

Ans: False.

2. Basella of mainly grown for its tender pods and leaves

Ans: False.

3. Basella is a rich source of Vitamin A, protein and Iron.

Ans: True.

4. Optimum temperature about15-20^{0}c is i deal for best growth of basella.

Ans: False..

5. Sandy loam soils are preferred for Basella cultivation.

Ans:.True

6. Damping off, leaf spot and mosaic diseases are common in basella.

Ans: True.

7. Basella can be propagated by seeds as well as by tubers.

Ans: False.

8.100-100-50 kg of NPK/ha has to be applied for best growth & development of Basella.

Ans: False.

9. The first cutting of Basella starts from 30 days after planting.

Ans: False.

10. The quantity of 30- t/ha of green matter can be harvested in Basella.

Ans: False.

Lecture 16. Origin, area, production, economic importance, description of varieties and hybrids, climate, soil requirement, propagation, preparation of field, planting, irrigation, growth regulators, nutrition and weed management, harvest , post harvest handling and storage of curry leaf

- Area and Production
- Importance and utility
- Varieties:
- Soil and climate
- Propagation
- Crop production
- Nutrition
- Weeding
- Harvesting and yield
- Post harvest management

CURRY LEAF

Botanical Name	**:** *Murraya koenigi*
Family	**:** Rutaceae
Chromosome number	**:** 2n=18.
Origin	**:** Burma

Area and Production

Curry leaf is grown on large scale in West Bengal, Assam, Deccan plateu, Western Ghats, TamilNadu, Karnataka and Kerala. It is cultivated in Coimbatore, Salem and Thruchirapalli districts of Tamil Nadu on a commercial scale.

Importance and utility

Curry leaf is an important perennial tree vegetable cum spice crop of India. It is an under exploited crop. The leaves are widely used in Indian cookery for flavouring food stuff. The leaves have slightly pungent, bitter and feebly acidic taste and they retain their flavour and other qualities even after drying. Curry leaf is used in many of the Indian Ayurvedic and Unani prescriptions.

It has many industrial values and medicinal uses. Since the leaves are widely used for foods flavouring in curry preparation. Its leaves, roots and bark are credited with tonic, stomachic and carminative properties. Leaves are reported to cure piles and allay heat of body. The green leaves are said to be eaten raw for treatment of dysentery. External application of pulped bark and root is reported to relive eruptions and bites of poisonous animals. An injection of toasted leaves is used to stop vomiting. The tribal people of India use its ground bark and they rub the bark on the bitten part as a snake bite remedy. The powdered leaf is used to aid in healing of fresh cuts and decoction of the leaves is drunk for dropsy.

The dried curry leaf powder is a good spice powder for use in the food stuff preparation. It is also being exported. Fresh leaves on a steam distillation under high pressure yield 2.6 % (curry leaf oil) volatile oil which is used as fixative for heavy type of soap and perfume. Rectified leaf oil is deep yellow in colour with a strong spicy odour and pungent clove like taste. A volatile oil a crystalline glucoside 'Koenigia" from the leaves and 'Murayam from the flowers are industrial products.

Varieties:

DWD-1 (Suwasini): It was evolved at UAS, Dharwad. It is a clone of single plant root suckers. The leaves are dark green (0.1629 mg of chlorophyll/ gram of fresh leaf), shiny and highly aromatic. It is sensitive to low temperature in winter season and hence the bud burst is poor. The leaves have oil content of 5.22 % and can be dehydrated at 50^{o}C without loss of quality and made into powder.

DWD-1 (Suwasini) **DWD-2**

DWD-2: It was evolved at UAS, Dharwad. It is a seedling progeny of unknown source. The leaves are slightly pale green and less aromatic. It is not very sensitive to low temperature and much superior in number of bud burst, inter nodal length and 8 times higher in growth of shoot than DWD-1.

Senkambu: It is a Coimbatore local type and the leaves have better aroma and flavour due to higher oil content.

There are other two types of curry leaf *viz.,* broad leaved and small leaved types. The small leaved types are more fragrant and hence used for the extraction of essential oil.

Soil and climate

Though it can be cultivated in wide variety of soil, red loamy soil with high organic matter is best suited for its cultivation. Curry leaf is grown in warm climate. It can tolerate maximum temperature up to 26-37^{o}C. When temperature falls down to 16^{0}C, the vegetative buds become dormant arresting the new growth of the plant.

Propagation

Curry leaf is propagated through seeds. Polyembryony has been reported in curry leaf and about 14% of the fruit contains two seeds per fruit and such seeds are separated by a thin papery seed coat. On removal of the seed coat, differentiated embryos of 4-5 are recorded. When embryos are separated out and planted, they are capable of developing into a potential plant. When whole seeds are planted, the weaker embryos are powered by the bigger ones producing only two seedlings per fruit. The seeds are to be sown in the raised nursery bed (one metre breadth and any length) well prepared by mixing equal parts of sand, red soil and FYM. Seeds can also be sown in PE bags filled with this mixture. Harvest well ripe fruits from the selected high yielding mother tree. Normally fruits for seeds are available during July- August in Tamil Nadu. Each fruit contain 2-3 seeds. Seeds are to be extracted and sown immediately. If it is nursery bed, sow the seed uniformly in lines of 10 cm apart at a depth of 1 cm. Two seeds can be sown in poly bags. The seeds will germinate in 3 weeks. Irrigate the nursery to maintain optimum moisture. The seedlings are ready for transplanting in one year.

Crop production

Plough the field 3-4 times to get fine tilth. Apply FYM 25t/ha. Dig pits of 60cm^{3} at a spacing 3 meters rows and 1.5 meters between pits. One month before planting fill the pits

with soil mixed with FYM. Irrigate the pits and allow settling. Well grown seedlings of 15-20 cm height are planted into each pit and irrigate the pit. Form one channel in between rows of pits. Afterwards irrigations are provided once in week. Allow the plants to grow up to 1 meter and then cut the terminal bud to encourage basal branching. This will also facilitate to maintain the plant in a bushy shape so that the harvest will be easier. In total 5-6 branches can be maintained. In some areas curry leaf is pruned four times in a year and young shiny leaves are harvested. At each pruning, the bushes are manured and irrigated profusely.

Nutrition

Curry leaf needs high quality of organic manure before planting. Apply 20kg FYM/pit at the time of planting and after each pruning. Inorganic fertilizers have to be applied as follows (grams/plant).

	1 year	2nd year	3rd year and onwords
N	50	150	300
P	25	37	50
K	25	37	50

Weeding

Keep the field clean by frequent weeding. Raise inter crops like cowpea, black gram and green gram etc.

Harvesting and yield

The leaves can be clipped from young shoots at the end of 1st year. A total number of 4 harvests can be had. The yield ranges from 5t/ha in 2nd year to 10t/ha in 4th year. From 4th year onwards the foliage yields around 20t/ha.

Post harvest management

Young shoots and leaves are packed in gunny bags and transported. The leaves are dried and ground into powder and used as curry powder.

Questionnaire

I. Encircle the most appropriate answer.

1. Curry leaf is a backyard crop in many of the ------- home steeds.

a. Central India, b. Western Indian, c. North Indian, d. South Indian.

2. A volatise oil a crystalline glycoside "koenigin" from the leaves and a glucoside" from the flowers are a few industrial products from the treas of .

a. Curry leaf, b. Drumstick, c. Chekkurmans, d. Winged bean.

3. Murriya koenigin indigenous to.

a. India, b. Myanmar, c. Bangladesh, d. Srilanka.

4. Murriya paniculata, Murriya exotica and Murriya Koenigin are realities of

a. Drumstick, b. Curry leaf, c. Tree tomato, d. None of above.

5. Curry leaf belongs to family.

a. Rutaceae, b. Asteraceae, c. Eupherbiaceae, d. Convolulaceae.

6. Somatic chromosome numbers of curry leaf is.

a. 10, b.14, c.16, d.18.

7. Curry leaf is grown commercially in

a. Tamilnadu, b. Assam, c. Karnataka, d. Kerala.

8. Senakambu is a variety of

a. Drumstick, b. Amaranths, c. Palak, d. Curry leaf.

9. Curry leaf is propagated through.

a. Stem cuttings, b. Root cuttings, c. Seeds, d. None of above.

10. Average yield of curry leaf is---------- t/ha.

a. 5, b. 10, c. 15, d. 20.

11. Poly embryonic has been reported in.

a. Drumstick, b. Bhendi, c. Curry leaf, d. Asparagus.

II. Say true or false.

1. Curry leaf is biennial vegetable.

Ans: False..

2. The leaves are widely used in Indian cookery for flavouring food stuff.

Ans: True..

3. Curry leaf is cultivated commercially in Coimbatore and Thruchirapalli districts.

Ans: True.

4. Curry leaf oil is extensively used in Perfume industry.

Ans: True

5.The yield ranges from 5t/ha in 2^{nd} year to 10t/ha in 4^{th} year

Ans: True.

5. A volatile oil a crystalline glucoside 'Murayam' from the leaves.

Ans: False.

Lecture 17. Origin, area, production, economic importance, description of varieties and hybrids, climate, soil requirement, propagation, preparation of field, planting, irrigation, nutrition and weed management, harvest, post harvest handling and storage of moringa

- Importance and uses:
- Varieties
- Climate and soil
- Propagation
- Planting
- Manuring
- After care
- Irrigation
- Harvesting and yield

MORINGA

Botanical Name	**:** *Moringa oleifera*
Family	**:** Moringaceae
Chromosome number	**:** 2n =28
Origin	**:** North West Indian and African tropics

Importance and uses:

Drumstick is one of the most popular vegetables in the south Indian households. The fruits, leaves and flowers are used in culinary preparation. Immature fruits are cut into pieces and used in several culinary dishes. The roots of the plant are used for seasoning pickles. It is highly valued for the distinct and appealing flavour for its tender fruits. They are rich source of protein, minerals and vitamins. Seeds contain an oil called ben or behen oil which has been much used for illumination, soap industry and highly priced for lubricating watches, computers , delicate machinery etc. Seeds contain 38-40% of non drying oil which is clear and odourless, never becoming rancid. It is edible and useful in the manufacture of perfumes and hair dressing. The press cake remaining after oil extraction is high in saponin, not edible, but utilized as manure. The oilcake is a water coagulant and used for purifying effluent water. It is used as organic substitute for water purifying chemicals such as alminium

sulphate. Wood yields blue dye and coarse fibre. The plant is used for treatment of rheumatism and as cardiac and circulating stimulants.

Varieties:

Jaffna: It is introduced from Sri Lanka. Highly suited for coastal tracts of TN, Kerala and Karnataka. It bears long pods (60-90cm) and with a soft flesh of good taste. This type yields 500 pods/tree/year.

Moolanur Murungai : Fruits are 30-53cm in long with soft flesh. One tree yields about 500-600 fruits/year.

Chavakacheri Murungai: It is ecotype of Jaffna moringa, which bears pods as long as 90-120 cm . Due to long size of pods, this type of moringa is highly damaged during transportation. It yields 500-600 pods/tree/year.

Chem Murungai: Produces flowers throughout the year. Fruit tip is red in colour.

Palmurungi: Pods having thicker pulp content, produces 400-500 pods/year.

Kodikal Murungai: Predominantly found in betel vine garden. This tree is highly useful for training of beetle vine and also gives shade. Pods are shorter (20-25cm) and thick fleshed and very tastier. This is a distinct type propagated by seeds.

Kudumianmalai 1 (KM-1): It is selection from local annual type propagated through seeds. Plant are dwarf, pods are short and thick. The plant comes to bearing 6 months after planting. After each harvest, the plants can be ratooned for 2-3 years by cutting the trunk at a height of 1 metre; fresh planting can be taken after 3 years. Average yield 400-500 fruits/tree.

PKM-1: Evolved at Horticultural College and Research Institute, Periyakulam. Plants grow a height of 4 to 6 metre and come to flowering in 160-170 days after planting. Each tree bears on an average of 200-250 pods/year. Pods are 60-75 cm long with 6.0 cm girth and 150 g weight. They are very pulpy containing 70% of edible portion. Every year after the harvest is completed, the trees have to be cut back to about one meter from ground level during September and three ratoon crops can be taken in a period of three years.

PKM-1

PKM-2

PKM-2: It was released from HC & RI, Periyakulam. It is hybrid derivative of the cross between MP 31 and MP 28. Plants are quick growing. Each tree has 12 branches and bears flowers in clusters, 3-4 pods/ cluster, pods harvested 170-180 days. Length of the pod 125 cm and girth 28 cm. the pods having lees seed with more flesh. Each tree yields 220 pods in a hectare and yields of 98 tonnes.

GKVK-1: It was released by UAS, Bangalore. Plants are dwarf, grow to a height of 1.5m, produce 250-300 plants/year. Length the pod is 35 cm. this variety is suitable for high density planting.

GKVK-2: It was released by UAS, Bangalore. Plants are dwarf and produces 300-400 pods/year.

GKVK3: Plants are dwarf, pods triangular with black mixed green colour, produces 250-300 fruits/plant, suitable for high density planting.

Dhanaraj : It was released by UAS, Dharwad. Dwarf, bears 250-300 fruits/year after two year of planting. Starts yielding from 9-10th month of sowing each pod measuring 35-40 cm in length.

Climate and soil

It is a tropical plant. However, it is found growing in the subtropical climate also. It is predominantly a crop of dry and arid track where it has been found to perform well with higher yields. The optimum temperature is 25-35^{0}C. It is highly susceptible to frost, water logginig & high temperature exceeding 40^{0}C causes flower shedding.

It grows almost all types of soils except stiff clays. However sandy loam soils containing lime is the best suited for its cultivation. The crop is more or less confined to sandy soils as seen in the coastal areas.

Propagation

The perennial types are propagated by limb cuttings. Limb cutting of 1-1.5m length and 15-16cm circumference obtained from selected trees are planted in situ during June-October in TamilNadu. Annual types are propagated by seeds. Planting dwarf types 500 g seeds and 928 number of limbs, whereas for tall types, 100g of seeds and 392 limbs/ha are required.

Planting

The limb cuttings are planted in well prepared pits of 60 x 60 x 60 cm at spacing of five metres for perennial types. For annual types pits 45 x 45 x 45cm are dug with 2.0 x 2.5m or 3.25 spacing. The pits are filled with a mixture of top soil and 120 kg FYM. Seeds can be either sown *in situ* in the prepared pits or can be transplanted after raising the seedlings in PE bags. The PE bags may be size of 15 cm length and 4 cm width. The seedlings are ready for planting in one month after sowing .An additional numbers of 75 to 100 plants are to be raised in PE bags separately for gap filling after one month of planting.

Manuring

Add 25 tonnes of FYM per hectare. A fertilizer dose of 45:15:30 g of NPK/pit may be applied 3 months after sowing. Apply 45 g of N/pit after 6 months when the crop is in bearing. For ratoon crops above schedule with FYM is recommended.

After care

When the seedling reach 75 cm height, the shoot tips are nipped off to encourage side shoots.The plants which are exposed to heavy winds, slender branches are liable to be damaged and break easily at the joints, especially when fully loaded with fruits .In such situations, mounds are to be formed around the tree trunks up to height of 30-45 cm from the ground level. In young plantation inter crops like cowpea or bhendi or ground nut can be cultivated till the moringa plants become dense and cover the interspace.

Irrigation

Generally drumstick does not require much irrigation and it is a drought tolerant crop. Irrigation is given in the pits before sowing and on the third day after sowing .Care should be taken to avoid moisture stress till the germination. Later on, irrigation is done once in 10 to 15 days according to soil type. There should not be any water stagnation. There will be flower drop when the soil is dry or wet. Hence optimum moisture should be maintained.

Harvesting and yield

The annual drumstick types come to harvest in six months after sowing while the perennials types propagated through limb cuttings take 8-9 months for bearing. Fruits of sufficient edible maturity are harvested. The fruits are ready for harvest in 60 days after flowering. The period of harvest extends for 2-3 months and each plant bears 200-250 fruits

in annual types. In perennial types, the yield will be generally low (80-90 fruits/plant/year) in the first two year of bearing. Then it increases to about 500-600fruits/plant/year in 4^{th} and 5^{th} year and the pods are harvested mainly in march-June. A second crop can be harvested in September to October. The ratooned crops will develop new shoots and will start bearing after six months. At each and every ratoon the plants are to be supplied with manures and fertilizers. The trees of perennial types are retained for about 12-15 years.

Questionnaire

I. Encircle the most appropriate answer.

1. The name of the crop derives from the shape of pod resembling the slender and curved stick used for beating the drum.

a. Drumstick, b. Curry leaf, c. Wined bean. d. None of above.

2. Cinavakacherri Murunga, Puna murangai and PKM-1 are varieties of.

a. Curry leaf, b. Basella, c. Broad bean, d. Drumstick.

3. Drumstick belongs to the family.

a. Emphorbiaceae, b. Araceae, c. Moringaceae, d. Fabaceae.

4. Scientific name of Moringa is

a. Moringa oleifere, b. Murraya koenigin, c. Monihot esinlenta, d. None of above

5. Drumstick is indigenous to.

a. America, b. Asia, c. India, d. Brazil.

6. Drumstick is commercially grown in.

a. Karnataka, b. Maharashtra, c. Tamilnadu, d. Bihar.

7. Seeds of Moringa contains ---------- % of non drying oil.

a. 10-15, b.15-20, c.20-30, d. 35-40.

8. Perennial drumstick types are propagated by.

a. Seeds, b. Tubers, c. Root cuttings, d. Limb cuttings.

9. Annual types of Moringa propagated through.

a. Seeds, b. Stem cuttings, c. Root cuttings, d. Limb cuttings.

10. Dhanaraj is variety of.

a. Curry leaf, b. Moringa, c. Bhendi, d. French bean.

II. Say true or false

1. Moringa seeds contain oil called Ben or Behan oil.

Ans: True

2. The Fruits, Leaves and Flowersof Moringa are used in culinary preparation.

Ans: True .

3. The roots of drumstick are used for seasoning Pickles.

Ans: True

4. The oil of Moringa is a water coagulant and used for purifying effluent water.

Ans: False.

5. PKM-1 & PKM-2varieties of drumstick released at Kerala Agricultural University.

Ans:.False.

6. GKVK-1 variety of drumstick developed byUAS, Dharwar.

Ans.False.

7. The optimum temperature is 20^0c prefers for growth and development of drumstick.

Ans. False

8. The annual drumstick types come to harvest 4 months after sowing.

Ans. False

9 .High temperature exceeding30 ^{0}c causes flower shedding in drumstick.

Ans. False

10. The average yield of annual type of drumstick is 400 fruits / plant.

Ans. False

Lecture 18. Origin, area, production, economic importance, description of varieties and hybrids, climate, soil requirement, seed rate and preparation field, sowing, spacing, irrigation, growth regulators, nutrition and weed management, harvest, post harvest handling, storage, marketing and seed production of cowpea

- Economic importance:
- Description of popular varieties/hybrids
- Soil and climate
- Season
- Cropping system
- Land preparation
- Seed rate
- Spacing
- Nutrition
- Irrigation
- Weed control
- Growth substances
- Harvesting and yield
- Marketing
- Storage
- Seed production

COWPEA

Botanical name **:** *Vigna uniguiculata* L. Walp. or *Vigna sinensis*

Family **:** Fabaceae

Chromosome number **:** 2n =22,24

Origin **:** Africa

Economic importance:

Cowpea is grown both for its tender pods and also for its dry seeds used as pulse for culinary purposes. The pods are rich in protein, vitamin and minerals. It is also used as a

fodder and green manure crop. On dry weight basis the cowpea grains contain 23.4 % protein, 1.8 % fat and 60.3 % carbohydrates.

Description of popular varieties/hybrids:

Pusa Phalguni: IARI, dwarf, bushy, mature in 60 days. Suitable for February-March sowing, yields 5-10t/ha.

Pusa Phalguni

Pusa Barasati

Pusa Barasati: IARI, suitable for kharif season, viny plant habit and comes to harvest in 45 days after sowing, yield about 9-9.5t/ha.

Pusa Dofasli: IARI, it is cross between Pusa Phalguni X Philipine selections. Photo insensitive, bushy cultivar and suitable for both summer and rainy seasons. The crop comes to harvest in 55-60 days and yields about 7.5-8t/ha.

Pusa Komal: It is selected through pure line selection. Photo insensitive, indeterminate, bushy cultivars. Pods are light green, 25-30cm long. It flowers in 40-45 days. Resistant to bacterial blight, comes to harvest in 60 days and produces 10t/ha of green pods.

Pusa Komal

Arka Garima

Pusa Rituraj: The variety can be grown in summer as well as kharif due to it's highly photo thermo insensitive nature, bushy type. Pods are 22-24cm long, thin and palatable. Dual purpose variety. Seeds brown. The harvest starts from 45-50 days. Average yield is 8-9t/ha green pods.

Arka Garima Derivative of the cross T.U.V.762 x V.uniquiculata sub sp.sesquipedalis Developed by back cross and pure line selection. Plants tall, vigerous, bushy, with small vines and photo insensitive. Leaf colour light green.Flower colour purple. Pods light green, long, thick, round, fleshy and string less. Suitable for vegetable purpose. Tolerant to heat, drought and low moisture stress. Duration 90 days. Pod Yield 18 t/ha.

Arka Suman and **Arka Samrudhi**: Bushy, photo-insensitive, pods medium long, medium thick, yield 15t/ha. Early variety (70-75 days).

Selection 263: Bush, photo-sensitive, yield 19t/ha

Narendra Lobia-1: Pusa Komal X Varanasi local. Determinate and photo-insensitive, green pods, 28-32cm long. Seeds bold with black hilum. Yields 9.0 t/ha.

Soil and climate:

It can be grown almost in all types of soils with pH 5.5 to 6.5. It is a warm season crop and thrives best between 21 and 35^0C. It cannot withstand frost, heavy rainfall and waterlogging. It is a drought hardy plant comes up well under rainfed condition.

Season:

Generally two crops are grown starting from January-February and May-June. But in places having mild climate, where summer and winter are moderate, it can be grown round the year.

Cropping system:

It fits well in sequential and intercropping systems. It is grown as a catch crop after the first crop of paddy or after the late winter crop. It fits well as an intercrop with widely spaced vegetables and it is grown as a cover crop in basins in fruit orchards.

Land preparation:

The soil should be ploughed, clods are broken and weeds are removed and brought to fine tilth.

Seed rate:

20-25 kg/ha for summer crop and 12-15 kg/ha for winter season crop. Seeds are inoculated with *Rhizobium* species. It helps in the fixation of atmospheric nitrogen.

Spacing:

The seeds are dibbled in rows 45-60 cm and plant to plant distance of 10-15cm.

Nutrition:

Although cowpea is a legume crop, it responds well to the application of fertilizers. About 25 tonnes of FYM is applied at the time of final preparation of land. Application of 25 kg N, 75 kg P_2O_5 and 60kg K_2O/ha is recommended. Half of the N along with entire dose of P and K should be applied at the time of sowing Remaining half of N should be applied at the time of earthing up after 3^{rd} week of sowing. Spraying micronutrients shall improve the quality besides increasing yield.

Irrigation:

Cowpea is a hardy crop comes up well under rainfed condition. Flowering and pod development periods are the critical stages. Depending on the atmospheric conditions 2 or 3 protective irrigations may have to be given. For higher yields the crop should be irrigated regularly at 5-7 days interval. Hardening during pre flowering for avoiding excess vegetative growth and will induce early flowering

Weed control:

Effective control of weeds in the first 20-25 days of the crop season is essential. Atleast 2 weedings or hoeing required to check the weeds. Pre sowing application of Fluchloralin @ 2l/ha is recommended.

Growth substances:

Spraying of maleic hydrazide at 50-200 ppm just before flowering increases the pod yield. Spraying of NAA 15 ppm induces fruit set.

Harvesting and yield:

Tender pods are harvested for marketing. Harvesting starts from 45-60 days and should be done at short interval before the pods become fibrous and unfit for marketing. Marketable pods are available continue up to 100 days in flushes. It produces about 5-10 t/ha green pods. Yard long beans varieties give 15-18t/ha. the yield of dry seed is 1.2 -1.5 t/ha.

Marketing:

After harvest, the pod should be kept in shade and all diseased and damaged ones should be removed. Washing can also be done if they are covered with dust. The pods are filled in baskets and sent to the market in the morning.

Storage:

Room temperature pods can be stored for 2-3 days at 0^0C with 85-90 % RH. Pods can be stored for 15-20 days.

Seed production:

It is a self pollinated crop and requires 50 and 250 metres. Isolation distance for Foundation seed and Certified seed respectively. The crop should be inspected thrice during the crop period. First, before flowering second at the time of flowering and finally at the time of pod ripening. Dried pods are plucked from time to time from the plant, these are dried and seeds taken out by beating with stick or on large scale by tractor.

QUESTIONS:

I. Encircle the most appropriate answer:

1. The protein content in cowpea seeds varies---------- per

a. 10-15, b.15-20, c.30-40, d.23-28.

2. The origin place of cowpea is.

a. North America, b. Central Africa, c. North Africa, d. South Africa.

3. Pusa Rituraj variety of cowpea can be grown in.

a. Summer season only, b. Winter season only, c. Raining season only, d. Summer, winter and raining seasons.

4. Kashi Gauri and kashi shyamal are varieties of.

a. French bean, b. Indian bean, c. Cowpea, d. Jack bean.

5. Basic chromosome number in cowpea is.....

a. 14, b.18, c.16, d.20.

6. ---------- variety of cowpea is a cross of pusa palguni and Philippines selection.

a. Pusa Dophasali, b. Pant anupma, c. Kashi gauri, d. Kasha shymal.

7. Philippines early is a variety of.

a. Cowpea, b. Indian bean, c. Pea, d. Jack bean.

8. Cowpea is ready for harvesting after------- days of sowing.

a. 70-80, b.40-50, c.60-70, d.120-130.

9.---------- is chemically mutant male sterile line of cowpea.

a. IIHR 61B, b. Steppe 287, c. Pant anupama, d. Kashi Gauri.

10. The presence of anti nutritional factors such as hydrate, oligosaccharides and protease inhibitors has been reported in dry seeds of.

a. French bean, b. Pea, c. Broad bean, d. Cowpea.

