PRODUCTION TECHNOLOGY OF VEGETABLES AND FLOWERS



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LECTURE-1: Olericulture- Definition- Importance of vegetables in human nutrition and national economy – types of vegetable gardens

Olericulture is one of the branches of Horticulture that deals with the vegetables. The word olericulture is derived from the Latin word **Oleris** which means pot herb and the English word **culture** which means cultivation. Thus olericulture means cultivation of pot herbs. However, in the present days, it is bradly used to indicate the cultivation of vegetables. The term vegetable gardening is more popular to signify olericulture in the present context.

Vegetable: The term vegetable is applied to the edible herbaceous plant or plant parts thereof, which are consumed generally in the unripe stage after cooking.

Importance of vegetables in human nutrition:

The balanced diet contain adequate energy source, nutrients and vitamins, mineras, carbohydrates, fats, protein etc.

Vegetable are the reliable source for many dietary factors.

As vegetable contain many of the dietary factors like vitamins, minerals and amino acids they are considered as **protective supplementary food**.

They produce taste, increase appetite and produce fair amount of fibres.

They maintain good health and protect against degenerative diseases. They can neutralise the acids produced during digestion of proteins and fats.

Nutrients which are present in vegetables vary from crop to crop.

Peas and beans are enriched with **proteins**.

Root crops like Tapioca, Sweet potato and potato are well known for **carbohydrates**, calcium K, Fe are the important minerals which are lacking in cereals and these are available in abundant quantities in the vegetables like peas, beans, spinach and bendi.

Amaranth, cabbage, beans contain large quantity of cellulose which aid in digestion. All the leaf and fruit vegetables possess the required quantities of vitamins.

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S.No	Dietary factors	source vegetables
1	Calories	sweet potato, tapioca, yam, colacasia corms, potato, Brussels Sprouts, onion and garlic, immature seeds of broad bean and peas *Phaseolus lunatus* (Lima bean), *Pussia fada* (Broad bean).
2	Proteins	peas, double bean, winged bean (Psochocarpus tetragonolobus), Garlic, Brussels sprouts, cowpea, lema bean seeds, amaranthus Leaves, drumstick leaves and menthe.
3	Vitamin A (Beta carotene)	Carrot, spinach, turnip green, palak, mustard green, amaranth, coriander, colacasia leaves, sweet potato, pumpkin, tomato
4	Vitamin B complex	Peas, broad bean, lema bean, garlic, asparagus, colacasia and Tomato.
5	Vitamin C	Turnip green, green chillies, Brussels sprouts, mustard green, Amaranth, coriander, drumstick leaves, cauliflower, knoll khol Spinach, cabbage, bitter gourd and reddish leaves.
6	Calcium	curry leaves, amaranth leaves, drumstick leaves, menthi, turnip, Mustard green, coriander and palak.
7	Iron	drum stick leaves and fruits, amaranth, menthi, mint, coriander, Spinach, palak and mustard green. Spinach, lettuce, cabbage
8	Roughages	Amaranth and root vegetables.
9	Vegetable milk	Pea pods and cabbage leaves

Importance of vegetables in National economy:

1. Annually we produce about **129 million tonnes** of vegetables from an area of **7.98** million ha, contributing **13.4** percentage to the world's production. (2009 NHB Data)
2. Vegetables crops have high export potential and vegetables worth of Rs 4431 crores are being exported annually both in fresh form or processed form. APEDA is the nodal organization involved in regulation of export and import of various food products.

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3. Traditional vegetables like onion, potato, bhendi, bitter gourd and chillies and non traditional vegetables like asparagus, celery, paprika,

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sweet corn, baby corn, beans, peas and cherry tomato have been short listed by APEDA for export. Among the different vegetables, **77%** of the onion produced is being exported, thus earning valuable foreign exchange to the country. onion and traditional vegetables are being imported by gulf countries, Singapore, Malaysia, Srilanka, Bangladesh and Nepal. Non traditional vegetables are being imported by Australia, European countries, South East Asian and Gulf countries.

4. Out of the total out put of vegetables, **only 1%** is being utilized by the processing industry. Inadequate preservation techniques, and storage facilities contribute to 25% loss of vegetables produced. By improving post harvest techniques, we can ensure year round availability of vegetables.

Types of vegetable gardens: Vegetable gardens can be classified into **7** different types according to the **purpose for which** they have been developed. These are home-gardens or kitchen-gardens, market-gardens, truck-gardens, gardens for processing, gardens for vegetable-forcing, gardens for seed production and Floating vegetable garden.

1. Home or Kitchen garden: is a vegetable garden where vegetable crops are grown in the backyard of a house or any available space in the home compound to meet the daily requirement of the family.The layout of a home-garden will differ from individual to individual. However, broadly, a city home-gardener will follow a very intensive method of vegetable-growing compared with that followed by a home-gardener in a village.