II. say true or false

1. Cowpea is a winter season crop.

   Ans: False..

2. Cowpea pods, when they are not picked at the right stage, they become Puffy

   Ans: True.

3. On dry weight basis the cowpea grains contain 13.4 % protein,

Ans: False.

4. Pusa Dofasli is cross between Pusa Phalguni X Philipine selections.

   Ans:True.

5. Pusa Rituraj can be grown in summer as well as kharif due to it's highly photo thermo insensitive nature.

   Ans:True..

6. Arka Garima is a bushy, tall, stringless and pole type variety.

   Ans:True..

7. The seed rate for cowpea is10 kg/hectare

   Ans:False.

8. Arka Suman & Arka Samrudhi are photo sensitive varieties evolved at IIHR, Bangalore.

   Ans False.

9. The seeds of cowpea are dibbled in rows at 45 cm apart.

   Ans: False.

10. For higher yield the crop should be irrigated regularly at 15 days interval.

    Ans:False.

Lecture 19. Origin, area, production, economic importance, description of varieties and hybrids, climate, soil requirement, seed rate and preparation of field, sowing, spacing, irrigation, growth regulators, nutrition and weed management, harvest, post harvest handling, storage and seed production of cluster bean

- Economic importance:
- Description of popular varieties/hybrids
- Climate and Soil
- Season
- Cropping system
- Land preparation
- Seed rate
- Sowing
- Spacing
- Nutrition
- Irrigation
- Weed control
- Harvesting and yield
- Seed production

CLUSTER BEAN

Scientific name : *Cyamopsis tetragonoloba*
Family : Fabaceae
Common Name : Guar
Chromosome number : 2n = 14
Origin : India

Economic importance

It is grown for green pods used as vegetable and dry seeds. It is also grown as forage and green manure crop. Some of the varieties are used for extraction of gum (Guar gum). It is one of the most important vegetable crops in northern India. Among leguminous crops it is comparatively more drought resistant and is cultivated on a large scale as a forage crop in dry regions. The gum obtained from this crop is used in various industries particularly textiles,

cosmetics, explosives, paper and food processing industries. Today it is one of the significant foreign exchange earners of the country. Fresh pods contain 82.5% water, 9.9% carbohydrate, 3.7% protein, 0.2% fat, 2.3% fiber and 1.4% mineral matter.

Description of popular varieties/hybrids

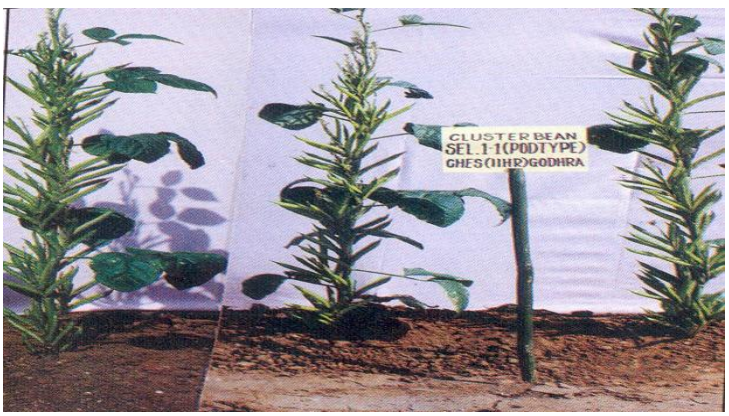
Pusa Mausami: It is a selection from local cultivar of north India. Plants have densely branching habit. Pods are smooth, bright green and 10-13 cm long. It comes for first picking in 80 days after sowing. Suitable for sowing only in rainy season.

Pusa Sadabahar: It is a selection from a local cultivar Jaipuri of Rajasthan. It is non branching type suitable for both rainy and summer seasons. First picking starts 40-50 days after sowing.

Pusa Naubahar: Developed by cross between Pusa Mausami and Pusa Sadabahar. It combines the good traits of both the above cultivars. Pods are longer (15cm) and of better quality. Susceptible to bacterial blight and lodging.

Sharad Bahar: It is evolved on the basis of single plant selection from IC11704. It is branching type producing 12-14 branches.

Pardeshi: Produces long pubescent pods about 12-15cm long. Mostly grown in Gujarat.



Goma manjari

Goma manjari Resistant to Powdery mildew, Bacterial blight and Leaf spot

NBPGR identified the following cultivars:

P28-1-1: It is developed from cross between Pusa Naubahar and IC11521. It is photoinsensitive, high branching can be grown both summer and rainy season. Yield 140-150q/ha.

Climate and Soil

Cluster bean is a drought resistant crop and can be grown successfully in areas where average rainfall is 30-40 cm. It is cultivated mostly as rainfed and warm season crop in semi-arid zones of northern India. It is a warm season crop, grows well in summer and rainy seasons. It cannot withstand water logging condition. It is photosensitive crop and comes into flowering and fruiting when sown in kharif season only.

All types of soils are suitable for growing cluster bean, however, well drained sandy loams are best suited with pH range from 7 to 8.0.

Season: June-July and Feb-March, in some areas it is grown during September-October

Cropping system: It is grown as a sole crop, mixed crop and border crop around the main crop. However it cannot tolerate shade.

Land preparation: 2-3 ploughings, clods should be broken and bring the soil to fine tilth

Seed rate: 25-30 kg/ha seeds are required for one hectare of area. Seed inoculation with rhizobium helps in nodulation and nitrogen fixation.

Sowing: Seeds are dibbled in row or drilled behind the plough sometimes broadcasting is also followed.

Spacing: 45cm X 15-20cm

Nutrition

25tonnes of FYM is applied to the soil at the time of final preparation. Application of 25:75:60 kg of NPK is recommended. Half of N along with entire dose of P and K fertilizer should be applied at the time of sowing in bands about 7-8 cm to the side of the seed.

Irrigation

Cluster bean is a hardy crop that comes up well under rainfed conditions. Flowering and pod development periods are the critical stages. For higher yield the crop should be irrigated regularly at 7-10 days interval.

Weed control

One or two weedings are essential for kharif season crop. Weedicides can be used to suppress the weeds. At the later stages of crop growth, weeds are kept under check due to the thick canopy of the crop.

Harvesting and Yield

Green pods will be ready for harvest at 45 days after sowing. Dry seeds are harvested when a large percentage of pods are full and most of the remaining will turn yellow. Yield is about 3-4t/ha of green pods.

Seed production

It is self pollinated crop and only 25-50 metre isolation distance is required for foundation and certified seeds. The crop should be inspected thrice during its growing period. When 60-70% pods change their colour from green to light brown, the crop should be harvested and kept on the floor for 8 to 10 days for drying. Later on threshing can be done by sticks or by tractor.

Questionnaire

I. ENCIRCLE THE MOST APPROPRIATE ANSWER

1. Cluster bean contains a mucilaginous substance known as

a. Galactomanon b. Manon c. Safforin d. None of the above

2. ---------- is also known as guar

a. Rice bean b. Cluster bean c. French bean d. Broad bean

3. The guar meal (Dry seeds) contains about ---------- per cent protein

a. 20 b. 10 c. 15 d. 33.3

4. Cluster bean seeds may be sown at a spacing of ----------cm

a. 45x45 b. 30x20 c. 60x90 d. 45x15

5. ---------- is the most serious disease of cluster bean

a. Fusarium wilt b. Bacterial wilt c. Leaf spot d. Rust

6. To sow one hectare area, about ----------kg seeds of cluster bean are required

a. 10-20 b. 25-30 c. 30-40 d. 40-50

7. Cluster bean plant required ----------conditions for induction of flowering

a. Long day b. Short day c. Day neutral d. Both a and b

8. Cluster bean originated from

a. America b. Europe c. Asia d. Africa

9. ---------- is botanically known as *Cyamopsis tetragonolobus* L.

a. French bean b. cluster bean c. Pea d. Broad bean

10. In ----------, cluster bean is grown throughout the year.

a. North India b. Western India c. South India d. Central India

11. Pusa Mausami, Pusa Sadabahar, Pusa Navbahar and Sharad Bahar are varieties of

a. French bean b. Cow pea c. Cluster bean d. Winged bean.

II. Say true or false.

1. Cluster bean is grown for during rainy season.

Ans: False

2. The diploid chromosome number of cluster bean is 22

Ans: False

3. Cluster bean is drought tolerant crop

Ans: true

4. The seed rate for cluster bean is 10-15 kg/ha

Ans: False

5. The bacteria rhizobium helps in quick nodulation on the roots.

Ans: True

6. Green pods of cluster bean ready for harvest 90 days after sowing

Ans: False

7. About8-10tons of green pods are expected from a hectare

Ans: False

8. Cluster bean is sown as an early crop in February – March months

Ans: True

9. Application of 50, 60, 60 kg NPK Per hectare is recommended in cluster bean.

Ans: True.

10. For higher yield of cluster bean, the crop should be irrigated regularly at 15 days interval

Ans: False

11. About 10 tons of green pods are expected from a hectare crop of cluster bean

Ans: 3-4

Lecture 20. Origin, area, production, economic importance, description of varieties and hybrids, climate, soil requirement, seed rate and preparation of field, sowing, spacing, irrigation, nutrition and weed management, harvest, post harvest handling, storage and seed production of Dolichos bean

- Economic importance:
- Area and production
- Description of popular varieties/hybrids
- Soil and climate
- Season
- Seed rate and seed inoculum
- Land preparation
- Sowing
- Nutrition
- Irrigation
- Weed control
- Harvesting and yield
- Storage
- Seed production

DOLICHOS BEAN

Botanical name	**:** *Dolichos lablab* or *Lablab typicus*
Family	**:** Fabaceae
Chromosome No.	**:** 20, 22
Origin	**:** India
Common name	**:** Indian bean, Hyacinth bean

Economic importance

It is grown for whole pod. Fresh seeds and dry seeds are used as pulse grain. It is used for pod, feed and green manure. It is very popular in villages as well as cities where less area is available for cultivation. Its fresh green pods contain 86% moisture, 3.8% protein, 6.7%,

CHO, 0.7% fat, 0.9% mineral matter, Vitamin A 312 IU. It is good source of Vitamin B and C also.

Area and production

In India, it is grown all over the country but compact large acreage for commercial production is uncommon.

Description of popular varieties/hybrids

Pusa Early Prolific (IARI): It is a pole type bean, suitable for autumn and spring season. It is an early variety, bears long, thin pods.

Blue Lake: It is an early variety. The colour of the seed is brown length of the pod is 6 to 8 cm. it becomes ready for harvesting 70-80 days after sowing.

Arka Amogh: Plants are medium tall, 50 % flowering in 40 days and pods are ready for harvest in 55 days. Pods are similar to Arka Jay and Konkan Bhushan. Yield: 19-20 t/ha.

Arka Jay: Developed through back cross and pedigree selection involving the Parents Hebbal Avare x IIHR 93. Plants dwarf, bushy, erect and photo insensitive. Flowers purple. Pods long, light green slightly curved, Without parchment. Vegetable type with excellent cooking qualities. Tolerant to low moisture stress. Duration 75 days. Pod Yield 12 t/ha.

Arka Sambhram: Plants are medium height, 50 % flowering in 40 days and pods are ready for harvest in 55 days. Pods are flat, light green, medium long (13-15 cm), medium width (1.5 cm). Yield: 19-20 t/ha

Arka Vijay: Developed through back cross and pedigree selection involving the Parents Hebbal Avare x IIHR 93. Plants dwarf, bushy, erect and photo insensitive. Leaves dark green, Flowers white. Pods short dark green. Seeds bold. Pods with characteristic aroma, without parchment. Vegetable type with excellent cooking qualities. Tolerant to low moisture stress. Duration 75 days. Pod Yield 12 t/ha.

Arka Soumya : Plants are medium tall, 50 % flowering in 45 days and pods are ready for harvest in 55 days. Pods are slender (1.0 cm width), medium long (13-15 cm). Yield: 19 t/ha

Arka Sambhram: Plants are medium height, 50 % flowering in 40 days and pods are ready for harvest in 55 days. Pods are flat, light green, medium long (13-15 cm), medium width (1.5 cm). Yield: 19-20 t/ha

Hebbal Avare-3: Developed at UAS, Bangalore. It takes 70-75 days to harvest and grown in all seasons throughout the year. Flowers are Photo-insensitive. Seeds are brown, round and short duration (100 days)

Co-3: It is a pure line selection from Yanaikathu Avare

Co-4: It is a pure line selection from Shivappu Avare

Co-5: It is a pure line selection from local type Kozhikkal avare

Characters: All are one pole type, photo- insensitive, pods are light green to deep purple. Yield about 8-11t/ha in 210-220 days.

Deepaliwal and Dasarawal: Released from PRKV, Akola, Maharashtra. Pole types beans, pods are extra long, whitish in colour in Deepaliwal whereas purple green in Dasarwal yields about 6-8t/ha in 200-210 days.

Pusa Sem-2 and Pusa Sem-3: Released from IARI,New Delhi. Pole type, pods are borne on separate spike in bunches above the plant canopy. Pods are dark green, tender, stringless, fleshy and borne in clusters of 11-13 members. Highly tolerant to anthracnose, YVMV, aphids, jassids, pod borers and frost. Yields about 13.7t/ha.

Konkan Bushan: Released from KVK, Dapoli, Maharashtra. Bush type, pods are tabular and green in colour, photo insensitive, yields 6-8t/ha in 100-110 days.

CO-13: It is a bush type, hybrid derivative of CO-9 (bush type) x Florika field. Photo insensitive, flowers white with long green pods, yields 10t/ha.

CO-2: Photosensitive. The pods are deep purple throughout, septate and fleshy.Yields 135 t/ha in 215-220 days.

Soil and Climate

It is relatively a warm season crop. Some strains are highly drought resistant. The best temperature for its seed germination is 18^0C to 27^0C. It can be grown in almost all types of soils. Sandy loam, silt loam and clay loam are best suited.

Season

Best time for sowing is June-July and February-March.

Seed rate and seed inoculum

Seed rate for dolichos bean is 40-50 kg/ha. Seeds treat with rhizobium helps in quick nodulation on the roots, which fix atmospheric nitrogen.

Land preparation

The soil is brought to fine tilth after a shallow cultivation. After the final preparation of the land the field should be divided into convenient size.

S**owing**

Seeds are sown in rows 1-1.5 m apart. It is dibbled or drilled behind the ploughed at a distance of 10-15cm. It climbs on the roof tops.

Nutrition

Although dolichos bean is a legume crop it responds well to the application of fertilizers, about 25t of FYM is applied to the soil at the time of final preparation of land. Application of 25 kg of N, 50 kg of P and 25 kg of K per hectare is recommended. Half of the N alone with the entire dose of P and K should be applied at the time of sowing. Remaining half dose of N should be top dressed 30 days after sowing.

Irrigation

It is a hardy crop comes up well under rainfed conditions. Flowering and pod development period are the critical stages. Depending on the atmospheric conditions 2 to 3 protective irrigations are needed. For higher yields the crop should be irrigated regularly at 7-10 days interval.

Weed control

Shallow cultivation during the early stages of crop is necessary to check the weeds and to facilitate earthing up. A pre sowing application of Fluchloralin @2lit/ha checks the weed growth for 20-25 days. At the later stages of crop growth, the weeds are kept under check due to the thick canopy of the crop.

Harvesting and yield

In bush variety the crop is ready for harvest at two months after sowing and in pole types it takes 3 months for first harvest. Fully grown pods are harvested. Interval between two pickings is about 15-20 days. It produces an average yield of 60-80q/ha of green pods.

Storage

Best storage temperature is 4.5^0C to 7.0^0C, RH 65-70%. Fresh pods can be kept for about 15 to 20 days in cold storage. Dry seeds can be kept for 2-3 years at room temperature under dry conditions.

Seed production

It is a self pollinated crop and requires only 25m isolation distance between 2 varieties. Three rouging should be done, before flowering, at the time of flowering and at the time of maturity. Completely matured and dried pods are harvested and seeds are extracted by threshing. Seeds should be dried completely and put in cloth bags or in tin containers at cool and dry conditions.

QUESTIONS:

I. Encircle the most appropriate answer:

1. The protein content in dolichos green pods contain---------- per cent

a. 2.5, b.3.8, c.5.5, d.6.5.

2. The origin place of dolichos is.

a. North America, b. India, c. North Africa, d. South Africa.

3. Indian bean belongs to family

a. Fabaceae, b. Compositae, c. Solanaceae, d. None of the above

4. Pusa Early Prolific and Blue Lake are varieties of.

a. French bean, b. Indian bean, c. Cowpea, d. Jack bean.

5. Basic chromosome number in dolichos is.....

a. 14, b.18, c.16, d.20.

6. ---------- variety of dolichos is a cross of Hebbal Avarae and Pusa Early Prolific.

a. Arka Vijay , b.Deepaliwal, c. Dasarawal, d. Pusa sem-2.

7. Konkan Bushan is a variety of.

a. Cowpea, b. Indian bean, c. Pea, d. Jack bean.

8. Indian bean is ready for harvesting after-------months of sowing.

a. 2, b.3, c.4, d. None of these.

9. Indian bean is _____ pollinated crop

a. Cross b. self _____ c. Often cross, d. None of these.

10. Seed rate for dolichos bean is _____kg /ha.

a. 10-20, b. 20-30, c. 30-40, d. 40-50.

II. Say true or false

1. Hyacinth bean is a: Warm/summer season crop.

   Ans.True

1. Indian bean is rich in Protein content.

   Ans: True

2. CO-4 is pure line selection from : Shivappu Avarae.

Ans. True

3. CO-2 yields10 tons/ha.
   Ans :False

4. Ideal spacing for cultivation of dolichos is 45cm apart
   Ans: False.

5. Isolation distance between two varieties is 50 meters
   Ans: False.
6. Arka Vijay is a cross between Hebbal Avare-3 X Pusa early prolific.
   Ans: True
7. Hebbal Avare-3 Developed at UAS, Bangalore.
   Ans: True.
8. CO-13 is a bush type, hybrid derivative of CO-9 (bush type) x Florika field.
   Ans: True.

Lecture 21. Origin, area, production, economic importance, description of varieties and hybrids, climate, soil requirement, propagation and preparation of field, planting, spacing, irrigation, growth regulators, nutrition and weed management, harvest, post harvest handling, storage, marketing and seed production of French Bean/snap bean

- Economic importance:
- Description of popular varieties/hybrids
- Climate and soil
- Season
- Cropping system
- Land preparation
- Seed rate
- Sowing
- Nutrition
- Irrigation
- Weed control
- Staking
- Use of growth regulators
- Harvesting and yield
- Maturity standards
- Marketing
- Storage
- Seed production

FRENCH BEAN

Botanical name **:** *Phaseolus vulgaris*

Family **:** Fabaceae

Chromosome No.: 2n=22

Origin **:** Southern Mexico and Central America

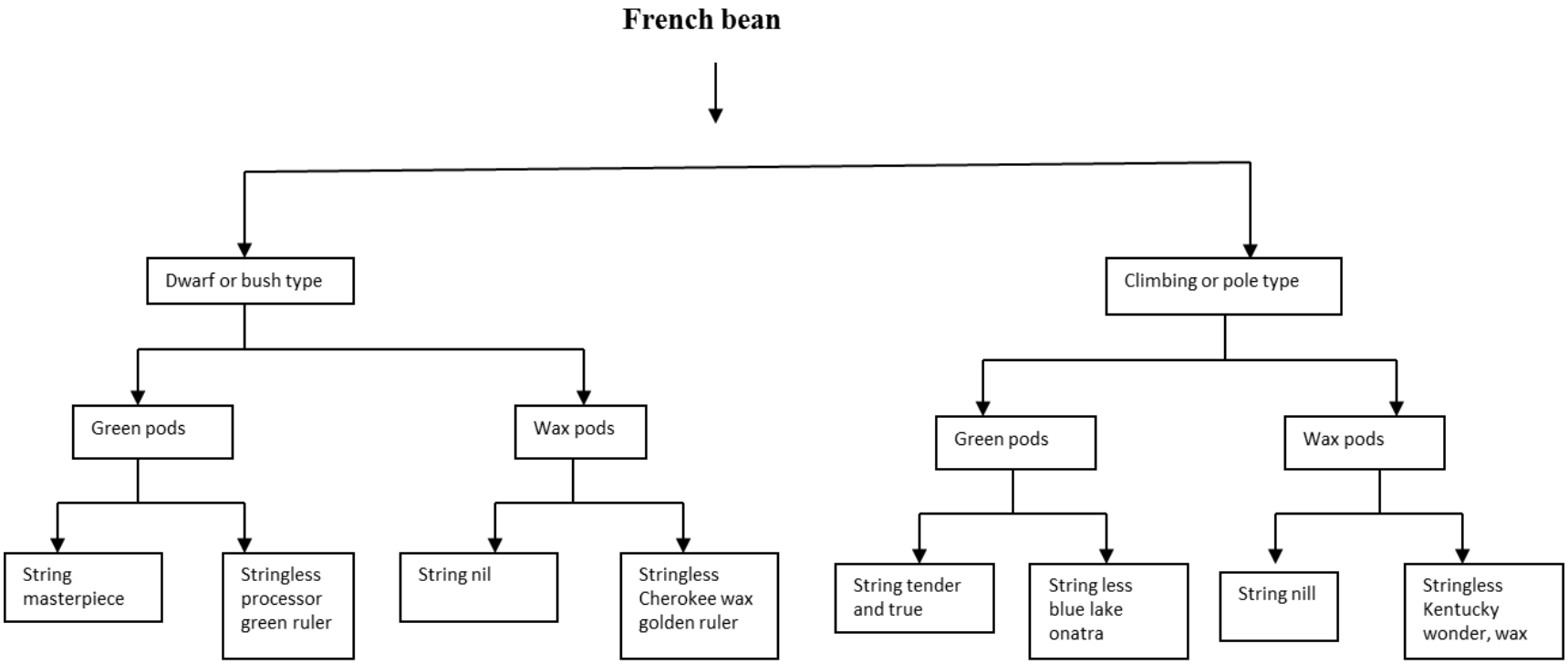
Common name **:**Kidney bean, Haricot bean, Snap bean, Navy bean

Economic importance

It is grown for the tender green beans and dry seeds. The pods are slender, 10-25 cm long, straight or slightly curved with prominent beak. Seeds are kidney shaped, elongated and white, red, purple or blackish in colour or mottled. The vegetable is in great demand in cities and is grown both commercially and in home gardens. Its major area is confined to hills, where it is grown for green pods. Punjab, Jammu and Kashmir, Gujarat, Karnataka, Tamil Nadu, Uttar Pradesh and Himachal Pradesh are the main states where it is being cultivated on large scale. In India, it is grown in area of 4268 hectare with annual production of 24778 tonnes. Dry grains are an excellent source of cheap protein and many varieties contain 22-23% protein. Hundred grams of edible fresh pods contain 91.4% water, 1.7% protein, 0.1% fat, 0.5% mineral matters, 4.5% carbohydrates, 50 mg Ca, 28 mg P and 1.7 mg Fe. Its 100g dry seeds contain 9.6% water, 24.9% protein, 0.8% fat, 3.2% mineral matters, 60.1% carbohydrates, 60 mg Ca, 433 mg P and 2.4mg Fe. In India, it is mostly grown for fresh consumption, while in USA it is grown for processing in large quantities.

Description of popular varieties/hybrids

There are three type of French bean *viz.,* bush type with short internodes, semi-pole type with longer internodes than those in bush type and the pole typed having longer internodes than that of semi pole type. French cultivars are classified into string less type based on the extent of fiber in the pod and into bush type and pole types according to the growth habit.


French bean
Dwarf or bush type
Climbing or pole type
Green pods
Wax pods
Green pods
Wax pods
String masterpiece
Stringless processor green ruler
String nil
Stringless Cherokee wax golden ruler
String tender and true
String less blue lake onatra
String nill
Stringless Kentucky wonder, wax

There are a large number of French bean cultivars. Thompson and Kelly (1957) classified cultivars are as follows:

Snap beans-for vegetable pods

Green shell beans-used in the green shelled condition

Dry shell beans – used in the dry state(Field beans)

Each group is further divided into climbing (Pole) and dwarf types.

Some of the important snap bean cultivars are as follows:

The flat types are bountiful, plentiful, green ruler, golden ruler

The oval types include Pusa Parvati, Contender, Premier, Tender Green, King Green etc.

The pole type include Blue Lake, Kentucky Wonder

Bush type

Contender: It is an introduction from USA. It takes about 50-55 days for first picking. Pods are green round, 13-14 cm long, stringless, yields 8 to 9.5 t/ha. Tolerant to powdery mildew and mosaic.

Premier: Pods 11-13 cm long, ready for harvest in 55-60 days. Less susceptible to wilt and mosaic, average yield 75-90 q/ha.

Pusa Parvathi: Released from IARI, Katrain. It is developed through X-ray irradiation of the American variety 'Wax pod'. Early bearing, stringless, yield 8-8.5t/ha. Resistant to mosaic and powdery mildew.

Arka Komal: A pure line selection from IIHR-60 (Collection from Australia). Plants erect and bushy, Photo insensitive Flat, green straight pods. Seeds light brown, oblong and large. Good transportation and cooking qualities.Seed yield 1500 kg./ha Duration 70 days. Pod Yield 20 t/ha.

Arka Sharath

It has round, string less, smooth pods suitable for steamed beans. Pods are crisp, fleshy with no parchment and perfectly round on cross section. Plants are bushy and photo insensitive and it is suitable for both *kharif* and *rabi* seasons. It gives maximum number of pods per plant (44.5) compared to checks. It has high pod yield potential of 18.5 t/ha in 70 days.

Arka Suvidha: Suitable to grow throughout the year. Early stringless and first picking 70 days after sowing, yield is about 9t/ha.

Arka Bold: Grown throughout the year. Pods are flat 16 cm long, stringless, resistant to rust, ready for picking 70 days after sowing . Yield is about 8t/ha.

Bountiful: Introduction from USA. Pods borne in clusters on the main stem. Average yield is10-12t/ha.

Jampa: It is a Mexican variety. Plants are shy in tillering habit. Early variety, pods are flat, smooth, pale green in colour. The seeds are black, smooth and small in size. Yields around 8-9t/ha. Highly resistant to wilt disease and withstand warmer conditions.

V.L. Bauni Bean 1: It has been developed by Vivekananda Parvathiya Krishi Anusandhanashala (VPKAS), Almora, Uttaranchal. It produces non stringy, long, fleshy green pods. It does well in the hills but suffers badly from mosaic.

Pant Anupama*:* Released from GBPUAT, Pantnagar. It is recommended for hills of Uttaranchal and UP. Prolific bearer, round, straight and green pods, first picking is done at 55-65 days after sowing. Yields 9t/ha. Moderately resistant to mosaic virus and rust.

Pant Bean-2: Released from GPPUAT, Pantnagar. It is cross between Turkish x Brown Contender. Pods are flattish round, non stringy, yields around 9t/ha. Moderately resistant to mosaic and rust.

YCD-1: Released from TNAU, Yercard. Pods slightly flat, seeds bold, attractive, dark purple in colour. It is resistant to root rot, rust, YVMV and anthracnose. Yields 9.5t/ha in 105 days.

Arka Anoop: It is a pedigree selection from the cross Arka Bold x Arka Komal, plants are busy, photo insensitive, long pods (17-18cm), resistance to rust and bacterial bight. Yield is 15t/ha.

Phule Surekha: Developed at MPKV, Rahuri. Suitable for all seasons, pods are 9-10 cm long, resistance to anthracnose, yellow mosaic and wilt. Yield is 15 t/ha.

Pole types:

Kentucky Wonder: It was introduced to India from USA. Plants are tall, creeping or viny habit, pods ready for harvesting 60-65 days, 4-5 pods/cluster, pods long, flattish, stringless, seeds light brown yields 100-125 q/ha.

SVM-1: It is developed through hybridization between *P.vulgaris* var Contender x P. *Multiflorus* var. PBL 257. Pods are green, round, stringless, 13-14cm long, 5-10

seeds/pod. Ready for harvest at 65-75 days after sowing. Average yield is 105-250 q/ha. Recommended for hill area. Resistant to angular leaf spot.

Lakshmi: It is a cross between Contender x Local (Pole) type. Pods formed in clusters of three, 13-14 cm long, stringless, ready for picking in 65-70 days. Average yield is 120-140 q/ha. Tolerant to angular leaf spot.

TKD1: It is a hybrid derivative of a cross between two pole types, *viz.*, Selection and PV118. Green tender pods harvested from 60 days after sowing. Pods are long, flat, low fiber content. Yields 5-6t/ha.

KKL1: It is also known as Moringa bean. Developed at TNAU, Kodaikanal. Best suited for elevation 1800-2400m. It has a potential yield of 7t/ha. Pods or 3t/ha of grains.

Pusa Himlata: Developed at IARI, Katrain. Pods are straight, 14cm long; light green, stringless with white seeds.

Azad Rajmah-1: Developed at CSAUAT, Kanpur. Pods are highly attractive, smooth, stringless. Yields about 7.5-8t/ha.

Climate

French bean requires mild worm weather for good yield. It is a day neutral crop except some few semi-pole varieties which are short day types. It is sensitive to frost and very high temperature. The optimum temperature ranging between 15-25^{0}C. It is also sensitive to high temperature and high RH. The plants shed their blossom or young pods in very hot or rainy weather.

Soil

French bean is grown in variety of soils ranging from light sandy soils to clay soils but it can withstand water logging. The optimum soil pH is between 5.3 and 6.0. High moisture content and high nitrogen caused delay in maturity.

Season

There are two main growing seasons for French bean in the plains of India. The first sowing is done during July-September and May even extended up to September. The second sowing is early spring that is between January to February. In hilly regions seeds are sown on the month of March-May.

Cropping system

Being a leguminous crop, it fits well in any crop rotation. Red kidney varieties are preferred to white seeds in heavy rainfall areas. Such varieties also fit well in crop rotation

with wheat. It can also be grown as an intercrop in widely spread cucurbits till the main crop begins to throw veins.

Land preparation

The soil should be ploughed, clods are broken and weeds are removed and brought to fine tilth by shallow cultivation.

Seed rate

The seed rate varies considerably depending on the variety, soil and climatic conditions. The rate for bush varieties is 60-65 kg/ha while it is 25-30kg/ha for pole varieties. Inoculation of seed with rhizobium species facilitates quick nodulation on the roots, and help in the fixation of atmospheric nitrogen.

Sowing

The seeds of bush beans are sown in rows 30-45 cm apart and 10-15 cm away from seed to seed whereas pole beans are in the spacing's of 60 cm to100 cm between rows and plant to plant 30cm. the depth of the sowing shall be 2 cm. To avoid fungal infection, treat the seed with *Rhizobium phaseoli* @ 30 g/kg of seed.

Nutrition

Before sowing, at the time of ploughing apply FYM @ 25 t/ha. Although French bean is a legume, it responds well to the application of nitrogen. Application of 63kg N, 100 kg P_2O_5 and 75kg K_2O ha is recommended. Half of the N along with entire dose of P and K fertilizer should be applied at the time of sowing. Remaining half of N should be applied at the time of earthing up after 3^{rd} week of sowing. Spraying micronutrients improves the quality besides increasing yield.

Irrigation

Prior to sowing the plots are irrigated and after 2-3 days when the soil is in moist condition seeds are sown along the sides of the ridges. Light irrigation is given after 2^{nd} to 3^{rd} day after sowing. French bean is shallow rooted crop. Water stress has marked influence on yield and quality of pods. About 6-7 irrigations would be required at regular intervals. Depending upon the atmospheric conditions, the amount of irrigation will be decided. The crop should be irrigated at an interval of one week. Excess water reduces nodule formation and ultimately growth of plant.

Weed control

A pre sowing application of fluchloralin @ 2 l/ha checks the weed growth. At least two hand weedings are required before earthing up. Shallow cultivation during the early stages of crop is necessary to check the weeds and to facilitate earthing up. At the later stages of the crop growth, the weeds are kept under check due to the thick canopy of the crop.

Staking

Staking is an important operation for pole beans. The bamboo sticks or other wooden sticks or branches which are locally suitable can be used for the support. If the plants are grown in rows, single stick of about 2m length should be fixed near the plant. If the plants are grown in hills, the twigs and branches will give good support.

Use of growth regulators

Application of growth regulators improves the plant growth, flowering fruit set and pod yield in French bean. Plant regulators like PCPA @ 2ppm, L-naphthly acetamide or B-naphthal acetic acid at 5-25ppm shown favourable effect on fruit set. GA_3 sprayed at 50-200 ppm proved effective in improving the crop growth. Paclobutrazol at 150 ppm can be used for increasing yield and suppressing vegetative growth of pole type varieties of French bean.

Harvesting and yield

The crop is ready for first harvest in about 45 days after sowing. The green pods are to be picked when they are immature and fully grown but still tender. As the harvest is delayed, the total yield increases but the quality falls rapidly due to over maturity of pods, fiber development and rough surface. The yield of tender pods varies from 8-10t/ha in bush varieties and 12-15 tons in pole types.

Maturity standards

The various maturity parameters like seed size, seed percentage, dry matter content and distribution of pods according to sieve size are found to reliable maturity standards.

Marketing

After harvesting, pods kept in shade to avoid evaporating. Over matured, diseased and damaged pods should be sort out. Pods may be packed in baskets/gunny bags and transport it to the market.

Storage

The pods stored for 2-3 days in summer and 4-6 days in winter at room temperature. In cold storage, pods can be stored at 2^0C to 4^0C with 60-70 % RH for about 15-20 days.

Seed production

It is self pollinated crop. Even then an isolation distance of 50 and 25 m should be maintained for Foundation seed and certified seed respectively. First rouging before pod set on the basis of foliage and flower characters, second at the time of pod formation on the basis of pod characters. Completely dried pods are harvested and kept in sunlight for drying. Threshing and cleaning can be done by hand or thresher. The average seed yield is about 15-20q/ha.

Questionnaire

I. Encircle of the appropriate answer:

1._____is also known as kidney bean or snap bean.

a)Pea b)Indian bean c)French bean d)Broad bean

2. Arka Komal and pant Anupama are the varieties of

a) Cowpea b)French bean c)Cluster bean d) Pea

3. Tender crop and cascade are cultivars of _____suited for processing purpose.

a) Indian bean b) French bean c) Cowpea d) Winged bean

4. For best growth and yield of French bean , the optimum temperature should be

a) 25-30^{o} C b) 10-15^{o}C c) 15 -25^{o}C d) 35 -40^{o}C

5. French bean is sown during _____month in south Indian plains.

a) July b) August c) September d) November

6. About _____kg/ha seed is required for cultivation of dwarf bean.

a) 20-30 b) 10-20 c) 40-50 d) 60-65

7._____ application in French bean enhances nodulation in roots.

a) Phosphorous b) Calcium c) Magnesium d) Potassium .

8. The French bean is ready for harvesting in _____ days.

a) 20 b) 30 c) 45 d) 75

9. Basic chromosome number of French bean is

a) 24 b) 22 c) 12 d) 14

10. French bean is said to be a _____ resistant

a) Salinity b) Drought c) Frost d) Cold

II. Say true or false.

1. Among the pole type s of French bean Kentucky Wonderis the most commonly grown variety.

Ans:True.

2.French bean is probably a native of France.

Ans: False.

3. The seed rate of French bean pole varieties are10-150kg/ha.

Ans: False.

4. Contender is an introduced variety from USA.

Ans: True.

5. Pusa Parvathi is developed through X-ray irradiation of the American variety ‘Wax pod’

Ans: True.

6. With respect to day length French bean is long day plant.

Ans: false.

7. Best soil PH for cultivation of French bean is 7.0

Ans: False.

8. Rhizobium facilitates quick nodule formation and nitrogen fixation .

Ans: True.

9. French bean is deep rooted crop.

Ans: False.

10. A pre sowing application of flochloralin checks the weed growth of French bean.

Ans:. True.

Lecture. 22. Introduction to cucurbits. Origin, area, production, economic importance, description of varieties and hybrids, climate, soil requirement, seed rate and preparation of field, sowing, spacing, irrigation, growth regulators, nutrition and weed management, harvest, post harvest handling, storage and marketing of muskmelon

- Introduction to cucurbits
- Uses
- Muskmelon
- Economic importance
- Varieties
- Climate
- Soil
- Season
- Cropping system
- Preparation of field
- Sowing
- Spacing
- Seed treatment
- Training and pruning
- Nutrition
- Irrigation
- Weeding
- Use of growth regulators
- Harvesting and yield
- Maturity standards
- Post harvest management
- Marketing
- Storage

Introduction to cucurbits

Cucurbits are the popular name of the family cucurbitaceae, commonly known as the gourd family. They are widely distributed in the tropics and warm temperate regions of south, southeast and East Asia, Africa including Madagascar, central and south America. The family is represented by about 120 genera and 800 species. Cucurbits are mostly climbers and trailers, are rarely woody and arborescent. They are characterized by inferior ovary and parietal placentation. The most common uses of cucurbits are as vegetables and fruits. They are valuable sources of vitamins and minerals.

Sl No.	Common Name	Scientific name	Chromosome. no
1	Cucumber	*Cucumis sativus*	2n=14
2	Watermelon	*Citrullus lanatus*	2n=22
3	Muskmelon	*Cucumis melo*	2n=24
4	Ridgegourd	*Luffa acutangula*	2n=26
5	Bittergourd	*Momordica charantia*	2n=22
6	Pumpkin	*Cucurbita moschata*	2n=40
7	Gherkin	*Cucumis angaria*	2n=24
8	Bottlegourd	*Lagenaria siceraria*	2n=22
9	Cantaloupe	*Cucumis. melo var cantaloupensis*	2n=24
10	Round melon(Tinda)	*Pracitrullus fistulosus*	2n=22
11	Summer squash	*Cucurbita pepo*	2n=40
12	Winter squash	*Cucurbita maxima*	2n=40
13	Spongegourd	*Luffa cylindrica*	2n=26
14	Pointedgourd	*Trichosanthes dioica*	2n=22
15	Snakegourd	*Trichosanthes cucumerina*	2n=22
16	Waxgourd	*Benincasa hispida*	2n=24
17	Ivygourd	*Coccinia grandis*	2n=24
18	Chow Chow	*Sechium edule*	2n=28

River bed cultivation of a number of cucurbits is economical. The river beds of big rivers used for cucurbit cultivars are: Ganga, Yamuna, Saraswati, Narmada, Sutlej, Krishna,

Kaveri, Godavari, Mahanadhi, Sabarmati, Bramhaputra etc. Cucurbits are popular because they are easy to grow. They do not require high inputs. They can be grown on even soils of marginal fertility. They are useful to prevent soil erosion.

Uses:

1. Vegetable: Bitter Gourd, Ridge Gourd and Sponge Gourd, Round Gourd, Pointed Gourd and Pumpkin are used as vegetables. Immature fruits of Musk melon are also cooked as vegetable only in some areas.
2. Salad: Excellent salad is made from Cucumber and Little Gourd
3. Table Purpose: Muskmelon, Water melon, Cucumber.
4. Pickle: Cucumber, Little gourd and Bitter Gourd are used for making pickle.

Muskmelon

Botanical Name	**:** *Cucumis melo* L.
Family	**:** Cucurbitaceae
Chromosome No.	**:** 2n=24
Origin	**:** Tropical Africa
Common name	**:** Kharbuza

Economic importance and uses

Musk Melon is valued as a summer fruit. It is stated to have a cooling effect on the body system. Further, it is a demulscent, diuretic and aphrodisiac. It is applied as a lotion in several skin conditions. The roots have emetic and purgative properties. Mature fruits of muskmelon are round in shape and 8-16 cm in diameter. Nevertheless some oblong, flat and oval fruit shaped varieties are also available. Immature fruits are used as vegetable and seeds are edible.

The fruits of *C. angaria*(West Indian gherkin) is mostly used in pickles and also as a cooked vegetable. There is another form called snap melon (*Cucumis melo var. momordica*) found throughout India.It is consumed at full ripened stage.The flesh is crispy and sour in taste. There is a tremendous intra specific variability in *C. melo.* Some botanical varieties are widely grown in certain regions for the purpose of fresh salad or

for pickling. These include *C. melo var. utilissimus* (Long or serpent melon). This is very popular in Indo-gangetic plains as a summer salad.

River beds of India it is commonly grown and it occupies an area of 28484 ha with annual production of 625414 tonnes having the average productivity of 21.95 t/ha.

The fruits are sweet and musky in flavour and are relished by millions. The fruits contain 0.6% protein, 0.2% fat, 3.5% CHOs, 32 mg Ca, 14 mg phosphorous, 1.4 mg iron, 16mg carotene and 26 mg Vitamin C per 100 g fresh weight of the fruit.

There is no proper survey of the foreign markets taken up about the quality requirements and surpluses that the country is exporting. Further no new market has been explored. There is a need to have research and development activities of export oriented types in each crop. In 1997-98 the melons are exported in quanity of 3593 mt which is valued at Rs.160 lakhs. The fruits exported should have good keeping quality.

Varieties

Muskmelon is a polymorphic taxon, encompassing a large number of botanical and horticultural groups. It includes both dessert as well as cooking and salad types like cucumber. African botanists (Nandin, 1859) divided this species into several botanical varieties adopting a trinomial classification. These includes

Cucumis melo var. agrestis.
Cucumis melo var. cultura.
Cucumis melo var. reticulatus (netted melons).
Cucumis melo var. cantalupensis (cantaloupe melons)
Cucumis melo var. inodorus (winter melons & cresn Shaw).
Cucumis melo var. flexuosus (snake or serpent or long melon).
Cucumis melo var. chito (mango melon or lemon melon).
Cucumis melo var. momordica (snap melon).
*Cucumis melo var. conomom (*oriental pickling melon).

Several varieties have been bred in India and released for commercial cultivation. Important characteristics of these varieties are described below.

Pusa Sharbati: An early cultivar maturing in 85 days, leaves 5 lobed, green, pubescence and medium long petiole. Salmon orange flesh is firm and thick with small seed cavity, moderately sweet (11-12% TSS). It is a derivative from the cross Kutana X PMR-6 of USA.

Pusa Madhuras: It is a selection from a Rajasthan collection with roundish flat fruits weighing a kg or slightly more. Vigorous vines, leaves entire green pubescent with large petioles. Salmon-orange flesh, juicy and sweet (12-14% TSS) and poor keeping quality. The average yield is 12-16 t/ha. Suitable for growing in northern India.

Pusa Rasraj (F_1): It is F_1 hybrid (Monoecions 3x Durgapura Madhu) developed and released by IARI. It has been recommended for commercial cultivation in Delhi, U.P, Punjab, and Haryana & Bihar. Average fruit weight is 1-1.2 kg; high yielding (25t/ha) producing sweet (11-12% TSS), take 75-80 days for first harvest. Suitable for both garden land river bed cultivation.

Hara Madhu: It is released by PAU, Ludhiana. It is a late cultivar developed from a local collection of Haryana. Vines are 3-4 m long and vigorous. Very sweet (12-15% TSS) and poor keeping quality.

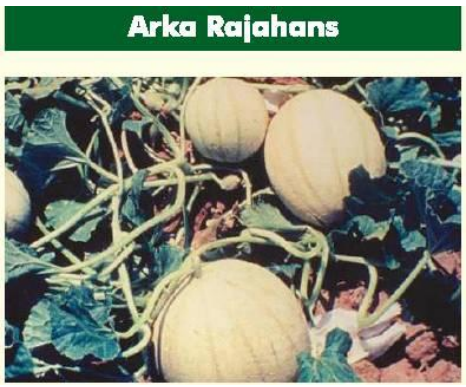
Punjab Sunheri: A derivative from the cross Hara madhu x Edisto, early maturing, pale green, thick skin, salmon orange and thick flesh, moderate sweetness (11-12% TSS) released by PAU, Ludhiana.

Punjab Hybrid (F_1): It is a F_1 hybrid between a male sterile line (ms1) and Hara Madhu. Vines are long (2-2.5m) vigorous and luxuriant growth. Early maturing with orange fresh and netted skin, Suitable for distant transportation and released by PAU.

Punjab Rasila: It is developed from a cross between C.melo var.momordica 'phut' x Indian cultivar. Fruits are round, green thick, juicy and it takes 80 days for fruit picking and about 10 days earlier than Hara madhu. Average yield is 16t/ha. Fruit weighing about 600g, TSS around 11% resistant to powdery mildew & moderately resistant to dowmy middew. Released by PAU, Ludhiana.

Durgapura Madhu: A very early cultivar confined to Jaipur region of Rajastan .Fruits are oblong weighing to 500-600g, Pale green rind, light green flesh, very sweet 13-14% TSS, seed cavity big.

Arka Rajahans: Mid season variety bearing large oval fruits and fruits has transportable quality. It is tolerant to powdery mildew, keeping quality excellent.



Arka Rajahans **Arka Jeet**

Arka Jeet: An early cultivar selection from Bati strain of Uttar Pradesh. Relatively dwarf habit. Fruits are flat small weighing about 300-500g. Orange to orange brown skin, white flesh, big seed cavity, very sweet (12-14%TSS). Excellent flavour and high vitamin C content.

Sona (cantaloupe): A hybrid from Indo American hybrid seeds company. Fruits are closely netted, slightly ribbed, orange cream colored, tolerant to Powdery & Downey Mildew and possess good keeping quality.

Swarna (cantaloupe): This is also a hybrid from IAHS, Fruit is yellow orange in colour with very sweet, dark orange flesh inside. It can withstand long distance transport.

Gujatat muskmelon-1: It is a selection from local collection from sabarkantha district in Gujarat. Fruits are small, tasty, lemon yellow and 5-6 fruits per /plant.

Gujatat muskmelon-2 : It is a selection from local collection from sNagpur area of Maharashtra. Friuts are medium in size, ttasty , 4-5 fruits /plantand average fruit weight is 1.3 kg. Skin is orange green with slight netting and no sututre.

Climate

Muskmelon is essentially a warm season crop grown mainly in tropical and sub-tropical regions. Generally a long period of warm, preferably dry weather with abundant sunshine is required. Melons require fairly high temperature of 35-40^{0}C during the fruit development. Cool nights and warm days are ideal for accumulation of sugars in the fruits. Maturity is hastened if nights are warm. The average temperature for good growth would be around 30-35^{0}C with maximum ranging around 40^{0}C and minimum between 20-25^{0}C for musk melon. They are very susceptible to frost. Excess humidity will promote diseases like

Powdery Mildew, Downey Mildew, anthracnose and viral diseases and pests such as fruit fly. For good quality and sweetness in muskmelon, dry weather during fruit development is necessary.

Soil

The soils should not crack in summer and should not be water logged in rainy season. Muskmelon prefers a soil PH of 6-7 and it is slightly more tolerant to soil acidity than cucumber. A well drained loamy soil is preferred for all the cucurbits including muskmelon, cucumber and watermelon. Soil temperature should be less than 10^0C or otherwise there would not be any seed germination. Lighter soils that warm quickly in spring are usually used for early yields. In heavier soils vine growth will be greater and fruits mature late.

Season

Jan-Feb months are preferred for sowing but there should be high temperatures at the time of fruit maturity and ripening which increases the sweetness. During rainy seasons non dessert forms of muskmelon are grown primarily in most parts of the country. In North India, early sowing is generally done in riverbeds in November and it extends to mid-February in garden lands.

Cropping system

Muskmelon could be grown in different cropping system. Brinjal-turnip-Muskmelon is the best rotation in North West India. In central Gangetic plains potato, garden pea-muskmelon- maize; and Paddy, muskmelon rotations are followed. Mixed cropping of melons is done in the initial stages of sugarcane in eastern UP and with cotton in Punjab. In rice fallows of Cuddappa district of AP, there is a small well defined pocket of growing muskmelon between February and May, the fruits of which reach the market after the riverbed crops are over.

Under sequential cropping system okra + French bean- capsicum + onion-Muskmelon + radish out yield by 193% compared with the sole crops of Okra- Capsicum-Muskmelon.

Preparation of field

Land should be thoroughly prepared to get fine tilth for seed bed.

Sowing

Seeds soaked in water for 12-24 hours before sowing gives better germination. This is practiced if temperature is very low. If transplanting is to be done, seeds can be sown in PE bags (15x10cm) of 100-200 gauge and germinated under cover to protect them from low temperature. The seedlings are transplanted from the bags at two true leaf stage. Normally the cucurbits do not stand transplantation beyond the stage due to tap root system. The recommended seed rate per hectare is 1.25 kg. Various systems of sowing are followed such as furrow, bed, pit and mounds. In case of furrow sowing the furrows are made at 2.0-3.0 meters with a plant to plant distance of 0.9m with 4-5 seeds in each hill and two vines are finally retained in each hill. Sowing is usually done at top of the sides of furrows and the vines are allowed to trail on the ground.

Pit system is practised especially during rainy season and in river bed cultivation. The pits spaced at 1.5 to 2.0 are dug about a meter deep and well mannered with FYM. 5-6 seeds are sown in a pit and finally 2-3 vines are retained in each pit. In riverbed system of sowing, i.e. in trenches of 30 cm wide, 60 cm deep and of a convenient length is done. The distance between 2 trenches is kept 2-3m. The trenches are filled with FYM, 3-4 seeds are sown in the pits / trenches.

Spacing

The spacing required for sowing depends upon the crop and the variety grown. In general row to row distance of 2.5-3m and hill distance of 60-90 cm is advocated for muskmelon.

Seed treatment

Soaking of seeds in Ethephon at 480 mg/litre for 24 hours improved the germination in muskmelon. At low temperature seed dressing with thiram controlled fungi effectively and also enhanced seed germination.The seeds of muskmelon should be soaked in water overnight and than should be kept in Moist cloth or gunny bag near a warm place before planting. Germination start within 3-4 days.

Training and pruning

Pruning (as the first hermaphrodite flower is borne on secondary branch arising from the eight node, the secondary branches are pinched off up to the seven node) in combinations with staking is found to be more effective. Removing the secondary shoots up to the 7^{th} node on the main stem is found optimal to improve plant growth and fruit set and induce early flowering. The yield and fruit quality is improved with pruning in muskmelon. Fruits from pruned plants have higher TSS, ascorbic acid and reducing sugars and better pulp thickness than un pruned plants.

Nutrition

Well rotten farm yard manure at the rate of 25t/ha is applied to the field at the time of land preparation. Full dose of P&K and ½ of N should be applied as basal dose, remaining of N should be applied at the time of earthing at 4 weeks after sowing. Foliar application of N & K at 1.5% increases the numbers of hermaphrodite flowers. An application of Ca (20-30PPM) and Boron (7.5-10.0 PPM) promotes plant growth, increases fruit yield, flesh and rind thickness.

Fertilizer recommendations for various states of India.

States	N (kg/ha)	P (kg/ha)	K (kg/ha)
Punjab	125	62	62
Haryana	50	25	25
Karnataka	100	75	50
Utter Pradesh	80	75	50
Tamil Nadu	80	60	30
Rajasthan	80	60	40

Irrigation

Usually pits, ridges or beds are lightly irrigated a day or two prior to sowing of seeds and subsequent irrigation is given 4-5 days after seed sowing .In general, irrigation once in 5-6 days will be necessary depending upon soil, temperature and location. It is always necessary to keep moisture well maintained at the root zone to provide rapid tap root development. Irrigation water should not wet the vines or vegetative parts, especially when flowering, fruit set and fruit development is in progress. Usually frequent irrigation is to be

reducing when fruits reach maturity and completely stopped at the last stages of harvest. Frequent irrigation is very important in spring summer crop, while in rainy season crop, irrigation may not be necessary at all if rainfall is well distributed between July-September.

Weeding

During early stage of crops, beds, ridges etc. need to be kept free from weeds. At the time of top dressing with nitrogenous fertilizers, weeding and earthing up are done when the vines start spreading; weeding in between the rows or ridges becomes unnecessary since vine growth can smother the weeds. Most of the pre and post emergence weedicides are phytotoxic to the seedlings or reduce plant growth in muskmelon. Application of fluchloralin alone or nitrofen reduce the uptake of N, P & K by weeds in both direct sown and transplanted crops of muskmelon. Some times, nutrient uptake by the crop is enhanced by herbicide application compared to that with no weed control.

Use of Growth regulators

.In muskmelon application of ethrel (250ppm) increases the fruiting and in turn the yield. Exogenous application of silver thiosulphate (300-400ppm) induces the male flower in gynoecious muskmelon. These chemicals/plant growth regulators should be applied twice at 2 true leaf stage and second at 4 true leaf stage.NAA at 25 ppm and GA at 10 ppm increases the fruit yield.

Harvesting and yield

Fruits have to be picked at full maturity stage, ready to be consumed as dessert fruit; the fruit usually will be ready in 30-35 days. Yield varies with the varieties used. Average yield of musk melon is about 15-20 t/ha. Hybrids give about 25t/ha.

Maturity standards

Muskmelon is a climatric fruit, which ripens during transit and storage and hence it is harvested before it is fully ripe so that it well reach the consumer at full ripe condition. More juicier the flesh, the less will be the keeping quality of the whole fruit. Firmer flesh stands transport well. The fruits when mature slip out easily from the vine with a little pressure or Jerk or if not, remain separated the next day. This is called full slip stage. The quality characteristics in muskmelon are several and varied namely thick skin and netting suitable for long distance, hauling, juicer flesh with at least 10% TSS.

Post harvest management

The cucurbits are not usually processed. Similarly muskmelon is not generally processed except the flesh of muskmelon is used in ice-cream in western countries. On small scale the juice of muskmelon flesh could be prepared; however, it has to be consumed within short time because it does not have any storage quality.

Marketing

Muskmelon especially can be hauled to the long distance metropolitan markets of Bombay (from A.P) Calcutta (from UP) and Delhi (from Rajasthan, Luknow etc). Muskmelons are transported in trucks without any individual packing and are liable to bruises and damage during transit.

Storage

Muskmelon can be stored for 2-3 days if they have reach full slip stage. Period of storage can be increased by lowering the storage temperature at 0^0C and 80-90% relative humidity.

Questionnaire

I ENCIRCLE THE MOS APPROPRIATE ANSWERS

1. In muskmelon, the TSS content varies from ---------- per cent

a. 8-10 b. 5-6 c. 8-17 d. 3-4

2. Hara Madhu, Pusa Madhuras and Arka Rajhans are varieties of ----------

a. Watermelon b. Muskmelon c. Snapmelon d. Long melon

3. ---------- is also known as Kharbooz

a. a. Watermelon b. Muskmelon c. Bitter gourd d. Bottle gourd

4. ----------variety of muskmelon is cross Hara Madhu x Edisto

a. Sugar baby b. Arka Manik c. Punjab Sunhari d. Hara Madhu

5. Swarna is a hybrid of ----------

a. Pumpkin b. Watermelon c. Bottle gourd d. Muskmelon

6. Muskmelon seed does not germinate at temperature lower than

a. 18^0 C b. 24^0 C c. 30^0 C d. 25^0 C

7. In south India, musk melon is sown in the month of

a. June – July b. September- October c. October – November d. February-March

8. ----------kilogram seeds per hectare are required

a. 10-15 b. 4-6 c. 15-20 d. 8-10

9. Removal of all secondary growth upto ---------- nodes in Hara Madhu variety of muskmelon has been reported to enhance fruit yield.

a. 7^{th} Node b. 8^{th} Nodes c. 9^{th} Nodes d. 10^{th} Nodes

10. The musk melon crop is ready for harvesting in about ---------- days after seed sowing depending upon the variety and season.

a. 50-60 b. 70-90 c. 110-110 d. 50-60

11. ---------- is botanically known as *Cucumis melo*

a. cucumber b. water melon c. *Muskmelon* d. Long melons

12. The maturity in ---------- can be determined from the change in outer colour to yellow, green or brown and the fruit also slip from the vine.

a. bottle gourd b. Water melon c. Muskmelon d. Long melon

13. Basic chromosome in muskmelon is ----------

a. 24 b. 20 c. 12 d. 10

14. ---------- variety of muskmelon in cross of Kutana X Cantaloupe

a. Pusa Sunhei b. Hara Madhu c. Pusa Sharbati d. Sugar baby

15. ---------- is the primary centre of origin of Muskmelon

a. Japan b. Tropical Africa c. Asia d. Europe

16. Full slip stage of muskmelon contains ---------- amount of sugar

a. Minimum b. Maximum c. Opitmum d. Average

II. Say true or false.

1. Optimum temperature for growth of muskmelon is about20-25^{0}C

Ans: False.

2. Pusa Rasila developed from a cross WMR 29and Hara Madhu.

Ans: True.

3. Muskmelon is Summer/warm season crop and susceptible to frost.

Ans:, true.

4. Muskmelon prefers soil pH of 6-7.0.

Ans: True.

5. In general, row to row distance of 60 cm and hill to hill distance of 45 cm is advocated for muskmelon.

Ans: False.

6. In muskmelon application of NAA increases the fruiting and in turn the yield.

Ans: False.

7. Hara Madhu is released by PAU, Ludhiana.

Ans: True

8.Durgapura Madhu a very early cultivar confined to Jaipur region of Rajastan .

Ans: True

9.Punjab Hybrid is a F_1 hybrid between a male sterile line (ms1) and Hara Madhu.

Ans: True

10. Foliar application of N & K at 1.5% increases the numbers of female flowers.

Ans: False

11. Exogenous application of silver thiosulphate (300-400ppm) induces the female flower in gynoecious muskmelon.

Ans: False.

Lecture 23. Origin, area, production, economic importance, description of varieties and hybrids, climate, soil requirement, seed rate and preparation of field, sowing, spacing, irrigation, growth regulators, nutrition and weed management, harvest, post harvest handling, storage and marketing of water melon

- Area and production
- Economic importance
- Varieties
- Climate
- Soil
- Season
- Cropping system
- Preparation of field
- Sowing
- Training and pruning
- Nutrition
- Irrigation
- Weeding
- Use of growth regulators
- Harvesting and yield
- Maturity standards
- Post harvest management
- Marketing and storage

WATER MELON

Botanical name **:** *Citrullus lanatus* (Thunb.)

Family **:** Cucurbitaceae

Chromosome number **:** 2n=22

Origin **:** Tropical Africa

Area and production

It is grown in garden lands and river beds in India. In river beds. In India it is grown in area of 16194 ha with annual production of 205884 tonnes, having the average productivity of 12.71 t/ha.

Economic importance

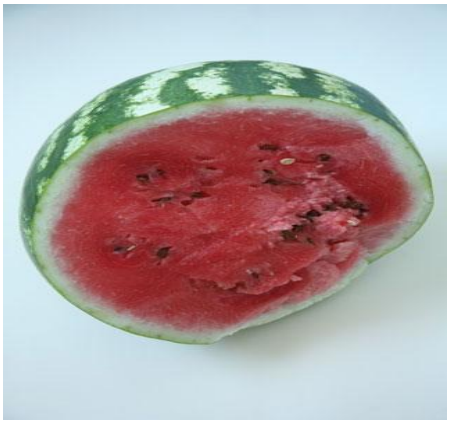
The fruits contain 95% water, 0.2% protein, 0.3% minerals and 3.3% CHO per 100g fresh weight. It is also a rich source of iron. The seed kernels are also used in various sweets and other delicious. The unripe fruits are also cooked as a vegetable in some parts of India. The sweet, juicy pulp of the ripe fruit is eaten fresh throughout the tropics and subtropical regions. The fruit has cooling effect and is used as an expectorant, diuretic and stomachic and is allaying thirst. It is a common man's fruit relished by both rich and poor alike. The fruit juice is also consumed by many after adding a pinch of salt & black pepper. The juice is delicious and nourishing and exerts a cooling effect in hot summer months.

Varieties

Asahi Yamato: It is Japaneese introduction, producing medium sized fruits averaging 6-8 kg. The rind colour is light green with deep pink flesh (TSS 11-13%). The fruits ripen in 95 days. Released by IARI.

Sugar Baby: An early season American introduction, the fruit is slightly small is size, weighing 3-5 kg ,round in shape having bluish-black rind and deep pink flesh (TSS-11-13%) and small seeds. The fruits ripen in 85 days. Released by IARI.

Sugar Baby



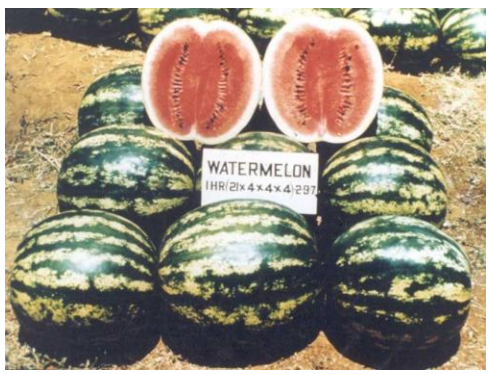
Crimson Sweet

Arka Jyoti: A mid season F_1, hybrid (IHR 20 x crimson sweet) with round fruits weighing 6-8 Kg. TSS 11-13%, excellent texture, very sweet with excellent flavour. Average yield 48t/ha released by IIHR, Bangalore.

Pusa Bedana: It is seedless watermelon developed at IARI, by crossing Tetra 2 (tetraploid) x Pusa Rasal. The fruits are seedless yields 3-4 fruits/vine. Fruits are medium green in colour.

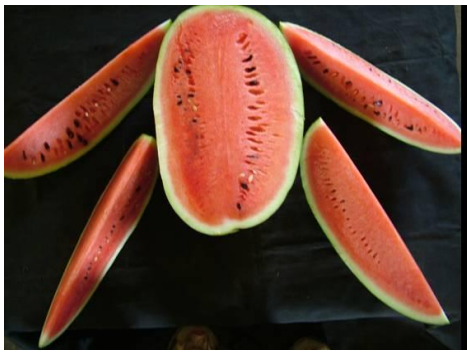
Arka Manik: Evolved by crossing a local IHR 21 From Rajasthan and Crimson sweet from USA followed by modified backcross method. A cultivar resistant to Powdery Mildew, Downey Mildew and tolerant to anthracnose. Fruits are round to oval with green rind and dull-green stripes. The average fruit weight is 6 kg, sweet (12-13% TSS) and few small seeds. It stands well in long distance transportation and storage. It is released by IIHR. Yields 41t/ha of fruits in 100-110 days.

Arka Madhura



Arka Manik


Arka Akash




Arka Aiswarya



Arka Muthu.

Arka Muthu :High yielding variety with unique character of dwarf vine of 1.2 mt, vine length, shorter internodal length and early maturing type (75-80 days). It has Round to oval fruits with dark green stripes and deep red flesh. Average fruit weight is 2.5-3 kg with T.S.S ranging from 12 to 14 %. Fruit yield 55 to 60 t/ha.

Arka Aiswarya: High yielding F_1 hybrid. Green with Dark green deeply lobbed foliage, round to oval fruit, Dark green with light green broken stripes, red flesh, with TSS of 13-14% (brix), average fruit weight 7.5kg with 1-2 fruit per vine. Duration 95-100 days. Fruit yield 75 to 80 t/ha, red flesh, crispy, delicious, juicy and very good taste. Good keeping and transport qualities.

Arka Akash: High yielding F_1 hybrid. Dark green with light green broken specks slightly deep foliage, oblong fruit red flesh, with TSS of 12-13% (brix), average fruit weight 6.5kg with 1 fruit per vine. Duration 90-95 days. Fruit yield 65 to 70 t/ha, red flesh, juicy and very good taste. Good keeping and transport qualities.

Arka Madhura :Triploid seedless watermelon variety, High yield 50-60 t/ha, T.S.S 13-14 %. Unique type , sweet , juicy and fully seedless .Longer shelf life and transport quality .Suitable for year round production under protected condition

Improved Shipper: An introduction from USA, a big sized watermelon weighing 8-9 kg. The fruit is dark green with moderate sweetness (8-9% TSS) released by PAU, Ludhiana.

Special No.1: Fruits are round and small with red flesh and red seeds. It is early in maturity. The average TSS is slightly lower than shipper. Released by PAU, Ludhiana.

Durgapura Meetha: A late cultivar maturing in 125 days with well spread vines. Fruits are round with light green, rind is thick with good keeping quality, flesh sweet, TSS around 11% with dark-red colour, Average fruit weight 6-8 kg, seed with black tip and Margin. Picking starts in 110-120 days and yields 40-45 t/ha. Released by ARS, Durgapura and Rajasthan.

Durgapura Kesar: It is a late cultivar; fruit weight 4-5 kg, skin green with stripes and flesh yellow in colour, moderately sweet, seeds large. Released by ARS. Durgapura. Rajasthan.

PKM 1: Fruits are dark green, Flesh pinkish red, yield is 36 to 38 t/ha in 120 to 135 days.

Fuken: released at HAU, Hisar which is resistant to anthracnose disease.

Crimson Sweet: The amply proportioned crimson sweet is famous for its sugary, bright red flesh; it is a cross of the Charleston gray, miles, and peacock varieties and has a honeyed taste.

Climate

Generally a long period of warm, preferably dry weather with abundant sunshine is required. Watermelon is essentially a warm season crop grown mainly in tropical and sub-tropical regions. They are very susceptible to frost. Excess humidity will promote diseases like PM, DM, anthracnose and Virus diseases and pests such a fruit fly. Melons require tropical climate and fairly high temperature of 35-40^{0}C during fruit development. Cool nights and warm days are ideal for accumulation of sugars in fruits. Maturity is hastened if nights are warm. The average temperature for growth would be around 30-35^{0}C with maximum ranging around 40^{0}C and minimum between 20-25^{0}C for watermelon. For good quality and sweetness in watermelon, dry weather during the fruit development is necessary.

Soil

Lighter soils that warm quickly in spring one usually used for early yields. In heavier soils vine growth will be high and fruits mature late. In Sandy River- beds alluvial substrate and subterranean moisture of river streams support cucurbits. In fact, long tap root system is adapted to the growth of cucurbits in riverbeds. The soils should not crack in summer and should not be water logged in rainy season. Watermelon prefers a soil P^H of 6-7.0.

Season

Jan-Feb months are preferred for sowing but there should be high temperatures at the time of fruit maturity and ripening which increases the sweetness. During rainy seasons non dessert forms of watermelon are grown primarily in most parts of the country. In North India, early sowing is generally done in riverbeds in November and it extends to mid-February in garden lands.

Cropping system

In rotation, in some districts of circars of AP, watermelons are usually grown after rice from Dec-April. Watermelon is sown in relay system just before digging of potatoes in late January or early February in North India.In garden land areas, in contrast to riverbeds, there is a definite system of growing watermelon in rotation and mixed cropping. In riverbeds water melon is grown usually as mixed cropping.

Preparation of field

Land should be thoroughly prepared to get fine tilth for seed bed.

Sowing

Watermelon is a seed propagated crop and *insitu* sowing is practised. In some cases where early crop is desired seeds can be sown in polyethylene bags (10X15 cm) of 100-200 gauge and germinated under cover to protect them from low temperature and then could be transplanted at 2 true leaf stage. The recommended seed rate for watermelon is 750-1125 g/ha.

Various system of sowing are followed, such as furrow, bed, pit (deep or shallow) and mounds. In case of furrow sowing the furrows are made at 2.5 to 3 meter and sowing is done at 1 metre spacing between plant to plant. The other methods of sowing are described under muskmelon.The seeds of watermelon should be soaked in water overnight and then should be kept in moist cloth or gunny bag near a warm place before planting. Germination would start within 3 to4 days. Soaking of seeds in ethephon at 480 mg/litre for 24 hrs improves the germination. Seed dressing with Thiram controlled fungi effectively and also enhanced seed germination.

Training and pruning

Yield and fruit quality are improred with pruning in watermelon. Retaining 3-4 main shoots per plant and keeping 30cm between two hills give highest yield.

Nutrition

Watermelon responds well to manuring. The quantity of ferlizers depends upon the availability of nutrients present in the soil.

Fertilizer recommendations for various states of India.

States	N (kg/ha)	P (kg/ha)	K (kg/ha)
Punjab	62	40	40
Haryana	50	25	25
Karnataka	100	88	100
Madhya Pradesh	100	50	50
Tamil Nadu	55	55	55
Rajasthan	80	40	40
Assam	68	68	130

Irrigation

Frequent irrigation is very important in summer to spring crop, while in rainy season crop, irrigation may not be necessary at all. If rainfall in well distributed between July-September. Other aspects of irrigation requirements are discussed under musk melon.

Weeding

At the time of top dressing with nitrogenous fertilizers, weeding and earthing up are done when the vines start spreading; weeding in between the rows or ridges becomes unnecessary since vine growth can smother the weeds. For successful growing of

watermelon, plots kept tree from weeds. During early stage of crops, beds, ridges etc need to be kept free from weeds.

Use of Growth regulators

In watermelon to increase the fruiting and the fruit yield exogenous application of chemicals such as TIBA (25-250 PPM), boron (3-4ppm), Molybdenum (3-4 ppm) and calcium (20-25PPM) is recommended. These chemicals/plant growth regulators must be applied at 2-true leaf stage, repeat the spray at 4- true leaf stage. Foliar spray of GA at 25-50 ppm, ethrel 500 ppm, MH 100 ppm and NAA 200 ppm increases fruit yield.

Harvesting and yield

In watermelon where fruits have to be picked at full maturity stage, ready to be consumed as dessert fruit, usually takes 40-45 days from anthesis to harvesting. The fruit thinning increases the size and quality of the fruit. Normally 3-4 fruits per each vine should be kept in order to get good quality fruits. Average yield of watermelon is 35-50 t/ha.

Maturity standards

In water melon, maturity is judged by several factors.

Dull sound when the fruit is thumped in contrast to metallic sound.

Withering of tendril at the fruit axil

Ground spot (Where the fruit touches the ground) turning yellow.

Rind of the ripe melon yields to presume.

Cumulatively all these criteria will help to judge the fruit for picking. Most of the cultivars have deep pink or pink or pale pink flesh colour with slightly reddish tinge containing largely lycopene and anthocyanin pigments. The average sweetness will record around 9-10% TSS.

Post harvest management

The cucurbits are not usually processed. Watermelon is not generally processed except the flesh of watermelon is used in ice-cream in western countries. On small scale the juice of watermelon flesh could be prepared; however, it has to be consumed within short time because it does not have any storage quality

Marketing and storage

Most of the cucurbits do not stand long transportation. Watermelon is transported in trucks without any individual packing and are liable to bruises and damage during transmit.Especially in rainy season crops or crops damaged by summer rains, fly attacked fruits would be considerable which will have to be culled out before sending to market. Anthracnose affected fruits of watermelon are of poor quality. Being highly perishable, marketing of cucurbits involve risks and losses and hence cultivation of these vegetables are more concentrated around metropolitan cities. Watermelons require careful handling as they are easily damaged and they cannot be stored more than 2-3 weeks.Some far flung river bed growing supply watermelon to the distant markets.

Questionnaire

I ENCIRCLE THE MOST APPROPRIATE ANSWER

1. Pusa Bedana is a seedless variety of

a. Muskmelon b. Watermelon c. Sponge gourd d. Round melon

2. ----------variety of watermelon is cross of Tetra-2 X Pusa Rasal

a. Arka Jyoti b. Sugar baby c. Arka manik d. Pusa Bedana

3. ---------- is powdery mildew resistant variety of watermelon

a. Arka manik b. Suagr baby c. Pusa bedana d. Shipper

4. *Citrullus lanatus* is botanical name of

a. Muskmelon b. Watermelon c. Pumpkin d. Round melon

5. Centre of origin of water melon is

a. Tropical Asia b. South America c. Tropical Africa d. India

6. Watermelon is rich source of

a. Potassium b. Sodium c. Iron d. Calcium

7. Arid region of ---------- is best for production of quality fruits of watermelon

a. Bihar b. Uttar Pradesh c. Rajasthan d. Gujarat

8. Germination of water melon seed is

a. Hypogeal b. Epigeal c. Semi hypogeal d. both a &b

9. In watermelon, ----------performs pollination

a. wind b. wasp c. Butterfly d. Honey bee

10. Watermelon is ----------annual

a. Monoecious b. Andromononecious c. Dioecious d. trioecious

11. Basic chromosome number in watermelon is

a. 14 b. 11 c. 12 d. 24

12. Watermelon crop is ready fro harvesting in about ----------days after sowing depending upon cultivar and season

a. 45-60 b. 70-75 c. 75-100 d. 100-120

13. A well maintained crop can yield ----------quintals of watermelon of high quality from one hectare area

a.100-120 b. 150-200 c. 400-600 d. 200-300

14. Micronutrient like boron and molybdenum at ----------ppm proved effective in sex expression in watermelon

a. 20 b. 10 c. 3 d. 15

15. Cucurbitacin is found in seeds of

a. Bitter gourd b. snap melon c. Watermelon d. Pumpkin

II. Say true or false.

1. Watermelon varieties viz Asahi Yamato and Sugar baby are introduced from Japanese and America respectively,

Ans: True.

2. Arka manik is evolved by involving a cross between IHR 21 X crimson sweet.

Ans: true.

3. Arka manik is resistant to Powdery mildew, Downey mildew and tolerant to Anthracnose disease.

Ans:,. True

4. Watermelon requires fairly high temperature of 25-30 C during the fruit development and to get quality fruits ‘

Ans: False.

5. Exogenous application of growth regulators such as GA_3 to increase fruit set and fruit field

Ans: False.

6. Average yield of watermelon is10-20 t/ha

Ans : False.

7. The soils should not be cracking and water logging for watermelon cultivation.

Ans: True.

8. The average sweetness of water melon fruit should be around15-20% TSS.

Ans: False.

9. Ideal spacing for watermelon between rows 1.5 m and between plants 60 cm.

Ans: False.

Lecture 24. Origin, area, production, economic importance, description of varieties and hybrids, climate, soil requirement, seed rate and preparation of field, sowing, spacing, irrigation, growth regulators, nutrition and weed management, harvest, post harvest handling, storage and marketing of cucumber

- Area and production
- Economic importance
- Varieties
- Climate
- Soil
- Season
- Cropping system
- Preparation of field
- Sowing
- Spacing
- Nutrition
- Irrigation
- Weeding
- Use of growth regulators
- Pruning
- Harvesting and yield
- Marketing
- Storage

CUCUMBER

Scientific name **:** *Cucumis sativus* L.

Family **:** Cucurbitaceae

Chromosome number : 2n=14

Origin : India

Common name : Khira

Area and production

This crop is grown in garden lands and river beds. Also it can be grown as mixed crop. It is grown in area of 16288 hectare with annual production of 105690 tonnes .

Economic importance

Fruits are good for people suffering from constipation, jaundice and indigestion. It is rich in vitamin B and C as well as minerals such as calcium, phosphorous, iron and potassium. Fruits contain 0.4% protein, 2.5% CHOs, 1.5mg iron and 2 mg of vitamin C per 100g fresh weight. Immature fruits of cucumber and gherkin are used as salad and for pickling. Tender leaves are also used as a vegetable. In temperate countries it is extensively grown in glasshouse. The fruits & seed possess cooling properties. The fruit is also used as an astringent and antipyretic. The seed oil is also used as antipyretic. Cucumber is characterized by the presence of bitter principle called cucurbitacins, which are tetra cyclic triterpenes.

Varieties

Cucumber cultivars are usually classified on the basis of how they are used, fresh market (slicer) and pickling. In general fruits of slicer are longer than pickling cultivars and they develop a darker and heavier skin with uniformly cylindrical shape. Present day pickling cultivars tend to develop shorter vines than fresh market once and they are more prolific. Cucumber cultivars are also classified according to the spine colour, generally slicing cucumber have white spine colour and pickling cucumber have black spine colour.

Japanese Long Green: It is introduction. It is suited to hills and lower hills, extra early with 45 days maturity, fruits 30-40cm long, flesh light green, crisp, released by IARI.

Japanese Long Green:

Poinsette:

Straight Eight: Early cultivars suited to hills, white spined fruit, medium long, thick straight with round end, colour medium green. Released by IARI, Regional station Katrain (Kallu vally).

Pusa Sanyog: It is a F_1 hybrid (Japanese Gynoecious line X Green Long of Naples). Early and high yielding hybrid, fruit 28-30 cm long, cylindrical and dark green with yellow stripes crisp flesh, maturity in 50 days. Suitable to temperate region & hills of subtropical region.

Poinsette: An American introduction multiplied by National Seed Corporation. Fruit dark green 20-28cm long, carrying resistance to Downey mildew, anthracnose and angular leaf spot.

Himangi: It is developed by selection from the cross poinsett & Kalyanpur Ageti. Fruits are white in color and resistant to bronzing. Duration 100-110 days. Average yield is 19t/ha. Developed by MPKV, Rahuri (Maharastra).

Phule Shubahangi: Fruits are green colour, high yielder than Himangi released by MPKV, Tolerant to powdery mildew.

Sheetal: Released by konkan krishi vidyapeeth Dapoli. Fruits are light green skin colour.

K 90: High yielder under temperate condition released by YSPUH&F, Solan.

Solan Hybrid: Released by YSPUH &F. It is F_1 hybrid suited to temperate region, high yielding.

China: Long duration variety. Fruits are 40 cm length and fruits are light yellow colour.

AAUC 2: Fruits are long, cylindrical, medium size and white green.Days to harvest 60 to 65.Yield 45 to50 t/ha.

Swarna Poorna: Fruits are long, cylindrical, medium size and light green. Tolerent to powdery mildew.Days to harvest 55 to 60.Yield 30 to35 t/ha in 120 days.

Swarna Sheetal: Fruits are long, cylindrical, medium size and whitish green. Days to harvest 60 to 65.Yield 25 to30 t/ha.

Several local cultivars are grown in different regions. In Pune region, there is cultivar called poonakhira. In UP there is a cultivar called Balam Khira. In West Bengal a variety called Darjeeling. In Karnataka local varieties viz West coast and Hassan local.

Climate

Cucumber prefers slightly lower temperature than Water melon and Muskmelon. The optimum temperature is 26.4^{0}C. If the temperature goes above 30^{0}C, the production is reduced considerably .Seeds of cucumber geminates well if the day temperature is 20-30^{0}C. It is essentially a warm season crop but is successfully grown in tropical, subtropical and temperature regions. This is very susceptible to frost. Excess humidity promotes disease like Powdery Mildew, Downy Mildew, anthracnose & pests such as fruitfly.

Soil

The soils should not crack in summer and should not be water logged in rainy season. The soil PH should be 6-7.A well drained loamy soil is preferred for cucumber. Lighter soils that warm quickly in spring are usually used for early yields. In heavier soils vine growth will be greater and fruits mature late. In sandy river beds, alluvial substrate and subterranean moisture of river streams support cucurbits.

Season

In South and central India where winter is mild cucumber is grown almost throughout the year. In the hills the sowing season starts from April-May. In Karnataka

Jan-Feb months best for sowing.In North India sowing of cucumber is done from Nov-January when it is grown in river beds. For garden crops, it is sown by middle of February. For rainy crop it is sown in June-July.

Cropping system

In river beds cucumber is grown usually as a mixed cropping. In rotation, it is sown in relay system just before digging of potatoes in late January or early February in north India.

Preparation of land:

Land should be thoroughly prepared in order to get fine tilth for seed bed.

Sowing

2.5 kg seeds are required for a hectare area. Seeds are directly sown in the soil. In some cases where early crop is desired, seeds can be sown in PE bags (10X15cm) of 100-200 gauges and germinated under cover to protect them from low temperature.

Spacing

In general row distance of 1.5 -2.5 m and hill to hill distance of 60-90 cm is advocated.

Nutrition

Fertilizers should be given as per availability of nutrients in the soil after soil testing.

Table. Recommended quantity of NPK in various parts of India

State	N (kg/ha)	P (kg/ha)	K (kg/ha)
Punjab	100	50	50
Himachal Pradesh	100	50	50
Karnataka	60	0	50
Tamil Nadu	35	0	0
Maharashtra	50	40	0
Orissa	50	30	75

Full dose of N &K & half of N should be applied as basal dose and remaining 50% N should be incorporated into the soil during earthing up.

Irrigation

Frequent irrigation is very important in spring summer crop, while in rainy season crop irrigation may not be necessary at all if the rainfall is well distributed between July-Sep. Over irrigation should be avoided, as cucumber cannot withstand under water logging conditions.

Weeding

For successful growing of cucumber, early stages of crop growth to be kept from weeds. At the time of top dressing with N fertilizer, weeding and earthing up are done. When the vines start spreading, weeding in between the rows or ridges become unnecessary since vine growth can smother the weeds. As mentioned in case of muskmelon flochloralin at 1.20 kg a-i/ha (pre-plant), flochloralin 0.48 kg + nitrogen at 0.5 kg/ha (pre-emergence) could be applied to control the weeds in cucumber.

Use of Growth regulators

Application of Ethrel (150-200 ppm) increase the number of flowers, fruit set and in turn increases the yield. GA (1500-2000ppm) and silver nitrate (200-300 ppm) induce male flowers on gynocecious cucumber. Soil drenching of paclobutrazol 75 ppm increases the yield. These chemicals/plant growth regulators may be applied at 2 true-leaf stage and repeat the spray at 4 true leaf stages.

Pruning

Pruning of all the primary branches after 2 nodes gives highest yield compared to unpruned once.

Harvesting and **yield**

Picking of fruits at the right edible maturity stage is dependent upon the varieties. In salad or slicing cucumber, dark-green skin colour should not turn into brownish yellow

and white spine color will also be a useful indication for edible maturity. Optimum length of the fruit will be around 20-25cm at edible maturing stage, depending upon the cultivar in case of slicing cucumber. In small fruited types, which have pale green skin colour, the length of fruit should be around 8-12 cm. Here also fruits turning yellow will be over mature. In western countries, most of the pickling cultivars are adopted to machine or once over harvest.

Yield

About 15-20t/ha is obtained from open conditions by using monoecious variety. This yield could be doubled by using tropical gynoecious variety. Under green house conditions about 200 t/ha yield is obtained using tropical gynoecious hybrids.

Marketing

In cucumber crook neck shaped fruits produced especially at the fag end of the harvest would have less marketable value. These fruits are produced because of imperfect pollination and fertilization and also due to fly attack. Other consideration in harvesting of cucumber is the distance of the market; cucumber does not stand much to long distance transportation. In fact, cucumber has to be sold out in heavy urban markets. Cucumbers are packed in baskets and transported. Being highly perishable, marketing of cucumber involves risks and losses and hence its cultivation is concentrated around the metropolitan cities.

Storage

Chilling injury is a physiological storage disorder of cucumber is noticed, when fruits are exposed to temperature below -10^0C for prolonged period.For good storage life, optimum temperature is near -10^0C & RH of 85%. It is better if fruits are consumed immediately after removal from storage. Cucumbers can only be stored for 10-14 days.

Questionnaire

I ENCIRCLE THE MOST APPROPRIATE ANSWER

1. ----------is also known as Khira

a. Watermelon b. Muskmelon c. Cucumber d. Bitter gourd

2. ---------- is botanically known as *Cucumis sativus*

a. Muskmelon b. watermelon c. Bitter gourd d. cucumber

3. Average daily temperature of ---------- is most favourable for cucumber growth

a. 18-24 ^{0}C b. 10-14^0 C c. 28-30^0 C d. None of the above

4. ---------- is the chief pollinating agent in cucumber

a. Housefly b. Bumble bee c. Honey bee d. None of the above

5. Cucumber is ---------- in nature

a. Monoecious b. Dioecious c. Gynomonoecious d. Andromonocious

6. Seed production of cucumber, maintain ----------meter isolation distance between two cultivars.

a. 1600 b. 800 c. 1000 d. 400

7. The origin place of cucumber is ----------

a. India b. Brazil c. China d. Peru

8. Basic chromosome number in cucumber is ----------

a. 11 b. 10 c. 12 d. 7

9. Straight eight is a variety of

a. Pumpkin b. cucumber c. Tinda d. Bottle gourd

10. ----------kg of cucumber seeds required for raising one hectare crop

a. 2-4 b. 4-5 c. 8-9 d. 10-12

11. The Average yield of cucumber fruits per hectare is

a. 30-40 tons b. 50-60 tons c. 8-10 tons d. 20-30 tons

12. High humidity hastens formation of pistillate flowers in ----------cultivation

a. Tomato b. Spinach c. Brinjal d. Cucumber

13. High temperature and longer light period induces ---------- in cucumber

a. Maleness b. femaleness c. fruit growth d. vegetative growth

II. Say true or false.

1. Cucumber grows best at a temperature between 18-24^0 C
   Ans: true.

2. Cucumber grows well at a row to row spacing of 1.5 to 2.5 m and plant to plant spacing of 60-90 cm.
Ans, True.

3. Cucumber mosaic is readily transmitted by white flies.
Ans: False.

4. Straight Eight is a F_1 hybrid cross between Japanese Gynoecious line X Green Long of Naples.
Ans: False

5: Pusa Sanyog is an early cultivar suited to hills.

Ans: False.

6. Himange is developed by selection from the cross Poinsette, Kalyanapur Ageti.
Ans: true.

7. Growth regulators like GA and Silver nitrate are used to induce the female flowers on gynoecious cucumber
Ans: False.

8. Optimum storage temperature and relative humidity for cucumber are 5^0C and 60 per cent RH
Ans: False.

9. In the hills the sowing season starts from August and the fruits of cucumber are harvested up to April – may.
Ans: False.

10. *Cucumis sativus* is the scientific name of cucumber
Ans: True.

Lecture 25. Origin, area, production, economic importance, description of varieties and hybrids, climate, soil requirement, seed rate and preparation of field, sowing, spacing, irrigation, growth regulators, nutrition and weed management, harvest, post harvest handling, storage and marketing of bottle gourd

- Area and production
- Economic importance
- Varieties
- Climate
- Soil
- Season
- Cropping systems
- Preparation of field
- Sowing
- Spacing
- Nutrition
- Irrigation
- Weed control
- Training and pruning
- Use of growth regulators
- Harvesting and yield
- Storage
- Marketing

BOTTLE GOURD

Botanical name **:** *Lagenaria siceraria*

Family **:** Cucurbitaceae

Chromosome number **:** 2n=22

Origin **:** Tropical Africa

Area and production

It is also commonly grown in Ethiopia, Africa, Central America and other warmer regions of the world. It is commercially grown in a few states. The exact figures on area and production are not known. However, it has some share in gourd cucurbitaceous vegetables. In India, bottle gourd is grown in the area of 116939 ha with annual production of 1428296 tonnes.

Economic importance

Fruit may be long, oblong or round depending upon the variety. Immature fruits are consumed in a number of ways. *Kofta is* most popular preparation. The fruits contain 0.2% protein, 2.9% carbohydrates, 0.5% fat and 11mg of vitamin C per 100g fresh weight. It is good for people suffering from biliousness and indigestion.

Bottle gourd is a commonly grown vegetable in India. The fruits of bottle gourd can be used as a vegetable or for making sweets (e.g. *halva, kheer, pedha* and *burfi)* and pickles. As a vegetable it is easily digestible, even by patients. A decoction made from the leaf is a very good medicine for curing jaundice. The fruit has a cooling effect; it is a cardiatonic and diuretic. The pulp is good for overcoming constipation, cough, night blindness, and as an antidote against certain poisons. The plant extract is used as a cathartic and the seeds are used in dropsy.

The fruits are variable in shape and size. They are 15-100cm long and light greenish in colour. While the tender fruits are widely used as a vegetable, the dry hard shells of the fruits have been used for making a wide range of articles of common use, including bowls, bottles, ladles, containers, floats for fishing nets, pipes and musical instruments. In addition, the seeds and seed oil are edible. Bottle gourd is suitable for cultivation in dry areas.

Varieties

Pusa Summer Prolific Long: This was developed at Indian Agricultural Research Institute, New Delhi, through selection from local germplasm, suitable for growing as summer crop, although it can be grown in rainy season also. Fruits are 40-50cm long and 20-25cm in girth.

Pusa Summer Prolific Round*:* This was developed through selection from local germplasm at Indian Agricultural Research Institute, New Delhi. It has vigorous growth, round fruits of 15-18cm girth. It is a prolific bearer and heavy yielder.

Pusa Meghdoot*:* This is an F_1 hybrid between pusa summer prolific long and Sel.2 developed and released by Indian Agricultural research Institute, New Delhi in 1971. Fruits are long, light-green and attractive. It is relatively early and suitable for cultivation in spring-summer season. Considerably high yielder than Pusa Summer Prolific Long.

Pusa Manjari*:* This is a round fruited F_l hybrid (Pusa Summer Prolific Round and Sel. 11) developed and released at Indian Agricultura1 Research Institute, New Delhi in 1971. It has given 48% higher early yield and 106% total yield over Pusa Summer Prolific Round.

Pusa Naveen*:* This is a recent release of Indian Agricultural Research Institute, New Delhi. It is high yielding (30 tonnes/ha) and takes about 60 days for first harvesting. Fruits are perfectly cylindrical and straight without any crook-neck or curve. Average fruit weight is 850g.

Punjab Komal*:* It is an early maturing, medium sized, oblong fruited variety developed and released by Punjab Agricultural University, Ludhiana. Marketable fruits are available in about 70 days after sowing. The fruits are light-green with pubescence. There are 10-12 fruits per vine. The fruits are tender and borne on medium long, thin pedicels on 4-5th node onwards. It is tolerant to cucumber mosaic virus. The yield potential is 40 tonnes/ha.

Arka Bahar*:* This was developed and released by Indian Institute of Horticultural Research, Bangalore; this is a selection in local cultivars of Karnataka. Fruits are straight, devoid of crook-neck, medium in size, each weighing about 1kg. The skin is light green, shining and tender with pleasant aroma. The yield potential is about 40 tonnes/ha in 120 days.

Kalyanpur Long Green*:* This variety was developed at CSAUAT Vegetable Research Station, Kalyanpur, and Kanpur. The vines are vigorous and long, fruits are long with tapering and somewhat pointed blossom end. The yield potential is 30 tonnes/ha in 120 days.

Samrat*:* This was developed by selection from local germplasm from Dahanu District of Maharashtra and released during 1992 by Mahatma Phule Krishi Vidyapeeth, Rahuri. Fruits are 30-40cm long and perfectly cylindrical in shape, fruit are green with dense pubescence and good keeping quality. It is good for box packing.average yield 40 tonnes/ha in 120 days.

Pusa Hybrid 3: It has recently been released by Indian Agricultural Research Institute, New Delhi for commercial cultivation in northern plains. Fruits are attractively green, long and straight without any neck, weighing on an average l kg each. The fruits are highly suitable for easy packaging in cardboard boxes for distant marketing. It can successfully be grown both in spring-summer and *Kharif* seasons in northern plains. It is very early in maturity. On an average it gives 40-45% higher yield than Pusa Naveen. The average yield being 42.5 tonnes/ha in spring summer and 47 tonnes/ha in *Kharif.*

Pant Shankar Lauki 1.This F1 hybrid has medium long fruits, Released by central variety release committee in 1999.

CO 1: Pale green coloured and bottle shaped fruits with narrow neck and round bottom. Yield 25 -30 t/ha.

Azad Nutan: Early variety with long neck free fruits weighing 1.5 kg.

Pusa Sandesh: Round green medium fruits. Early variety ready for picking in 55-60 days. Yield 29-32t/ha

Punjab Round: fruits are round, light green and yield 15.5t/ha

Punjab Long; tolerant to CMV, light green, yield 40t/ha.

Navendra Rashmi: moderately tolerant to pumpkin beetle. Fruits are bottle shaped having shallow neck, average weight is1.0kg, yield 30t/ha.

Climate

It is worm season crop .It cannot tolerate high cold and frost . The bottle gourd is a typical tropical plant which requires warm and humid climate for the best growth. The optimum temperature for growth 24°-27°C. It is highly sensitive to photoperiod. High rainfall amounts with prolonged cloudiness results in a higher incidence of diseases and in turn drastically reduces the yield. Short days and humid climate promote femaleness.

Soil

Bottle gourd can be grown on all types of soils, but sandy loam soils with high organic matter content are considered best. Soil should be well drained and the pH between 6-7. The soil should be deep soil so that is can support the vine for a longer period. Soil-moisture is important for rapid growth and it should be at least 10-15% above the permanent wilting point.It can be raised successfully in riverbeds. The soils should not crack in summer and should not be water-logged in rainy season. The soil temperature for good crop growth should be 18°-22°C.

Season

The sowing time of bottle gourd different for different regions and conditions .The season of growing is mainly determined by the rainfall and temperature conditions. Bottle gourd is grown in summer and rainy season. In summer, the crop sown in December—January and in rainy season (June—July). In South and central India, where winter is neither severe nor long this crop can be grown almost through out the year.

Cropping systems

Usually cucurbits are sown in relay system just before digging of potatoes in late January or early February in North India and crops like bottle gourd and pumpkin derive residuary benefit of heavy fertilizers applied to potato. In garden land areas, in contrast to the river beds, there are definite systems of growing cucurbits in rotation and mixed cropping. In eastern India bottle gourd and pumpkin are grown in rice follows after `aman' paddy.

Preparation of land

The land should be thoroughly prepared in order to get fine tilt for seed bed.Various systems of sowing have been adopted depending on the season, crop and system of cultivation. In garden soils, furrows are made at 2-3m. The sowing is done on the top of the sides of furrows and the vines are allowed to trail on the ground.

Sowing

. Two seeds sown in both sides of furrows. Finally good and healthy one seedling per hill should be kept. Pre-sowing treatment of seeds with 600ppm of succinic acid for 12hr improves germination and seedling growth as evidenced by more leaves per seedlings. Also see soaking in water for 12-24hr improves seed germination. Bottle gourd is propagated through seeds. The seeds are large white in colour, and seed count is about 450-500/kg the recommended seed rate is 3-6kg/ha. The seeds are sown directly in furrows or trenches or pits

Spacing

In Maharashtra, bottle gourd is trained on bowers and sown at 3.0 x 1.0m distance. In West Bengal and South India sowing is done in pits. Pits of 90cm width, 60cm depth and of convenient length are dug and filled with well-rotted farmyard manure, followed by top soil.The recommended spacing is 2-3m between two rows and 1.0-1.5m between two plants. The same spacing followed in river bed plantings. In Punjab, spacing of 2.5 x 2.0m is recommended for bottle gourd.

Nutrition

Bottle gourd responds well to Manuring and fertilizer application. The doses of fertilizers depend upon the soil type, climate and system of cultivation. It is difficult to be specific about fertilizer recommendations because of variation in soil types, soil fertility and system of cultivation. Nevertheless, well rotten farmyard manure at the rate of 15-20 tonnes/ha is applied to the field at the time of preparation of land. This is supplemented by a full dose of super phosphate and potash; and half dose nitrogen before sowing and remaining half dose of nitrogen should be applied about a month later. It is better to complete all the fertilizer applications just before the fruit set.

Fertilizer recommendation in different states of India.

State	N (kg/ha)	P (kg/ha)	K(kg/ha)
Punjab	100	50	50
Himachal Pradesh	100	75	50
Karnataka	50	50	37
Maharashtra	50	40	00
Tamil Nadu	32	24	24
Gujarat	25	50	25

Irrigation

During hot and warm weather, irrigation after every third or fourth day is needed to maintain proper soil-moisture level. Drip irrigation has been reported to yield 48% more fruit yield than furrow irrigation.In spring-summer crop, frequent irrigation is very essential, while in rainy season crop, irrigation may not be necessary at all, if rain fall is well distributed between July-September. The first irrigation may be given after seed sowing in order to improve the seed germination. The crop requires frequent irrigation as high humidity is needed for prolific bearing. The rainy season is very good for bottle gourd crop.

Weed control

Two or three weedings are necessary to keep the crop free from weeds. Herbicides can also be used in this crop. Better weed control was obtained with Fluchloralin 2.0kg a.i. /ha and Alachlor and Butachlor 2.5kg a.i. /ha in bottle gourd variety Pusa Summer Prolific Long.The cucurbits do not require much attention by way of interculture. In the early stages

before they start vining, the beds, ridges, etc. require to be kept free from weeds. Hand weeding should be done carefully so that the root system is not damaged.

Training and pruning

This increases yield over untrained vine. High productivity on bower system is due to better use of sunlight by maximum number, of leaves and higher number of side branches resulting in better assimilation of carbohydrates. A spacing of 2.5 x 1.0m was adopted in this experiment. In small home gardens, bottle gourd is trailed over thatched huts and walls. Various pruning methods failed to exert favorable effects on fruit yield of bottle gourd. Bottle gourd is trained on bower systems.

After germination of seed the vine is to be trailed on bower with the help of jute string. The auxiliary buds are to be removed weekly till the vine attaining bower and finally the top of the vine is to be pruned 15cm below the bower allowing two auxiliary buds to grow which are later on trialed on the bower. Two months after sowing male flower initiate following the female in the sequence of 5:5 at the end of 5th flower of female the vines are again pruned allowing 2-3 auxiliary bud to grow on the primary vines. When crop attains 2-3 months and stem of vine becomes thumb thickness the jute string is to be removed and the older pale to yellow coloured leaves near the bottom of the vine are to be removed and destroyed.

Use of Growth regulators

Fruit set can be increased by spraying the plants twice at the 2 and 4-true-leaf stage with Ethrel (150ppm), Malichydrazide (400ppm), Triodobenzoic acid (50ppm), boron (3-4ppm) and Calcium (20ppm). Yields can also be increased by maintaining adequate soil fertility levels; particularly when growing hybrids. Malichydrazide at 400ppm along with 100kg N/ha promotes the female flower production and increases fruit set and inturn the yield

Harvesting and yield

Fruit should be picked every 3-4 days. Picking of fruits at the right edible maturity stage depends upon individual kinds and varieties. Further, over mature fruits would show carpel separation in transverse section of the fruits. The crop is ready for harvest approximately 60 days after seed sowing, depending upon the variety and season. Bottle gourd fruits take about 12-15 days after fruit setting to reach the marketable stage. Precautions should be taken while cutting the fruits so that neither vines nor the fruits are

injured. The tenderness and edible maturity are judged by pressing the skin and little pubescence persisting on the skin. Seeds should be soft, if examined in transverse section. Hence smaller fruits fetch better price in the market. The harvest maturity of a vegetable depends upon the purpose for which it is harvested. When the bottle gourd fruit is to be harvested for vegetable, it should be harvested at edible stage. In bottle gourd picking is done in about 12-15 or even 20 days after fruit set. In bottle gourd, tenderness and edible maturity are judged by pressing the skin and little pubescence persisting on the skin.

Yield

The average yield of bottle gourd is 20 tonnes/ha. However, the improved varieties/F_1 hybrids yield up to 40-50 tonnes/ha.

Storage

Fruits can be stored for 3-5 days under cool and shady conditions. In cold storage they can be stored for longer period. The fruits are packed in polythene bag and kept in small boxes and these boxes are transported to the markets. It can be stored for few weeks under 10 ^{0}C and 60-70 per cent relative humidity.

Marketing

For local markets, fruits are kept in basket or crate and then marketed. For export marketing the fruits should be picked at edible stage and then packed in polythene pipe bags and these bags are kept in boxes of 50-100kg capacity. These boxes are then transported to marketing areas.

Questionnaire

I ENCIRCLE THE MOST APPROPRIATE ANSWER

1. The origin place of bottle gourd

a. South America b. Europe c. Asia d. Africa and India

2. -------variety of bottle gourd is a cross of PSPL X Selection -2

a. Pusa Naveen b. Pusa Manjari c. Pusa Gomal d. Pusa Meghdoot

3. Basic chromosome number in bottle gourd is

a. 11 b. 12 c. 9 d. 10

4. Bottle gourd is a ---------- crop

a. Self Pollinated b. Cross Pollinated c. Often Cross pollinated d. None of the above

5. Arka bahar is a variety of ----------

a. Pumpkin b. Bottle gourd c. bitter gourd d. None of the above

6. About ---------- of seed is enough for raising one hectare of bottle gourd

a. 3-6 kg b. 10-12 kg c. 25-35 kg d. 45-50 kg

7. ---------- is botanically known as *Lagenaria siceraria*

a. Bottle gourd b. Ridge gourd c. Sponge gourd d. Pumpkin

8. Bottle gourd belongs to the family of which of the following vegetable

a. onion b. tomato c. bitter gourd d. None of the above

9. ---------- is also known as white flowered gourd

a. Bottle gourd b. Snake gourd c. Ridge gourd d. Pumpkin

10. Bees are the pollination of

a. Tomato b. Brinjal c. Spinach d. Bottle gourd

11. Ecologically the family cucurbitaceae is

a. dichotomous b. Monochotomous c. Polychotomous d. None of the above

12. ---------- applied to the family and various of its members are gourd, melon, cucumber, squash and pumpkin

a. Leguminosae b. Cucurbitaceae c. Solanaceae d. None of the above

II . Say true or false.

1. Halva, Kheer and pedha sweets are prepared from bottle gourd.

Ans: True.

2. The pulp of bottle gourd is good for overcoming constipation and night blindness.

Ans: True,

3. Pusa Meghdoot is developed by cross involving Pusa summer prolific long and selection 2

Ans: True.

4. Punjab Komal variety is tolerant of cucumber mosaic virus

Ans: True

5. The optimum of soil pH and temperature for growth of bottle is 6-7 and 15-20 ^{0}C respectively

Ans: False

6. Fruit set in bottle can be increased by spacing growth regulators such as GA_3 and NAA.

Ans: False.

7. Short days and humid climate for bottle gourd promotes male flowers

Ans: False

8. The recommended spacing for bottle gourd is 1 m between rows and 1 m between plants

Ans: False

9. Pre sowing treatment of bottle gourd seeds with thiourea improves germination

Ans: False.

10. Bottle gourd is ready for harvest approximately 45 days after sowing seeds.

Ans: false.

Lecture 26. Origin, area, production, economic importance, description of varieties and hybrids, climate, soil requirement, seed rate and preparation of field, sowing, spacing, irrigation, growth regulators, nutrition and weed management, harvest, post harvest handling and storage of bitter gourd

- Area and production
- Economic importance
- Varieties
- Climate
- Soil
- Season
- Preparation of field
- Sowing
- Spacing
- Nutrition
- Irrigation
- Weed control
- Use of growth regulators
- Harvesting and yield
- Storage

BITTER GOURD

Scientific name : *Momordica charantia L.*

Family : Cucurbitaceae

Chromosome number :2n=22

Origin : Tropical Asia (Eastern India and Southern China)

Common names : Balsam pear, Bitter cucumber

Area and production

It is widely grown in India, Indonesia, Malaysia and Singapore and extensively grown in China, Japan, South-East Asia, tropical Africa and South America. At present , In India , it is grown in the area of 26004 ha with annual production 162196 tonnes. The cultivation of the

crop is very lucrative especially in south India from where fruits are exported to Gulf and European countries. The annual import of bitter gourd in UK comes to 1000 tonnes. The area and production are fast increasing and some of the leading states in the country are Uttar Pradesh, Orissa, Maharashtra, Andhra Pradesh, Tamil Nadu and Kerala. The approximate area and production in India are given in Table 1.

Table 1. Area and production of bitter gourd.

States	Area (ha)	Production (tonnes)
Assam	325	5,798
Gujarat	500	2,500
Orissa	5,230	20,920
Punjab	2,000	24,000
Rajasthan	219	578
Uttar Pradesh	14,800	1,08,400
Maharashtra*	12,054	1,20,540
Andhra Pradesh*	7,759	77,590
Tamil Nadu*	22,223	2,22,330
Kerala*	10,000	1,00,000

Source: PDVR bulletin No. 1991; *Estimated value.

Economic importance

. The fruits are rich in iron, vitamin A, B, C and are an inexpensive source of proteins and minerals. The fruit is reported to have germicidal effect and is laxative and easily digestible. It is considered good for curing blood diseases, rheumatism, diabetes and asthma. Bitter gourd leaves are known to act as galactogogs and a powder prepared from the leaves is good for treating ulcers. It has been reported that protein of bitter gourd inhibited growth of immune deficiency virus in human cell cultures.

Bitter gourd is grown for its bitter tender fruits. Fruits are covered with blunt tubercles. The fruits turn to an orange-yellow colour when ripe .The fruits are cooked in many ways but more commonly used as fried, boiled, stuffed and cooked. The cooked vegetable of bitter gourd remains quite fit for consumption for 2-3 days. The cucurbitacian-bitter glucoside- may help in preventing spoilage of cooked vegetable of bitter-gourd. The fruits are also utilized in the preparation of pickles and stored as a dry vegetable. Bitter gourd can be canned and pickled. The bitter gourd slices can be dried and used as a vegetable as and when required. The surplus fruits can be made into dehydrated products. From 16kgs

fresh fruit, l kg dehydrated product can be made. The market price depends on the domestic supplies and external arrivals. Establishment of farmers' markets in certain regions of Kerala has assured a reasonable price to farmers for their produce.

Varieties

The varieties in bitter gourd vary in size, shape, colour, spine character and bitterness. The market preference for colour, shape, size and bitterness also vary with locations. White coloured varieties are less bitter in taste and preferred in South India. The characteristic bitter taste in the fruit is due to the bitter principle `momordicine'. The following varieties are recommended for cultivation in various parts of the country**.**

Name	***Source***	***Salient features***
Pusa Do Mausmi	IARI New Delhi	Fruits are dark-green, club-like with 7-8 continuous ribs. Each fruit weighs 100-120g. It grows well in summer and rainy season. It has a yield potential of 12 – 15 tonnes/ ha in 120 days
Pusa Vishesh	IARI, New Delhi	A selection from a local variety of Hapur in Uttar Pradesh, suitable for growing in summer.
CO 1	TNAU, Coimbatore	Selection from a local type from Thudiyalur near Coimbatore. Fruits are dark green, spiny, 20-25 cm long weighing 100-115 g
MDU 1	TNAU Agrl. College, Madurai	Induced mutant with greenish white fruits, spiny fruits with length vary from 30-40cm. Yield potential is 30-35 tonnes/ha in 120-130 days.
COBgoH-1	TNAU, Coimbatore	F1 hybrid developed by crossing MC.84 X MDU.1 YIELD OF 44.4t/ha. The average individual fruit weight is 300g. The potential yield goes up to 51.29t/ha
VK 1 Priya	KAU, Vellanikkara, Thrissur	A selection from local type. Fruits are 39cm long, green-spiny-fruits with white tinge at stylar end. Yield potential is 30 tonnes/ha.

Preethi (MC 84)	KAU, Vellanikkara	Selection from local type. Fruits are white, medium, spiny, 30cm long and average fruit weight is 310g and per hectare yield is 15-34 tonnes
Priyanka(Sel. 1010)	KAU, SRS, Thiruvalla	A local selection from Thiruvalla. Fruits are uniform white, spindle-shaped with spiny-ridges, medium long, average fruit weight is 300g and yield/ha is 28 tonnes.
Arka Harit	IIHR, Banglore	It is an improvement over local collection from Rajasthan. Fruits are short, spindle-shaped, green with smooth regular ribs. They are thin fleshed with moderate bitterness. The variety is suitable for growing in kharif and summer. It yields 9-12 tonnes/ha in 120 days.
Harkani	MPKV, Rahuri	Developed by selection of local type. Fruits are dark green, 15-20cm long with prickles. Average yield is 13.8 tonnes/ha in 160 days
Phule Green	MPKV, Rahuri	Developed by selection from cross between Green Long x Delhi Local. Dark-green fruits, 25-30cm long and prickled. Average yield is 23 tonnes/ha in 150-180 days. Tolerant to downy mildew.
RHR BGH 1	MPKV, Rahuri	F_1 hybrid. Dark-green, prickled fruits with 20cm long fruits. Average yield is 20 tonnes/ha. Suitable for *Kharif* And summer growing. Tolerant to downey mildew
Konkan Tara	konkan Krishi Vidyapeeth, Dapoli, Maharashtra	Fruits are green, prickly, medium long (15-16cm) and spindle-shaped. Yield potential is 24 tonnes/ha. Fruits have good keeping quality, shelf-life is 7-8 days under ambient temperature

MDU 1

Priya

Pusa Do Mausmi

Pusa Hybrid 1

Pusa Vishesh

Arka Harit

Climate

It can be grown under both tropical and sub-tropical climates but warm climate is considered best. It is a warm season crop but has a wide range of adaptability and can be grown in regions with comparatively low temperatures. At temperature between 25°- 30°C, the growth is normal and yield is high. When the temperature is less than 18°C, the growth is slow leading to poor yield. When temperature is above 36°C there is poor production of female flowers resulting in poor yield. It is reported that short day treatment slightly reduced the production of staminate flowers and increased the number of pistillate flowers and lowered the node number at which the first pistillate flower appeared. Long-day treatment significantly increased the production of staminate flowers and suppressed the development of pistillate flowers. The production of female flowers was increased by low temperature treatment (20°C) under short-day.

Soil

The crop can be grown in all types of soils but sandy loam and silt loam soils are most suitable. The best pH would be 6.5-7.0. For higher production, the soil should be rich in organic manure either proper drainage facility.

Season

In hills, the seed is sown from April to July. In plains, seed is sown from January–March. The second crop is taken in June-July.

Sowing

Four seeds are sown per pit and later two to three seedlings per pit are retained. Instead of sowing in the main field, the seeds can be sown in polythene bags and can be shifted to pits in the main field after 15-20 daysFour to five kg of seeds is sufficient to sow one hectare. The seeds have to be treated with Thiram @ 2g/kg of seeds. Soaking the seeds for 6 hours will facilitate germination. The seed has a hard seed coat and germinate slowly due to slow absorption of water. Germination takes longer time at low temperatures. The seed germination is optimum at temperature between 25°C and 35°C and inhibited at 8°C, and above 40°C.

Preparation of field

Plough the field for 3-4 times. Apply 20-25 tonnes of farmyard manure at the last ploughing.

Spacing

Long channels of 60cm width are formed at a spacing of 2m. Along this channel, pits of 45cm are dug at a spacing of 1.5m. The package of practice recommendation of Kerala suggests making pits of size 60cm at a spacing of 2m.

Nutrition

Different recommendations for fertilizers and manures are available for different locations. Fertilizer recommendation for bitter gourd for different states is given below.

States	N	P	K (kg/ha)
Punjab	100	50	50
Himachal Pradesh	100	50	50
Karnataka	62	50	0
Tamil Nadu	20	30	60
Maharashtra	50	40	0

In the coastal regions of Karnataka N and P at 80: 30kgs/ha alone gave maximum yield of 17.12 tonnes/ha. In coconut gardens of Kerala (partially shaded conditions) maximum fruit set and yield were obtained at NPK 90: 25: 50kgs/ha. In Kerala, application of farmyard manure @ 18 tonnes + NPK 60: 30: 60kg/ha resulted in maximum yield and net returns.

Irrigation

Since bitter gourd is sown both in rainy and summer seasons, rainy season crop normally does not require much watering except during dry spells. Being a shallow rooted vegetable, roots are mostly concentrated at top 60cm soil layer. The crop should be irrigated immediately after planting in summer and subsequently at 2-3 days interval until flowering.

Weed control

The field should be free from weeds throughout cropping season. Glycophosphate at 4.5kg/ha if applied after weed emergence and before sowing, weeds can be effectively controlled.

Use of Growth regulators

Ethrel at 25ppm increases female flowers. GA at 60ppm reduces the ratio of male: female flowers. High levels of endogenous GA like substances occur between 45-60 days when the ratio of male: female flowers are low. MH at 150-250ppm when applied at 2 leaf stage in variety 'Pusa Do Mousmi' induced the formation of pistillate flowers at the lowest node. Seed treatment with B9 at 3-4 ppm for 20 hours gave the highest number of female flowers per plant. Application of growth regulators at 2-4 leaf stage play an important role in expression and sex ratio. MH at 50-150ppm and CCC at 50-100ppm increase female: male ratio and at a high concentration of 200ppm CCC it is reduced.

Application of cycocel at 250mg/litre gave the highest dry-matter, acetic acid and TSS content and flesh thickness. GA_3 at 25mg/litre gave highest number of seeds/fruit at 75kg N/ha. Application of paclobutrazol at 100 ppm improves the fruit yield. Soaking of seeds in Ethrel for 20ha/ppm or GA_3, MH, silver nitrate at 3 - 4ppm gave the highest number of female flowers and fruits per plant. Seed treatment with Boron 3-4mg/litre or foliar application @ 3-4mg/litre gave significantly higher yield.

Harvesting and yield.

Immature tender fruits are harvested. The colour of tender fruit is light-green or dark-green or whitish-green depending upon variety. At fully ripe stage the colour of the fruits turns to yellow or orange and for seed purpose the fruits are harvested at this stage. Regular harvesting at shorter intervals will increase the fruit number and irregular harvesting may delay the formation of successive fruit production and affect their growth and development adversely. The average yield of bitter gourd varies from 100-150 q/ha, while 200-300q/ha of hybrids.

Storage

After harvesting remove all fruits affected with insect pests or diseases and deformed ones. The harvested fruits cannot be kept for long time and to be sent to market as soon as possible. By sprinkling water over the fruits, freshness can be maintained for sometime in the initial stage. Fruits can be packed in polypropylene bag for extended shelf-life. Fruits in the basket can be kept for 2-3 days.

Questionnaire

I ENCIRCLE THE MOST APPROPRIATE ANSWERS

1. Pusa Vishesh is a variety of

a. Brinjal b. Bitter gourd c. Tomato d. Okra

2. For raising one –hectare crop of bitter gourd --------- of seeds are sufficient

a. 10-12 kg b. 500-600kg c. 15-20 kg d. 4.5-6 kg

3. Optimum temperature requirement for bitter gourd cultivation is

a. 25-30^{0}C b. 14-17^0 C c. 10-15^0 C d. 30-40^0 C

4. ---------- is botanically known as *Momordica charantia*

a. Pointed gourd b. Ridge gourd c. Bitter gourd d. Bottle gourd

5. Short days help in increasing female flower production in

a. Spinach b. Chow chow c. Bittergourd d.

6. ---------- is also known as balsam pear

a. Ridge gourd b. Ash gourd c. Snake gourd d. Bitter gourd

7. The origin place of bitter gourd is

a. Asia b. Indo-Myanmar c. China d. Europe

8. The chromosome number (2n) in bitter gourd is

a. 24 b. 22 c. 14 d. 32

9. The vegetable -------- is beneficial to diabetic patients

a. tomato b. radish c. Spinach d. Bittergourd

10. Optimum soil pH requirement for bitter gourd cultivation is

a. 6.5-7.0 b. 7.5-8.5 c. 4.5-5.0 d. none of the above

11. Red pumpkin beetle comparatively less harm

a. Pumpkin b. Cucumber c. Muskmelon d. bitter gourd

12. The alkaloid ----- imparts the bitter taste of the fruit

a. cucurbitacin b. Capsacin c. Momordicin d. Luffein

II. Say true or false.

1. Botanically bitter gourd is known as *Momordica charantia*

Ans: True.

2. Bitter gourd is also known as bitter cucumber.

Ans:True.

3. The fruits of bitter gourd are rich in calcium mineral element .

Ans: False.

4. When temperature is above 30 ^{0}C there is poor production of female flowers in bitter gourd

Ans: False.

5. The best pH for cultivation of bitter gourd is 5.5-6.0.

Ans: False.

6. 1-2 kg of seeds is required for sowing one hectare area of bitter gourd

Ans: False.

7. The seed germination of bitter gourd is inhibited when the temperature is below-15^{0} C and above 30^{0}C

Ans: False.

8. 50: 75 : 100 kg of NPK is sufficient for raising one hectare area of bitter gourd in

Karnataka

Ans: False.

9. Pre emergent weedicide flochloraline is applied for effective control of weeds.

Ans: false.

10. Application of growth regulators GA and MH increases female : Male ratio while CCC reduces the ratio of male: female flowers in bitter gourd

Ans: False.

11. The flowering starts in bitter gourd by 30-40 days and the first picking could be taken in 100-120 days after planting.

Ans: False.

Lecture 27. Origin, area, production, economic importance, description of varieties and hybrids, climate, soil requirement, seed rate and preparation of field, sowing, spacing, irrigation, growth regulators, nutrition and weed management, harvest, post harvest handling and storage of pumpkin

- Area and production
- Economic importance
- Varieties
- Soil
- Climate
- Season
- Preparation of field
- Spacing
- Sowing
- Nutrition
- Irrigation
- Weed control
- Use of growth regulators
- Training
- Harvesting and yield
- Storage

PUMPKIN

Botanical Name	: ***Cucurbita moschata***
Family	: Cucurbitaceae
Chromosome Number	: 2n= 40
Origin	**:** America

Area and production:

Pumpkin is grown throughout India. In India, C. *moschata* or field pumpkin is more widely distributed than other species. As it tolerates hotter conditions than the other cultivated species of *Cucurbita*, it is the most widely grown throughout the tropics of both

hemispheres today.

States	Area(ha)	Production(t)
Assam	3,518	6,266
Orissa	38,645	5,13,980
Punjab	300	9,000
Rajasthan	674	3,533
	43,137	**5,32,779**

Economic importance:

It is an important cucurbitaceous vegetable extensively grown in different parts of the country for its immature and mature fruits. They are used as fresh vegetable, processed food and stock feed. Immature and mature fruits are cooked as a vegetable. Their flesh is delicious when stewed, boiled or baked. They are sweetish when fully mature and fully ripen fruits are meshed and used for the preparation of a delicacy called *halwa,* other sweets and jams. They can also be candied or fermented to give a beverage. The *Yerusseri* prepared from immature fruits is very popular in Kerala. Fruit is also mixed with tomato in the preparation of sauce. Sometimes young tender tops of shoots and leaves are also cooked as vegetable. Pumpkin is one of the most popular summer vegetables grown all over India on a commercial scale. Because of its high carotene content and good keeping quality, it is considered as a vegetable of immense value. There is a good deal of confusion about the identity of the Indian cultivated species. Many of them are known by the same vernacular names. They are all utilized in the same way and the methods of cultivation are similar.

. The flowers of pumpkin are more nutritive than fruits. The seeds after removing from seed coats are used in confectionery. This crop is specially known for its low-cost of production and long keeping quality. The fruits can be kept for several months. The young leaves, flowers and fruits are rich in carotene, a precursor of vitamin A. Importance of pumpkin as a potential supplier of carotene has not been exploited till now. Medicinal uses of pumpkin to reduce tapeworm infection and its use as a diuretic are yet to be explored on a large scale.

Differences in flavour, consistency and appearance of varieties are related to their composition which determines their suitability for various purposes. Some varieties are excellent for culinary use during the early stages of maturity and very poor for the same use at

later stages, while the reverse may be true of other varieties.The varieties show differences in the composition of their fruits. Varieties with high sugar content contain larger amounts of acid hydrolysable polysaccharides; those with high total solids are rich in soluble solids and moderately rich in total nitrogen.

Varieties:

Varieties grown in the country differ in colour, shape and size of fruits, flesh colour etc. Characters of improved varities development in Indian are furnished below.

The distinguishing morphological characters among four cultivated species of Cucurbita are given in Table 1.

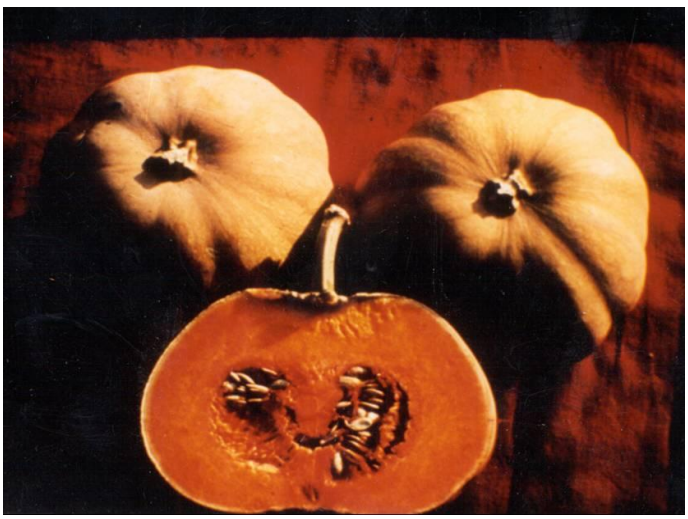
Table 1: Key characteristics differentiating the cultivated species of cucurbita

Species	***Common Name***	***Habit***	***Skin texture***	***Stem***	***Androecium***	***Peduncle***	***Fruit flesh colour and texture***	***Stage of edible fruit***	***Funicular attachement of seed***	***Seed margin***
C.moschata	pumpkin	Annual	Hard rind, smooth surface	Moderately hard, smoothly angled	Lind slender columnar substance sticking to seed. Yellow to orange flesh	Hard, smoothly angular, long keeping quality	Fine grained asymmetrical	Ripe, strong flavour	Obtuse slightly	Scalloped obtuse
C. pepo	Summer squash	Annual	Hard, angular	Hard, angular	Short, thick	Hard, angular	Coarse grained, deep yellow flesh	Immature poor keeping quality	Obtuse symmetrical	Smooth obtuse
C.maxima	Winter squash	Annual	Hard	Soft round	Short, thick columnar	Soft basically round, but enlarged by soft cork	Fine grained, without gelatinous substance sticking to seed	immature	Acute asymmetrical	Smooth obtuse
C.mixta	Winter squash	Annual	Hard	Hard angular	Long slender columnar	Hard basically	Coarse grained, deep yellow flesh	Immature	Obtuse slightly asymmetrical	Barely scalloped acute

Varieties

Name	Source	Remarks
Arka Suryamukhi	IIHR, Bangalore	A variety of C. *maxima*. It is a selection from a foreign introduction. Fruits are small (1-1.5kg) round with flat ends and deep-orange with streamy streaks on the rind. Flesh is firm and orange- yellow in colour. Keeping and transport qualities are good. It is also resistant to fruit fly *(Daucus cucurbitae).* It yields 36 tonnes/ha in 100 days duration.
Arka Chandan	IIHR, Hessargatta	A selection from Rajasthan collection (IIHR 105). Fruits are medium in size (2-3 kg), round with blos-som end. Rind colour is light-brown with creamy- patches at maturity. Flesh is thick, firm, sweet (TSS 8-10%), bright-orange and rich in carotene (3331 iu/100g of flesh) and keeping qualities are good and has got pleasant aroma. Fruits mature in 120 days and yield 32.5 tonnes/ha.
CO 1	TNAU, Coimbatore	A local collection with late maturing large, sized (7-8 kg) globular fruits with a characteristic broad proximal end. The distal end will be slightly tapering to form a tip. Immature fruits are dark-green in colour and turns to brownish-orange after full maturity. Fruit number per plant is 7-9 and flesh thickness is 4-5 cm. Yield 30 tonnes/ha and duration 150-160 days.
CO 2	TNAU, Coimbatore	A local selection with small flat fruits (1.5-2.0kg). An early maturing type (135 days) and yield about 23-25 tonnes/ha each plant produces 10-12 fruits. Fruit colour is green.
Ambili	KAU, Vellanikkara	A pure line selection from a local cultivar of Thrissur. A vigorously growing variety having flat round fruits of medium size (5-6 kg) with shallow grooves. Immature fruits are green and turn tan coloured during maturity. Leaves are characterized by white spots on the upper surface of the lamina. Flesh thickness is 4cm and yield potential is 34 tonnes/ha and matures in 130 days.
Saras	KAU, Vellanikkara	Fruits elongate, orange fleshed, Medium sized, yield 39t/ha.
Soorj	KAU,	Fruits round, Orange fleshed and average yield is 35t/ha

	Vellanikkara	
Suvarna	KAU, Vellanikkara	Fruits flat round green with white patches and spots at immature stage turning light brown at mature stage flesh orange in colour. average fruit length 13.5cm yield 37 t/ha
Pusa Biswas	IARI, New Delhi	A local selection of the line 'CM 10' A vigorously growing variety having dark-green leaves with white- spots veins, Fruits are spherical medium (5kg) and light-brown with thick golden-yellow flesh. Matures in 120 days and yield potential is 20 tonnes/ha.
Pusa Vikas	IARI, New Delhi	A small fruited semi dwarf to dwarf type. The fruits are-small (2.0kg), round and flat with yellow flesh. Highly, suitable for cultivation in spring-summer season in North India. Its yield potential is 30 tonnes/ha.
Solan Badami	YSPUH&F. Solan	Fruits are small and yield 22.5t/ha



Arka Chandan

Soil

Pumpkin is sensitive to acidic soils. A deep well drained loamy soil is preferred. Sandy loams are good for raising early crop whereas clay loams are good for high yield. Both should be with ample organic matter content. The long tap root system is adapted to its growth in river beds. The best pH should be 6.0-7.0.Soiltemperature should not go below 10°C and maximum beyond 30°C, the optimum range is around 20°-25°C. Soil-moisture should be at least 10-15% above the permanent wilting point.

Climate

The plants can be grown successfully between temperature ranges of 25°-30°C. Above 40°C and below 15°C the growth of the plant will be very slow and the yield goes down. It does not tolerate frost.Pumpkin requires a long and warm growing season. It can be grown in relatively cooler climates than the other cucurbits. Short-days, low-night temperature and high-relative humidity is best for pumpkin production.

Season

In Tamil Nadu, pumpkin is sown during June-July and December-January. In Kerala the best time is October even though it can be grown throughout the year. The mosaic incidence will be less during this time. The crop is sown in April-May in hills of North India and June-July or January-March in plains. This crop is grown in summer and rainy seasons. In south and central India, where winter is neither severe nor long, these are grown almost round the year.

Preparation of field

The field is ploughed four or five times. Various systems of cultivation have been adopted depending on the season. In rainy season, raised beds or mounds are made to facilitate drainage. The pits are filled with a mixture of farmyard manure (20-25 tonnes/ha) and top soil and basal dose of fertilizers are mixed with the soil. In summer season, pits of 60cm diameter and 45m depth are taken at a spacing of 2m in rows spaced at 4.5m. Furrows can also be taken at 4.5m spacing. Along these lines, long channels of 60cm width are formed for irrigation.

Spacing

The recommended crop spacing in Kerala is 4.5 x 2m. But in Tamil Nadu it is 2.5 x 2m. In Punjab it is 3m x 60cm. In West Bengal, the crop is sown at a spacing of 3.4m x1.8-2.5m.

Sowing

The recommended seed rate varies in different states. In Kerala and Tamil Nadu it is 1.0-1.5kg/ha, while in Punjab it is 3-5kg/ha. Two seeds per hill are sown on both sides of raised beds or furrows. In pits, 4-5 seeds are sown and pits are pot watered till germination. The seeds germinate in 7-8 days and after germination 2-3 healthy seedlings are left in each pit and other seedling are thinned out. After germination of seeds, the pits can be irrigated through channels once in three days.

Nutrition

The doses of manures and fertilizers depend upon the soil type, climate and system of cultivation. Various recommendations are furnished below:

Nutrients recommended for pumpkin in different states of India

State	Nutrients (kg/ha)		
	N	P	K
Punjab	100	50	50
Himachal Pradesh	150	100	50
Karnataka	100	100	40
Madhya Pradesh	60	50	50
Tamil Nadu	32	24	24
Assam	75	80	80
Kerala	70	25	25

The remaining N is to be applied in two equal split doses at the time of vining and at the time of full blooming. Well rotten farmyard manure is applied as basal dose along with the full dose of phosphorus and potash and half dose of nitrogen. In general, high N under high temperature condition promotes maleness in flowering resulting in low fruit set and low yield. Excessive vine growth can be pruned manually to promote higher female to male ratio. This is not practiced in commercial growing and the best way to control the vine growth within reasonable limits is by adjusting fertilizer doses and frequency of irrigation. It is better to complete all the fertilizer applications just before the fruit set.

Irrigation

. During flowering and fruiting stages, irrigation should be given on alternate days. During initial stages of growth, irrigation is given at an interval of 3-4 days Later

irrigation may be given at 5-7 days intervals. Excessive irrigation at maturity is not desirable as it may adversely affect the storability.

Weed control

Regular weeding should be done. Herbicides can also be used for this purpose. According to Khurana *et al.* (1988), pre-plant incorporation of Besulide @ 4-6kg/ha or Alachlor 2.5kg/ha as pre-emergence can be used for weed control in pumpkin.

Use of Growth regulators

A growth regulator, Ethrel can be applied to increase the female flower production which helps to increase the yield. The concentration of the chemical is very important. The recommended concentration is 250ppm (2.5m1 of Ethrel in 10 litres of water). The first spray has to be given when there are two-true-leaves (15 days after sowing). This is repeated once in a week for 3 more times.

Training

For trailing pumpkin, dried twigs are spread on the ground. During the time of manuring, raking of soil should be done. Then the plants are irrigated immediately.

Harvesting and yield

It is better to harvest at tender stage as a vegetable, this increases the yield. But for storage and seed extraction, it should be harvested only after full maturity. The pumpkin crop will reach maturity in about 75-180 days after seed sowing depending on the variety, season and other conditions. Fully matured fruits have to be harvested after the skin colour has turned completely brown from green colour and the pedicel (fruit stalk) separates from the vine or dried. Fully matured fruits have a long storage-life and they can also be transported easily to distant markets.

Yield

The yield varies from 20-30 tonnes/ha in crop duration of 120-140 days.

Storage

Pumpkin can be stored more than six months at a temperature of 100C and a relative humidity of 85 per cent. Lower temperature is harmful which may cause blemishes.

Questionnaire

I ENCIRCLE THE MOST APPROPRIATE ANSWER

1. Pumpkin is a monoecious ----------climber

a. Annual b. Perennial c. Biennial d. None of the above

2. The pumpkin fruits contain ----------mg vitamin A per 100 g edible portion.

a. 25 b. 30 c. 84 d. 60

3. Optimum temperature for pumpkin cultivation is ----------

a. 10-14^{0}C b. 18-24^0 C c. 8-12^0 C d. 30-34^0 C

4. Arka Chandan is a variety of ----------

a. Bottle gourd b. Bitter gourd c. Snake gourd d. Pumpkin

5. The origin place of pumpkin is ----------

a. Asia b. China c. Tropical America d. Africa

6. Basic chromosome number in pumpkin is

a. 14 b. 20 c. 32 d. 48

7. Botanical name of ---------- is cucurbita mus……

a. Tomato b. Pumpkin c. cucumber d. Ridge gourd

8. In plains, pumpkin is grown ----------in a year

a. Twice b. Once c. Three times d. None of the above

9. ---------- seeds are required for pumpkin cultivation.

a. 8-10 kg/ha b. 6-8 kg/ha c. 3-4 kg/ha d. 10-12 kg/ha

10. Pusa Viswas and Pusa vikas are varieties of

a. Pumpkin b. Bitter gourd c. Snake gourd d. Ridge gourd

11. Arka Suryamukhi is fruit fly resistance variety of

a. Ridge gourd b. bitter gourd c. snake gourd d. Pumpkin

12. Ethephon is best plant growth regulator in ---------- used for enhancing fruiting

a. Tomato b. Okra c. Pumpkin d. Brinjal

II. Say true or false.

1. Pumpkin is rich in vitamin C.

Ans: False.

2. Pumpkin is self pollinated crop due to monoecious nature

Ans: False.

3. Pumpkin is sensitive to saline soils and the best pH should be 6.0-7.0.

Ans: False.

4. Optimum temperature range around 15-20^{0}C for growth and development of quality fruits .

Ans: 25-30 C

5. The pumpkin reaches maturity in about 60 days after sowing and the yield varies from 10-15 t/ha .

Ans; False.

6. A growth regulator CCC can be applied to increase the female flower production.

Ans: False.

7. Pumpkin usually grown in rainy and winter seasons.

Ans: False.

8. Ideal spacing for pumpkin is 1.5 x 1.0 m.

Ans: False.

9. 100: 100: 80 kg/ha of NPK is recommended in Karnataka for growing pumpkin .

Ans: False.

10. Ambili is a variety of pumpkin released through mass selection method of breeding.

Ans: False.

Lecture 28. Origin, area, production, economic importance, description of varieties and hybrids, climate, soil requirement, seed rate and preparation of field, sowing, spacing, irrigation, growth regulators, nutrition and weed management, harvest, post harvest handling, storage and marketing of ridge gourd and sponge gourd

- Area and production
- Economic importance
- Varieties
- Soil
- Climate
- Season
- Cropping systems
- Preparation of land
- Sowing
- Spacing
- Nutrition
- Irrigation
- Weed control
- Use of growth regulators
- Training and pruning
- Harvesting and yield
- Storage and marketing.

RIDGE GOURD AND SPONGE GOURD

Botanical name	: Ridge gourd: *Luffa acutangula*
	Sponge gourd *Luffa cylindrica*
Family	: Cucurbitaceae
Chromosome number	: 2n=26
Origin	: Sub-tropical Asian (India)

Area and production

Both crops are commonly grown throughout India particularly in states like Andra Pradesh, Tamil Nadu, Karnataka , Gujarat etc.,. Ridge and sponge gourds are grown as mixed cropping in the river beds and as monocrop in the garden lands, hence the exact area and production are unknown. Nevertheless the estimated area under all the gourds is 4.05 lakh hectares in our country.

Economic importance

A fruit of ridge gourd are ribbed and is called *kali tori* whereas fruits of sponge gourd are smooth and is called *ghia tori.* Ridge gourd contains 0.5% protein, 3.4% carbohydrates, 37mg carotene and 18mg vitamin C per 100g edible portion. The sponge gourd fruits contain higher protein and carotene than ridge gourd. The fibre of dry fruits is also used in a number of ways. Some round varieties of ridge gourd is also used for stuffing purpose.

Ridge or ribbed gourd *(Luffa acutangula* Roxb.) and sponge gourd or smooth gourd *(Luffa cylindrica* Roem.) are popular vegetables both as spring-summer and rainy season crops. The genus derives its name from the product 'loofah', which is used in bathing sponges, scrubber pads, doormats, pillows, and mattresses and also for cleaning utensils. Both the species contain a gelatinous compound called luffein. Both ridge and sponge gourds have some medicinal uses.

In South, southeast, and East Asia, the tender fruits are eaten fresh or more commonly cooked and consumed as a vegetable. Sometimes, the tender leaves and growing shoots are also used as a pot herb.

VARIETIES

Ridge Gourd

Pusa Nasdar*:* A selection from Madhya Pradesh collection. An early maturing variety, producing club-shaped fruit, producing 15-20 fruits per vine, light-green in colour. Flowering starts in 60 days. Released by Indian Agricultural Research Institute, New Delhi. Suitable for summer and rainy seasons. Yields 15-16 tonnes/ha.

CO 1: It is an early bearing variety. Moderately vigorous, 10-12 fruits per vine, weighing 3-4

fruits per kg. The fruits are long 60-75cm and 30cm in girth, first harvest in 55 days from sowing and it is completed by 125 days. Released by Tamil Nadu Agricultural University, Coimbatore.

Satputia: This is a cultivar of Bihar, which is hermaphrodite in sex form and it produces smaller fruits in clusters. In each cluster 5-7 fruits are borne. Fruits are pale-green in colour. Average yield 20-25 tonnes/ha. It is mainly grown in Uttar Pradesh and Bihar.

Konkan Harita*:* This is developed by Konkan Krishi Vidyapeeth, Dapoli (Maharashtra) through selection. It gives first harvest in 45 days after planting fruits are dark green in colour, 30-45cm long and tapering at both the ends. Fruits have good market value. A vine produces on an average 10-12 fruits.

Punjab Sadabahar: The plants of this variety are medium sized with dark-green leaves. The fruit long, 3-5cm thick, slim, green, ridged, tender, slightly curved and rich in protein. This variety can be sown from May–July and gives an average yield of 10 tonnes/ha. Released by Punjab Agricultural University, Ludhiana.

IIHR 8: This is developed by Indian Institute of Horticultural Research, Bangalore. The fruits are round and green in colour. Each vine produces 40-45 fruits. First harvest in 55 days after planting. A fruit weighs about 100g. It gives an average yield of 40 tonnes/ha. Besides high yield, IIHR 8 is moderately resistant to downy mildew. The fruits are attractive light green with good cooking quality especially for stuffing purposes.

PKM 1: It is suitable for *kharif* and summer seasons. The crop duration is 160 days. Fruits are dark-green in colour. The average weight of a fruit is 300g. It gives an average yield of 28-30 tonnes/ha.

Arka Sumeet: Fruits lush green, cylindrical, 35-45 cm long, it takes 50-55 days for first harvesting.

Arka Sujat: Fruits lush green, cylindrical, 55 cm long, 25 cm girth. Yield is 63 t/ha in 100 days.

Arka Sumeet **Arka Sujat**

Swana Manjari: Tolerant to powdery mildew. Fruits are elongated, medium sized, highly ridged, green with soft flesh. Days to first harvest 65-70 days.Yield is 20 t/ha.

Sponge gourd

Pusa Chikni*:* A selection from Bihar collection. Early fruiting variety, flowering in about 45 days. The fruits are smooth and dark-green colour, more or less cylindrical, 15-20 fruits per vine, suitable for both spring-summer and rainy seasons. Released by Indian Agricultural Research Institute, New Delhi.

Phule Prajakta*:* It is a selection from local germplasm. It is released by Mahatma Phule Krishi Vidyapeeth, Rahuri (Maharashtra). It is suitable for summer and *kharif* season. Fruits are medium green, flesh white, dark-green. Yield 15 tonnes/ha.

Pusa Supriya*:* It is released by Indian Agricultural Research Institute, New Delhi. It is suitable for summer and kharif seasons. Fruits are distinct, pale-green, medium- long, 15-20cm long, straight and slightly curved at the stem end, pointed distal- end with long peduncles, smooth, non-hairy, slim, narrow green linings and spots, tender endocarp, skin very thin, on an average 10-12 fruits weighing a kg. The fruits are ready for first picking at 47-55 days after sowing. A fruit weigh about 110g. It is an improvement over Pusa Chikni. It gives a 220% more yield than Pusa Chikni. It yields 8-9 tonnes/ha during spring-

summer and 10-11 tonnes/ha during *kharif* season.

Pusa Sneha: Suitable for long distance transport, fruits are dark green, 20- 25 cm long with hard skin and soft flesh. Yield 12 t/ha.

Soil

Both the crops can be grown on a variety of soil types. Loamy soils are considered best if there is a good amount of organic matter and if it is well drained. Soil should have good moisture-holding capacity especially in summer season. A well drained soil having pH 6.0-7.5, good fertility and high organic matter are ideal for cultivation of ridge and sponge gourds.

Climate

Both the crops are well adapted to a fairly wide range of climatic conditions. It also grows best during the rainy season. Luffa requires a long warm season for best production.. Optimum temperature requirement for these crops is 25°-27°C. Due to its hard seed coat, there is a problem with seed germination when the temperature is low. Excessive rainfall during the flowering and fruiting period reduces the yield considerably. Long day promotes femaleness.

Season

In areas having mild winters sowing can be done in October, which gives an early crop in March. In river beds, in northern India, sowing is done in November- January. The time of planting usually depends upon the season, location and market demand. The crop is grown in both the summer and rainy seasons. Summer season crop is sown in January-February and rainy season crop is sown in June-July.

Cropping systems: In garden land areas there is a definite systems of growing cucurbits in rotation and mixed cropping.

Preparation of land

In the riverbeds the trenches or pits are prepared as described under muskmelon.

The land should be prepared to obtain the tilth desirable to facilitate rapid and better germination. As per requirement of the crop the raised beds, furrows or pits are prepared and field is kept ready for planting.

Sowing

Both the sponge and ridge gourds are propagated through seeds. The seeds of sponge gourd are white and that of ridge gourd are black. The seeds are soaked in water for 12-24 hours before sowing to hasten the germination.Seed rate for ridge gourd is 3.5-5.0kg/ha and that of sponge gourd is 2.5-3.5kg/ha. The seeds are sown in raised beds, furrows and pits.

Spacing

In Maharashtra, a spacing of 1.5x1.5m is followed. With the pit system a spacing of 1.5-2.0m between the two rows and 1.0-1.5m between the two plants is advocated.For sponge gourd and ridge gourd the row to row distance of 1.5-2.5m and hill to hill distance of 60-120cm are kept. Two seeds per hill in the case of raised beds and three to four seeds per pit are sown.

Nutrition

Under Haryana conditions, farmyard manure 10-15 tonnes/ha and 40-60kg N, 30-40kg P_70_5 and 30kg of K,O/ha are recommended for both the crops. In addition to N 20-30kg should be top dressed at the time of vining. In Punjab, 100kg of N, 60kg of P_20_5 and 60kg of K_20/ha is recommended.Farmyard manures at the rate of 15-20 tonnes/ha should be mixed in the soil at the time of preparation of field. The super phosphate, potash and the half nitrogen should be applied as a basal dose and one-half nitrogen should be given as top dressing after one month of planting.

Irrigation

During the rainy season, irrigation may be required during the early growth period. No systematic work is done on requirement of irrigation water and its management in these crops.The summer crop must be irrigated regularly. The first irrigation should be given immediately after the sowing. Summer crops require more frequent irrigation than rainy season crops. Irrigation may be carried out according to the soil moisture status and season.

Weed control

Weeding should be done 15-20 days after the sowing. The second weeding may be done 20-25 days after the first one. The crop is kept weed free during the entire growth period.

Growth regulators

Foliar spray of NAA 200 ppm at two and four leaf stage increases the yield. In these crops, the female and male flowers are borne separately on the same plant. The sex ratio can be regulated by exogenous application of growth regulators NAA (200ppm) increases the female flower production in ridge gourd and in turn increases the yield significantly. In sponge gourd, exogenous application of Ethrel 250ppm has been found to be beneficial.

Training and pruning

The early crop can be allowed to trail on the bed itself. In northern India the crop is generally not trained and the vines are allowed to trail on the ground. Rainy season crop should be staked so that the fruits are prevented from direct contact with the soil.In small homestead gardens, ridge gourd and sponge gourd are trailed over trelises arbours or pendals at 1.5-2.0m height. Commercial crop are trained on a kniffen system. The crop is trained when the seedlings are about 10-15cm tall.

Harvesting and yield

Fruits should be harvested when they are still immature. Picking should be done every 3-4 days. If there is delay in harvesting, the fruits become more fibrous and are unfit for human consumption. Fruits are harvested when they are tender and still immature. The flesh should not turn fibrous and picking should be done earlier. The crop is ready for harvest in about 60-90 days after the seed sowing, depending upon the season and variety. The fruit attains a marketable maturity about 5-7 days after anthesis of the female flower. There are long fruited types of ridge gourd in South India and hence tenderness would decide edible maturity and not the fruit size.

Yield

Average yield of sponge and ridge gourds is 8-12 tonnes/ha.

Storage and marketing

Fruits harvested at the marketable stage can be stored for 3-4 days in a cool place without any adverse effects. Harvesting should be done at proper edible maturity. Grading of fruits should be done according to size. The fruits are packed in separate baskets. The

fruits are marketed in local and distant markets. The plastic crates are also used for packing of fruits.Care should be taken that the fruits should not have any injury during transit. The fresh and tender fruits should reach the consumer. The fruits are packed in bamboo baskets with proper padding to prevent injury in transit.

Questionnaire

1. Pusa Nasdar is a variety of

a. Ridge gourd b. Sponge gourd c. Bitter gourd d. Bottle gourd

2. A hermaphrodite variety of ridge gourd is known as Satputia widely cultivated in ---------- state.

a. Gujarat b. Bihar c. Madhya Pradesh d. Delhi

3. Yard Long Ridge gourd variety ---------- in nature

a. Monoecious b. Dioecious c. Androecious d. Gynoecious

4. The origin place of ridge gourd is

a. Ethiopia b. India c. Brazil d. China

5. *Luffa actungula* is botanical name of

a. Sponge gourd b. Ridge gourd c. Snake gourd d. round gourd

6. The average yield of sponge gourd is -----quintal per hectare.

a. 50-60 b. 60-70 c. 80-90 d. 120-150

7. ---------- is also known as four angled gourd or angled loofah.

a. Ridge gourd b. Sponge gourd c. Bitter gourd d. Pointed gourd

8. Basic chromosome number in sponge gourd is

a. 10 b. 12 c. 13 d. 16

9. Sponge gourd is strictly ------- in nature

a. Hermaphrodite b. Gynoecious c. Monoecious d. Andromonoecious

10. Pusa Chikni is a variety of

a. Sponge gourd b. Ridge gourd c. Snake gourd d. bitter gourd

11. Sponge gourd is ---------- crop.

a. Cross pollinated b. Self pollinated c. often pollinated crop d. Wind pollinated.

12. Flower colour of sponge gourd is

a. Deep white b. bluish c. deep yellow d. Pinkish

13. Luffa cylindrical is botanical name of

a. Ridge gourd b. Sponge gourd c. Snake gourd d. Bitter gourd

14. Long day promotes ---------- in sponge gourd

a. Maleness b. Femaleness c. Hermaphrodite d. No effect on sex

15. The average yield of sponge gourd varies from ----------q/ha

a. 50-60 b. 40-50 c. 60-80 d. 100-120

16. The origin place of Sponge gourd is

a. Asia b. Africa c. South America d. India

17. Sponge gourd is propagated by

a. cutting b. Tuber c. Seed d. Root

18. Ethrel 200 ppm and NAA 200 ppm sprayed on very young seedlings on sponge gourd stimulated the production of ----------

a. Male b. Female c. Hermophrodite d. None of the above

II. Say true or false.

1. Fruits of sponge gourd should be harvested when they are fully mature.

Ans: false.

2. Te genus Luffa derived its name from the product Loofah.

Ans: True.

3. Sponge gourd contains a gelatinous compound called Luffein.

Ans: true

4. The sponge gourd fruits contain higher Protein and carotene than ridge gourd.
Ans:True.
5. Pusa Supriya is a variety of ridge gourd.
Ans: False.

6. Pusa Nasdar and Punjab Sadabahar varieties of sponge gourd released by IARI, New Delhi and PAU Ludhiana, Ludhiana respectively.
Ans: False.

7. Luffa requires a kharif season for best production.
Ans: false

8. Optimum temperature requirement for Luffa species is 25-27^{0}C.
Ans: true.

9. A well drained soil having pH6-7.5 is ideal for cultivation of ridge and sponge gourd.
Ans: True.

10. Seed rate for ridge gourd is 3.5-5.0 kg/ha and that of sponge gourd is2.5-3.5 kg/ha .
Ans: True.

11. For ridge gourd and sponge gourd the row to row distance of 1.5-2.5 m and hill to hill distance 60-120cm are kept
Ans: True.

12. Commercial crop of sponge gourd and ridge gourd are trained on a Knifen system
Ans:true.

13. Exogenous application of growth regulator ethrel increases the female flower production in ridge gourd
Ans: False.

14. Ridge gourd is ready for harvest in about 120 days after the seed sowing.

Ans: False.

Lecture 29. Origin, area, production, economic importance, description of varieties and hybrids, climate, soil requirement, seed rate and preparation of field, sowing, spacing, irrigation, nutrition, inter culture, harvesting and yield of summer squash

- Area and production
- Economic importance
- Varieties
- Climate
- Soil
- Season
- Preparation of land
- Spacing
- Nutrition
- Interculture
- Harvesting and yield

SUMMER SQUASH

Botanical name :***Cucurbita pepo***
Family : Cucurbitaceae
Chromosome number : 2n=40
Origin : America probably in north-eastern Mexico
Common name : Vilayatikaddu or Chappan kaddu or Safed Kaddu

Area and production

This crop is grown in limited scale in Punjab, Delhi and UP**.** Summer squash or vegetable marrow or field pumpkin is a quick growing and early yielding cucurbit which is cultivated throughout India. The fruits however, have many shapes and sizes. Summer squash is an annual bush or vine often trailing in habit. They produce stem with greatly shortened internodes and set fruits in close succession.

Economic importance

The fruits are picked before the seeds and skins become hardened, and used as vegetable. Generally the fruits are ready for picking in about six weeks and are picked tender within a few days after pollination. The immature fruits are used as vegetable. These bush squashes do not store well. They are also used for feeding animals.

Varieties:

Variety	Source	Remarks
Punjab Chappan Kaddu	Punjab Agricultural University	It is an inbred selection from the segregating local variety of Punjab. Plants are bush-type, foliage thick and erect leaves non-lobed and green without white specks, mild ribbed with flat stem end and attractive, average fruit weight is 80g and bears 10 fruits per plant, early maturing and is ready for first harvest in about 60 days from sowing. It has a predominant female tendency, field resistance to downy mildew and red pumpkin beetle. It is high yielding and gives about 20-25 tonnes/ha.
Patty Pan	IIHR, Bangalore	An introduction from USA and recommended by IIHR for cultivation during 1972. A bush type and fruits are disc-shaped, chalky white, tender and very attractive at edible stage. A short-duration variety (85-90 days), yield 54 tonnes/ha.
Early Yellow Prolific	IARI, Regional Station, Katrain	An early bush type variety. Fruits are medium sized, warted and tapering towards stem end. Light yellow skin turns to orange yellow on maturity. Flesh is tender at the stage it is consumed as vegetable.
Australian Green	IARI, Regional station, Katrain	An introduction. Very early bush-type variety. Green fruits are dark-green with longitudinal white stripes all over, 25-30cm long, 15-20 fruits/ plant and very tender at edible stage. Yield 15-16 tonnes/ha.
Pusa Alankar	IARI, Regional station, Katrain	An F1 hybrid between EC 207050 and Sel 1, PI 8 (a derivative from cross between chappan and Early Yellow Prolific), early maturing, having uniform dark green fruits with light-coloured stripes, slightly tapering towards the stem. The flesh is tender delicious and fruits mature in 45-50 days. High yield 20-30 tonnes/ha

Punjab Chappan Kaddu **Patty Pan**

Climate

It can be grown both in high and low temperature conditions. The plants can be grown successfully between a temperature range of 24°-27°C. It does not tolerate frost.

Soil

A well drained sandy loam soil with high organic content is considered best. They are sensitive to acidic soils and alkaline soils with high salt concentration are unsuitable.

Season

It can be grown in Feburary-March and June-July and October-January. In hills the optimum sowing time is April-May.T he rainy season crop is sown in April to May in West Bengal. In Tamil Nadu , optimum sowing time of rainy season is July to August.

Preparation of land

The field is ploughed four or five times and bring the soil to a fine tilth.

Spacing

In summer season, pits of size 45 x 45 x 45cm can be dug at a spacing of 1 x lm. The pit can be filled with a mixture of farmyard manure (20-25 tonnes/ha) and top soil. In rainy season raised beds or mounds are made to facilitate drainage. In river beds of North India, summer squash is a direct sown crop and sown in trenches.

Nutrition

Farmyard manure about 20-25 tonnes/ha should be applied at the time of soil

preparation. No research work has been done in the fertilizer requirement of vegetable marrow.

Fertilizer recommendation in different states of India.

State	N (kg/ha)	P (kg/ha)	K(kg/ha)
Punjab	100	50	50
Himachal Pradesh	150	100	50
Karnataka	100	100	40
Madhya Pradesh	60	50	50
Tamil Nadu	32	24	24
Assam	75	80	80

Interculture

Weeding should be done frequently in order to keep the weeds under check. First weeding is done 15-20 days after sowing. Irrigation should be given at an interval of 3-4 days depending upon season and type of soil. Application of ethephon 250 ppm increases the yield.

Harvesting and yield

The fruits are harvested when they are at one third maturity. Tender fruits are liked by the consumer. The crop will be ready for harvest in about 60-80 days after seed sowing. Fruits will become fit for harvest in about 7 days after fruit set. The picking should be done at an interval of 2-3 days in order to get highest fruit yield.

The yield ranges from 20-30 tonnes/ha in crop duration of 85-90 days.

Questionnaire

1. ---------- are also known as marrow or musky gourd.

a. Bitter gourd b. Sponge gourd c. Squashes d. Snake gourd

2. The other relatives of pumpkin is

a. ***Cucurbita pepo*** b. *Momordica charanta* c. *Citurllus vulgaris* d. *Benincasa hispida*

3. Lutein alkaloid is found in

a. *Cucurbita muschata* b. ***Cucurbita maxima*** c. Pointed gourd d. None of the above

4. Scientific name of summer squash is

a. *cucurbita moschata* b. *Cucurbita maxima* c. ***Cucurbita pepo*** d. *Cucurbita mixta*

5. Summer squash is originated from

a. Africa b. Asia c. America d. Europe

6. Summer squash variety patty pan released by

a. IIHR b. IARI c. IIVR d. None of the above

7. Australian green is a variety of

a. Winter squash b. Summer squash c. Pumpkin d. Cucumber

8. Summer squash plants can be grown successfully between temperature ranges of

a. 15-20^{0}C b. 24-27^0 C c. 30-32^0 C d. None of the above

9. Summer squash ready for harvest in about ---------- days after seed sowing

a. 40-50 b. 60-80 c. 80-90 d. 100-120

10. The yield of summer squash ranges from -----t/ha

a. 10-15 b. 15-18 c. 20-30 d. 40-50

11. Winter squash is botanically called

a. ***cucurbita maxima*** b. *Cucurbita pepo* c. *Cucurbita moschata* d. *Cucurbita mixta*

12. Summer squash is ---------- in nature

a. Monoecious b. Dioecious c. Androecious d. Gynoecious

II. Say true or false.

1. Arka Suryamukhi a summer squash variety, has been recommended by IIHR, Bangalore.

Ans: False.

2. Basic Chromosome number of winter squash is 22.

Ans: False.

3. Summer squash is also called Vilayati kaddu or chappan kaddu

Ans : True.

4. Punjab chappan kaddu is field resistance to Downey mildew disease and red pumpkin beetle.

Ans:,True.

5. Pusa Alankar an F1 hybrid derivatives from cross between Chappan and early yellow prolific.

Ans: True.

6. Arka Suryamukhi is a variety of *cucurbita moschata*.

Ans: false.

7. Arka Suryamukhi is susceptible to fruit fly insect.

Ans: False.

8. F1 hybrids obtained from interspecific hybridisation between summer squash and winter squash are normally fertile.
Ans:False.

9. Early yellow prolific released by IARI.
Ans: True.

10. Squashes are sensitive to Acidic and alkaline soils.
Ans: True

11. Usual spacing for cultivation of squashes is 2 x 2 m.
Ans: false.

Lecture 30. Origin, area, production, economic importance, description of varieties and hybrids, climate, soil requirement, seed rate and preparation of field, sowing, spacing, irrigation, nutrition and weed management, harvest, post harvest handling and storage of ash gourd

- Area and production
- Economic importance
- Varieties
- Soil and climate
- Season
- Seed sowing
- Spacing
- Nutrition
- Irrigation
- Weeding
- Harvesting and yield
- Storage

ASH GOURD

Scientific name	**:**	*Benincasa hispida*
Family	**:**	Cucurbitaceae
Chromosome number	**:**	2n=24
Origin	**:**	Java and Japan
Common name	**:**	Wax gourd

Area and production

In India, presently it is grown in area of 2497 ha with annual production 15326 tonnes having the productivity of 6.13 /ha. It is mainly grown in North India, especially in Uttar Pradesh, where it is used in the preparation of Petha sweet. Agra Petha is famous all over India. Ash gourd is cultivated throughout the tropical and subtropical regions of Asia, including south China.

Economic importance

The tender leaves and buds are also used as vegetable. It is primarily grown for its young and mature fruits, which are consumed as such or used to make sugar candies. The surface of the fruit is covered with a bluish-white, 'waxy' ash. The fruit has a long shelf life.

Fruits contain 0.4% protein, 1.9% carbohydrates, 0.3% minerals and traces of vitamin A, B and C per 100g edible portion. Ash gourd is considered good for people suffering from nervousness.

Varieties

There are two types of ash gourd, purple-green and green. They are also classified as round and oblong types. Ash gourd is an annual hispid (rough with bristle-like hairs), climbing, herbaceous monoecious plant varying several meters in length.

CO 1

Medium duration, fruits are globular in shape weighing 5-6 kg with less seeds. Six to eight fruits are borne on a vine. The crop duration is 140 days. Released by Tamil Nadu Agricultural University, Coimbatore.

CO 1

CO 2

CO 2

Early maturing variety (120 days), fruits small weighing 3kg, long spherical in shape,

less seeds (around 200-300 seeds), light green coloured flesh, higher yielder than CO 1. Released by Tamil Nadu Agricultural University, Coimbatore.

Mudaliar

Fruits are big, pale-green in colour. It is recommended for Tamil Nadu by Tamil Nadu Agricultural University, Coimbatore.

Mudaliar

Indu

Indu

Medium sized round fruits, tolerant to mosaic disease, average fruit length is 24.3 cm and fruit breadth is 23.78 cm and productivity is 24.5 tonnes per hectare. It was developed by Kerala Agricultural University, Thrissur.

Shakthi

It is recommended by Andra Pradesh Agricultural University, Hyderabad. Friuts are long, cylindrical, yield 30 to35 t/ha in 140 to150 days.

Karikumbala

It is developed by University of Agricultural Sciences, Bangalore. Local cultivar having dark green fruits without ashy coat.

Karikumbala **Boodikumbala**

Boodikumbala

Local cultivar where dark green fruits are covered with ashy coat. It is developed by University of Agricultural Sciences, Bangalore.

IVAG-502

Fruits are oblong with average weight of 12 to13 kg. Yield is 30 to35 t/ ha. It is evolved at IIVR, Varanasi.

Soil and climate

Sandy loam soils with high organic matter are considered best for ash gourd. The optimum soil pH is 6.0-7.0. This crop requires a warm and humid climate. The optimum temperature requirement is 24°-30°C. Short days, low night temperatures and humid climate are good for production of female flowers. It can be grown in mild climate, but it is sensitive to frost.

Season

In Northern plains of India, summer crop is sown February – March, whereas, in rest of India, it is sown in December –January. Ash gourd can be grown in both the summer and rainy seasons. It is commonly grown in February-March on the river bed cultivation. Planting time is June-July.

Seed sowing

The recommended seed rate for ash gourd is 5-7kg/ha. The seeds are sown on raised bed or in furrows or in pits. Two seeds per hill are sown on both sides of a raised bed, whereas 3-4 seeds are sown per pit.

Spacing

The recommended row to row spacing of 1.5-2.5m and plant to plant spacing of 60-120cm are recommended for ash gourd.

Nutrition

The quantity of well rotten farmyard manure at the rate of 15-20 tonnes/ha is applied to the field at the time of preparation of land. Fertilizer dose of 45-60 kg Nitrogen, 50-60 kg Phosphorous and 60-80 kg Potassium /ha is recommended for good growth and development of plant.

Irrigation

Less irrigation is needed for rainy season crop. During summer season, regular and frequent irrigation is needed during the vegetative phase. Intervals between irrigations may be maintained at 6-7 days depending upon the season and soil type. When crop mature, irrigation intervals may be increased.

Weeding

A total of 4-5 hand weedings are needed for the whole crop season. Hand weeding is done 15-20 days after seed sowing. The crop should be kept weed free for better growth.

Harvesting and yield

Both the immature and mature fruits are harvested. After anthesis, the immature fruits are harvested in a week and after 30-40 days for mature fruits. Ash gourd starts flowering 60-80 days after planting. Immature fruits need to be sending to the market early after harvesting. The mature fruits are harvested and stored. The fruit at maturity have a white waxy surface. There is a more wax bloom on ripening fruit and the peduncle withers. Average yield of ash gourd is 10-15 tonnes /ha.

Storage

Ash gourd can be stored longer than any other cucurbits. The waxing of the stem end prevents entry of pathogens.The fruits have good storage quality and can be transported long distance via truck. The fruit is mainly purchased by the confectioners, who use them to prepare Petha.

Questionnaire

1. Petha Kadu is known as

a. Pumpkin b. Ridge gourd c. Smooth gourd d. Ash gourd

2. Wax gourd is mainly grown in

a. Tamil Nadu b. Kerala c. North India d. None of the above

3. Ash gourd is considered good for people suffering from

a. Dysentery b. Stomach ache c. Nervousness d. High blood pressure

4. Short days, low temperature and humid climate are good for production of ---------- flowers in ash gourd.

a. Male b. Female c. hermaphrodite d. Both male and female

5. The recommended seed rate per hectare for ash gourd is

a. 2-3 kg b. 1-2 kg c. 5-7 kg d. 10-12 kg

6. Agra Petha, famous all over India is prepared from

a. Bottle gourd b. Pumpkin c. Muskmelon d. Ash gourd

7. Basic chromosome number in wax gourd is

a. 10 b. 12 c. 14 d. 16

8. Under good crop management, an average yield of ash gourd is ----------q/ha

a. 50-60 b. 100-150 c. 300-400 d. 600-1000

9. Wax gourd is -------- and annual climber

a. Monoecious b. Dioecious c. Trioecious d. Gynodioecious

10. *Benincasa hispida* is botanical name of

a. Snap melon b. Round melon c. Water melon d. Wax gourd

II. Say true or false.

1. Immature fruits of wax gourd are harvested and taken for preparing sweet known as peetha.
Ans: False.

2.CO-1 And CO-2 are improved varieties of wax gourd .
Ans: True.

3. India is the origin of Ash gourd.
Ans: False.

4. Purple green and green are the types of ash gourd.
Ans: True.

5. Optimum temperature requirement of ahs gourd is15-20^{0}C.
Ans: false.

6. High night temperature and humid climate are good for production of female flowers in ash gourd.
Ans: False.

7. Ash gourd is grown in both winter and rainy seasons.
Ans : false.

8. Seed rate for ash gourd is 2-3 kg/ha
Ans: False.

9. Spacing for ash gourd is 1.0 - 1.5 X 90-120 cm
Ans: False.

10. Mudliar is a variety of Ash gourd.
Ans: True.

Lecture 31. Origin, area, production, economic importance, description of varieties and hybrids, climate, soil requirement, seed rate and preparation of field, sowing, spacing, irrigation, nutrition and weed management, harvest, post harvest handling, storage and marketing of snake gourd

- Area and production
- Economic importance
- Varieties
- Climate
- Soil
- Season
- Seed rate
- Spacing
- Nutrition
- Irrigation
- Training
- Harvesting and yield
- Storage and marketing

SNAKE GOURD

Scientific name	**:**	*Trichosanthes cucumerina*
Family	**:**	Cucurbitaceae
Chromosome number	**:**	2n= 22 or 24
Origin	**:**	Indian Archipelago

Area and production

Snake gourd is popular vegetable in south India and also grown in Punjab, Delhi, Utter Pradesh , Bihar and some parts of the country. South-East Asia and tropical Australia**.** *T. cucumerina* is cultivated widely in south and south-east Asia. Wild forms of the species occur naturally from India to Australia.

Economic importance

It is a monoecious, annual, herbaceous climber. The immature fruit is boiled and eaten. The fruits are slender, long tapering and 30-150cm long. Occasionally, shoots and tender leaves are also used as vegetable.

Fruit improves the appetite, acts as a tonic and stomachic and cures bilousness. The root and seeds are anthelmintic and are also used in the treatment of diarrhoea, bronchitis and fever. The fruits are long, narrow, cylindrical and pointed at both the ends. The fruits are rich in carbohydrates, proteins, minerals and vitamins A, B and C.

Varieties

CO 1

An early maturing cultivar, first fruit comes to harvest in 70 days. Fruits are long (160-180cm), dark-green with white stripes, flesh light green, 10-12 fruits per vine are borne weighing 4-5kg. Mean yield of fruits per hectare is 18 tonnes. Developed by Tamil Nadu Agricultural University, Coimbatore.

CO 2

It is a selection, bearing short fruits (30cm long). Fruits are light greenish white. It gives an average yield of 35 tonnes/ha with a duration ranging from 105-120 days. It is suitable for high density planting. Developed by Tamil Nadu Agricultural University, Coimbatore.

PKM 1

It is an induced mutant from H.375 and yields on an average of 25.5 t/ha in crop duration of 145 days. The vines are vigorous growing. Fruit color is dark green with white stripes on outer side and light green inside, with a mean fruit weight of 700 g. The fruits are extra long (180-200 cm) and suitable for growing all through the year.

MDU 1

It is a F1 hybrid between Panripudal and Selection-1 from Thaniyamangalam. It is an easily flowering type (84 days) with a sex ratio of 1:38. It produces 13 fruits per vine weighing 7.15 kg with an average yield of 31.75 t/ha in a crop duration of 145 days. The fruits are medium long (66.94 cm) with white stripes under green background. Each fruit on an average weighs 55g. The fruits are fairly rich in vitamin-A (44.4 mg/100g) and very low in fibre content (0.6%).

PLR(SG) 1

It is a pure line selection from white long type. This variety is suitable for cultivation under irrigated conditions only. Excellent cooking quality due to less fibre and high flesh content and does not twist due to maturity. This is having a yield potential of 35 – 40 t/ha with 30.50 % increase over CO 1. This variety can be cultivated during June – September, November – March and April – May. It is highly adoptable to Cuddalore, Villupuram, Vellore, Tiruvannamalai, Kancheepuram, Tiruvallur and Perambalur districts of Tamil Nadu. It thrives best in well drained, organic matter rich, sandy loam soil.

TA 19

It is new collection recommended by the Kerala Agricultural University. Fruits are about 60cm long. At immature stage they are light green with white stripes at the stylar end. The average fruit weight is 600g and the fruits are ready in 65-70 days from sowing.

Konkan Swetha

It is developed by Konkan Krishi Vidyapeeth, Dapoli (Maharashtra). The fruits are medium long (90-100cm) and white in colour. Fruits have good flesh if harvested timely otherwise it becomes hollow. Average yield is 15-20 tonnes/ha. The crop duration is about 120-130 days.

APAU Swetha

Fruits are long with green strips in white background .Yield is 28-30 t/ha.

Kaumdhi, Baby and Manusree

These varieties are released from Kerala Agricultural University. These varieties are high yielding, attractive and suitable for easy handling and marketing.

Climate

Like other cucurbitaceous crops, it needs a warm and humid climate for best growth. High humidity is favourable for growth and fruit development. It cannot be successfully grown above an altitude of 1500 meters.

Soil

The most ideal soil for snake gourd is rich loamy or sandy loam soil. However, other soils can be used, as long as they are well drained and rich in organic matter.

Season

The summer season crop is sown in December - January and rainy season that of June - July. It is also planted in October - November where winters are mild. It is grown in both the

kharif and summer seasons.

Seed rate Seeds are sown in the hills near the edges of raised beds or pits. Seed rate for snake gourd is 5-6kg/ha seed.

Spacing

Row to row spacing of 1.5-2.5m and plant to plant spacing of 60-120cm are advocated for snake gourd.

Nutrition

Ten to fifteen tones/ha of farmyard manure should be incorporated during the preparation of field. Besides, 40-60kg nitrogen, 30-40kg phosphorus and 30-40kg potassium are applied. Half dose of nitrogen (20-30kg/ha) should be top dressed when the plants start bearing.

Irrigation

For summer crop, regular irrigation at 3-5 days intervals is necessary to maintain the desired soil- moisture level. At the time of fruit set and its development the frequency of irrigation should be maintained. There should not be any dry spell during this period. The first irrigation is given immediately after the sowing.

Training

The bower system of training is best for snakegourd. To obtain straight fruits, some growers tie weights to the bottom end of fruits. This facilitates hanging of the fruits which in turn enables them to grow straight downwards.The fruits are very long, slender and very soft it is always advisable not to allow the fruits to touch the ground. In other words, if the fruits are hanged, they generally grow downward straight. Therefore, training is essential to snakegourd.

Harvesting and yield

Fully mature fruits are lighter, fibrous, and hard and these kinds of fruits are not generally preferred in the market.Fruit set in snake gourd starts at the beginning of second month. Fruits are hand picked when they are still tender and about 1/4-1/3 their full size. A vine yields about 20-25 fruits and if it is properly managed, it can produce as many as 40-50 fruits in about 2-3 months. As the fruits have short shelf-life they should be sent to market promptly. The fruits need to be immediately packed in baskets or in other containers to protect them from injuries during transport. Average yield of snake gourd is 8-10 tonnes/ha.

Storage and marketing

In Maharashtra, some people cut the fruits into three to four pieces and tie them before sending to market on large scale. Generally the whole fruits are packed and then sent to the markets.After harvesting the fruits are sent to the markets as they do not have shelf-life more than two days.

Questionnaire

I ENCIRCLE THE MOST APPROPRIATE ANSWER

1. The origin place of snake gourd is

a. Asia b. China c. India d. Ethiopia

2. ---------- is also known as chinchida or Pallakaya

a. Bitter gourd b. Snake gourd c. Ash gourd d. Pumpkin

3. Basic chromosome number in snake gourd is

a. 14 b. 20 c. 24 d. 34

4. Snake gourd is a popular vegetable of

a. North India b. South India c. Central India d. western India

5. *Trichosanthes anguina* is a botanical name of

a. Snake gourd b. Bitter gourd c. Bottle gourd d. Pumpkin

6. Fruit length of snake gourd goes upto ---------- cm in length

a. 45 b. 60 c. 90 d. 150

7. Under ordinary condition, harvested fruits of snake gourd can easily be kept for about ---------- days

a. 10 b. 7 c. 15 d. 3

8. ---------- seeds per hectare are needed for snake gourd cultivation

a. 5-6 kg b. 1-2 kg c. 3-4kg d. 10-12 kg

9. The average yield of snake gourd is about ---------- quintals per hectare under good crop management

a. 70-80 b. 100-110 c. 70-90 d. 150-200

10. Snake gourd belongs to family

a. Solanaceae b. Cruciferae c. cucurbitaceae d. None of the above

11. Snake gourd is ---------- in nature

a. Monoecious b. Dioecious c. Gynoecious d. Androecious

II. Say true or false.

1. Snake gourd can be grown in Kharif and winter seasons .

Ans: False.

2. The winter season crop of snake gourd is sown in December – January months.

Ans: False.

3. The most ideal soil for snake gourd is clay loam.

Ans: False.

4. Co-2 and Co-4 varieties of snake gourd developed by TNAU, Coimbatore.

Ans: True.

5. Row to row spacing of 1.5-2.5m and plant to plant spacing of 60-120 cm are advocated for snake gourd.

Ans: True.

6. Snake gourd fruits are rich in vitamins, proteins and minerals.

Ans: False.

7. The roots and seeds of snake gourd are used in the treatment of diarrhea, bronchitis and fever.

Ans: True.

8.40-60: 30-40 and 30-40 kg NPK is recommended for raising one hectare area of snake gourd.

Ans: True.

9. Fruits of snake gourd are picked when they are fully mature.

Ans: False.

10. Normally snake gourd fruits are stored for 2-3 days in ordinary conditions.

Ans: True.

Lecture .32. Origin, area, production, economic importance, description of varieties and hybrids, climate, soil requirement, propagation and preparation of field, spacing, irrigation, nutrition and inter cultivation, harvest, post harvest handling, storage and marketing of pointed gourd

- Area and production
- Economic importance
- Varieties
- Climate
- Soil
- Propagation
- Production technology
- Nutrition
- Inter cultivation
- Harvesting and yield
- Storage and marketing

POINTED GOURD

Scientific name	**:**	*Trichosanthes dioica*
Family	**:**	Cucurbitaceae
Chromosome number	**:**	2n=24
Origin	**:**	India or the Indo-Malayan region
Common name	**:**	Parwal

Area and production

Pointed gourd is a perennial cucurbit extensively cultivated mostly in Bihar, Bengal, Madhya Pradesh , West Bengal, Assam and eastern Uttar Pradesh. *Trichosanthes dioica* (2n=22) is a dioecious climber with perennial rootstock. It is found in nature and also cultivated in south Asia.

Economic importance

It contains 2% protein, 0.3% fat, 2.2% carbohydrates, 153 IU vitamin A and 29mg

vitamin C per 100g edible portion. The fruits are used in making curry and fried and for making pickles. A famous sweet by putting the fruits in sugar syrup is made in India.

Immature fruits of pointed gourd are used as vegetables. It is recommended also for bronchitis, biliousness high fever and nervousness.The fruit is particularly recommended during convalescence. It is easily digested and is a diuretic, laxative, and cardiatonic.

Varieties

Not much systematic research work has been done to develop the improved varieties in pointed gourd. However, some improved strains are developed through selection from local germplasm in India which are grown in various states. These are as follows:

Madhya Pradesh - Green oval, green long striped and white oval. (In this state generally pale-white oval cultivars are popular).

West Bengal - Kazil, Bombay and Damodar.

Uttar Pradesh - Dandli, Kalyani, Guli, Bihar Sharif, FP 5, FP 4, FP 1 and FP 3.

Swarna Rekha

Elongated green fruits with stripes and soft seeds. Yield 15 -20 t/ ha in 220 -240 days.

Swarna Rekha

Swarna Alaukik

Swarna Alaukik

Fruits elongated and light green. Yield 20-25 t/ha in 220-240 days. Suitable for sweet preparations.

Rajendra Parwal 1

Fruits are green with stripes, long and tapering at both ends. Average fruit weight is 40 g. Yield is 17.5 t/ha.

Rajendra Parwal 1 **Rajendra Parwal 2**

Rajendra Parwal 2

Fruits are drum shaped, whitish green with light stripes, average fruit weight is 30 g. Yield is 16 t/ha.

Konkan Haritha

Fruits dark are green, 30-35 cm long tapering at both the ends, yields 10 -12 fruits per vine.

Climate

Hot and humid climate is best for its development. It is a warm season crop. During winter, it becomes dormant and sprouts again in summer. Rainfall is considered very well for pointed gourd but coastal climate is not suitable.

Soil

Both the sandy loam and loamy soils are best for growth and development of this crop. The soil should be well drained and rich in organic matter. It is also grown in the riverbeds.

Propagation

In order to plant one hectare area of pointed gourd, about 2,000-2,500 cuttings are required. Pointed gourd is vegetatively propagated through vine cuttings and root suckers. Seed propagation is avoided in pointed gourd because of poor seed germination and since it is dioecious in nature produces male and female plants in equal proportion if they are planted

from the seeds. In other words, 50% plants are non-fruiting (i.e. male plants). In order to ensure maximum fruit set and yield only 10-12% male plants are maintained in the garden to ensure the source of pollinizer and remaining plants must be female ones.

Production technology

Vine cuttings are transplanted in August on upland and in November on riverbeds, with a spacing of 2 x 2m. Vine cuttings are folded in the shape of a ring and planted in pits, keeping the ends above ground. Also straight vine cuttings are planted in a furrow filled with farmyard manure and soil, keeping the cutting ends above ground. Since the crop is dioecious, after every 10 female plants, a cutting from a male plant is planted. In root cuttings, roots from old vines are separated and planted either in nursery or in the field.

Nutrition

At the time of land preparation 20-25 tonnes of farmyard manure per ha is mixed with the soil in the furrows or in pits. A fertilizer dose of 90kg of N, 60kg of P_20_5 and 60kg of K_20 per hectare is advocated to the pointed gourd.

Inter cultivation

Water should be given as and when required. Early irrigation should be done more frequently. During the rainy season, less irrigation is required. Training the crops over bowers gives high yields. Picking also becomes very easy if the vines are trained. Weeding should be done only when plants have sprouted and are well set. Shallow intercultural operations should be followed.

Harvesting and yield

Harvesting should be done when the fruits are immature, tender and still green. Picking should be done frequently so that maximum fruits could be harvested from a vine. Pointed gourd is ready for harvest in 80-90 days after planting.Yield varies from 6-8 tonnes/ha in the first year, while it may increase to 14-15 tonnes/ ha during the second year.

Storage and marketing

Fruits after harvesting can be stored under ordinary conditions for about 3-4 days. Fruits are sent to the markets in the baskets or gunny bags.

Questionnaire

I ENCIRCLE THE MOST APPROPRIATE ANSWER

1. ---------- is also known as Parwal

a. Snake gourd b. Little gourd c. Pointed gourd d. Ridge gourd

2. ---------- is original home of Parwal

a. Bihar b. Orissa c. Uttaranchal d. Bengal

3. ---------- is considered as King of Gourds

a. Ridge gourd b. Snake gourd c. Little gourd d. Pointed gourd

4. For planting of one hectare area of pointed gourd, about ---------- cuttings are required

a. 200-500 b. 500-1000 c. 5000-10000 d. 2000-2500

5. Pointed gourd is commercially propagated by ----------

a. seed b. Root c. Rhizome d. Cutting

6. ---------- is botanically known as *Trichosanthes dioica*

a. Snake gourd b. Pointed gourd c. Ridge gourd d. Ash gourd

7. ---------- is a dioecious perennial, climbing or trailing in habit

a. Ash gourd b. Pointed gourd c. Water melon d. Spinach

8. Pointed gourd is most favourite vegetable in ----------

a. Maharashtra b.Assam c. Uttar Pradesh d. Gujarat

9. The vines of Pointed gourd come in dormancy in

a. spring season b. Rainy season c. Winter season d. Summer season

10. Pointed gourd is good crop for ---------- cultivation

a. Marshy land b. Rainfed c. Riverbed d. Hilly area

11. The Origin place of pointed gourd is ----------

a. Ethiopia b. Asia c. China d. India

12. Basic chromosome number in pointed gourd is ----------

a. 14 b. 48 c. 22 d. 32

13. Fruits after harvesting can be stored under ordinary conditions for about ---------- days

a. 7-10 b. 3-4 c. 10-15 d. 15-20

14. Pointed gourd belongs to family ----------

a. Solanaceae b. Cucurbitaceae c. Cruciferae d. Leguminoceae

15. ----------enhanced post harvest life of pointed gourd

a. GA b.NAA c. Salicylic acid d. Alar

16. Bitterness in Pointed gourd is due to ----------

a. Lutein b. Trichosanthin c. Momordiacin d. None of above

II. Say true or false.

1. Fruit of pointed gourd should be harvested when they are young and tender.

Ans: True.

2. Pointed gourd is a monoecious in nature .

Ans: False.

3. Pointed gourd is mainly propagated by seeds and root cuttings .

Ans: False

4. Spacing maintained for growing of pointed gourd is 3 x3 m.

Ans: False.

5. Fertilizer requirement of 90, 60 and 60 kg of NPK per hectare is recommended for pointed gourd plants.
Ans: True.

6. Pointed gourd is ready for harvest in 80-90 days after planting.
Ans: True.

7. Fruits of pointed gourd can be stored under ordinary conditions for about 3-4 days.
Ans: True.

Lecture 33. Origin, economic importance, description of varieties and hybrids, climate, soil requirement, preparation of field, planting, spacing, irrigation, nutrition and weed management, harvest and yield of Chow -Chow

- Economic importance
- Varieties
- Production technology

CHOW-CHOW

Botanical name : *Sechium edule*

Family : Cucurbitaceae

Chromosome number: 2n=24

Origin : **S**outhern Mexico and Central America

Common name : Chayote

Economic importance

It is grown principally for its pear-shaped fruits, which are cooked in many ways. The fruits, tubers, seeds, and leaves have long been used by the native Americans. The seeds are even considered a delicacy. Chayote has now spread throughout the tropics and subtropics.

The fruits are fleshy and pyriform with longitudinal furrows, about 10-20cm long and contain a single, large, flat seed about 5x3cm.

Varieties

Variations in fruit shape and colour occur in chow-chow and cultivars like Round White, Long White, Pointed Green, Broad Green and Oval Green are met with. In Bangalore region, two types *viz.*, green and creamy-green are grown. In North-East India, these types are met with besides minor variations in the fruit shape.

Production technology

Chow-chow grows well in well drained, loose soil rich in organic matter. The ideal pH is 5.5-6.5. A mature fruit containing a single germinating seed is planted to a depth of two thirds of its length in prepared planting holes, with the widest end downwards. Fruit used for seed should be carefully handled, not stored at <10°C, and planted without much delay. The single seed is located near the broad end of the pear-shaped fruit. Plant or seeds are placed in hills spaced 2m and rows 3.5m apart. Plant requires support by poles or a trellis.

Three to four months after planting the vines start flowering and production is continuous. In Bangalore regions, planting is done all round the year, but preferably in July. Pits or basins of 45-60cm diameter are dug and planting can be done. Pits are spaced at 1.8 x 2.4m. The pits are well manured before planting with 10-15kg of cattle manure per pit and sometimes seedlings raised in pots are transplanted. They are staked to reach the trellis. Under Bangalore conditions, fruiting is all round the year. A well grown plant of about one year yields 500-600 fruits per year. The crop is semi-perennial, lasting 3-4 years. The fruit weighs 200-150g. In North-East India fruits are slightly bigger. Average yield of 20-25 tonnes/ha has been recorded in different parts of the country.

Questionnaire

I. Encircle of the appropriate answer:

1.Scientific name of Chow-Chow is

a)*Coccinia indica* b)*Sechium edule* c)*Trichosanthes dioca* d)*Trichosanthus cucumeria*

2.Chow Chow belongs to family

a) Cucurbitaceae b) Cruciferae c) Convolvulaceae d) Compositae

3. Basic chromosome number of Chow - Chow is

a) 22 b)26 c)24 d)30

4. Origin of Chow- Chow is

a). Southern Mexico b)India c)Iran d)Africa

5. Ideal PH for growing Chow-Chow is

a) 5.5-6.5 b) 7-7.5 c) 4-5 d) None of the above

6. Chow –Chow is propagated through

a) Seeds b) Tubers c) Cuttings d) suckers

7. Chow-Chow is

a) Annual b) Biennial c) Perennial d) None of the above

8. Common name of Chow-Chow is

a)Chayote b) Parwal c) Wax Gourd d) Khira

9. An Average yield of Chow –Chow is _____t/ha.

a) 10-12 b) 15-18 c) 20-25 d) 30-40

10.Best season for planting of Chow- Chow should be

a) January b) March c)July d) October

II. Say true or false.

1. Chow –Chow belongs to cruciferous vegetable.

Ans: False.

2. Pits are used for planting of cuttings in Chow-Chow.

Ans: True.

3. The preferred spacing of Chow- Chow is 1.8× 2.4m.

Ans: True.

4. Edible part of Chow -Chow is tuber.

Ans: False.

5. Chow –Chow is predominantly grown in Bangalore regions.

Ans: False.

6. A well grown plant yields 500-600 fruits per year.

Ans: False.

7. Chow-chow is susceptible to frost injury.

Ans: True.

8. Fruits of Chow-Chow contain many seeds in a single fruit.

Ans: False.

9. Chow-Chow plant requires support for growth and development.

Ans: True.

10. Chow-Chow is a perennial vegetable.

Ans: True.

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