Advantages of kitchen garden:

1. It is best means of recreation and exercise
2. An excellent hobby and healthy occupation for young and old during their leasure time
3. Cut down the expenditure on purchase of vegetables
4. An ideal medium for training children in duty and order
5. Vegetables grown in kitchen garden are fresh and are free from market infection

2. Market garden: A market garden produces vegetables for the local market. Most of such types of gardens are located within 15 to 20 km from a city. The cropping pattern depends on the demands of the local market. The land being costly, intensive methods of cultivation are followed. A market gardener will like to grow early varieties to catch the early market. The high cost of land and labour is compensated by the availability of city compost, sludge, and water near cities and high return on the produce.

3. Truck garden: A truck-garden produces selected crops in a relatively large quantity for distant markets. It generally follows a more extensive method of cultivation than the market-garden. The commodities raised are usually sold through middlemen.The location is determined by soil and climatic factors

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suitable for raising particular crops. Truck gardener should be a specialized person and expert in the loge scale production and handling of some special

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crops.The cost of labour and land may cheap and he follows mechanized method of cultivation, hence his cost of cultivation is less. The net income is also less as this includes cost of transport and charges of middlemen.

4. Vegetable garden for processing: A vegetable garden for processing develops around the processing factories and is mainly responsible for supplying vegetables to the factories regularly. This type of garden grows particular varieties suitable for canning, dehydration or freezing.These gardens specialized in growing only a few vegetables in bulk.They choose heavier soil since their main consideration is a high and continuous yield rather than an early yield.The prices are paid on fixed contract basis on weight and quality of the product. The return may be low but the cost of marketing and the transport charges are neglisible.

5. Vegetable-forcing: Vegetable-forcing is concerned with the production of vegetables out of the normal season. The commonest forcing structures are glass and plastic houses.The vegetables commonly grown under these are tomato and cucumber.These are mostly used during wintr in the temperate region. Crops like cucumber and tomato can not be grown out side during coller months and as they are required throughout the year, they are grown under protection.Special varieties have been developed which do better under these structures.The growing of summer vegetables on river beds during winter months with the help of organic manure and wind breaks of dry grass is also a type of vegetable forcing. Sometimes for an early produce seedlings of crops like tomato or brinjal are forced to germinate in small protected structures. This may also be regarded as a type of vegetable forcing.

6. Vegetable garden for seed production: Vegetable seed production is rather a specialized type of vegetable-growing. A thorough knowledge of a vegetable crop in respect of its growth habits, mode of pollination, proper isolation distance, etc. are of prime importance in the production of quality seed. The handling of the seed-crop, its curing, threshing, cleaning, grading, packing and storage need specialized knowledge. A vegetable garden for seed production is , therefore, considered a special type of garden.The third and fourth stages of seed multiplication i.e registered and certified seeds are usually multiplied by growers.This an expanding industry in India and has good future.

7. Floating vegetable garden: Floating vegetable garden is seen on the Dal Lake of the Kashmir valley. Most of the summer vegetables are supplied to Srinagar from these gardens. Afloating base is first made from the root of Typha grass which grows wild in some parts of the lake.Once this floating base is ready, seedlings are transplanted on leaf compost made of the vegetation growing wild in the lake. All the intercultural operations and occasional sprinkling of water are done from boats.

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LECTURE-2: Classification of vegetables based on botany, plant part used as vegetables, seasons of growing and methods of culture

I. Botanical classicfication:

All vegetable belongs to Divison Angiospermae. The Angiospermae has 2 classes mono and dicotyledone.They are further divided in to families, genus, species, subspecies and botanical varieties.The grouping of vegetables therefore is as follows

A. Monocotyledonae:

1. Amaryllidaceae – Onion, Garlic, Leak, Shallot, Chive.
2. Liliaceae – Asparagus
3. Araceae – Colocasia esculenta
4. Diascoreaceae – Yam

B. Dicotyledonous plants (vegetables):

1. Chenopodiaceae – Palak, Beetroot, Spinach
2. Compositae – Lettuce, chikori
3. Convolvulaceae – Sweet potato.
4. Brassicaceae – Cabbage, Cauliflower
5. Crusiferae – Brussels, Cole rabi or knol-khol, radish, mustard.
6. Cucurbitaceae – All cucurbitaceous vegetables
7. Euphorbiaceae: Tapioca (Manihot esculenta)
8. Leguminosae : Pea (Pisum sativum)
   French bean (Phaseolus vulgaris)
   Lima bean
   Asparagus bean (Vigna unguiculata var sesquipedalis)
   Cluster bean (Cyamopsis tetragonoloba)
   Gem (Dolichos lablab)
   Winged bean (Psochocarpus tetragonolobus)
   Soya bean (Glycine max)
   Methi (Trigonella fonumgreacum)
9. Malvaceae: Okra (Bendi)
10. Poligonaceae: Sorrel, Rhubarb (Rheum rhapontiucm)
11. Solanaceae
    Potato: Solanum tuberosum
    Brinjal: Solanum melongena
    Tomato: Lycopersicon esculentum
    Chillies: Capsicum fruitescence
    Pepper: Capsicum annum
12. Umbelliferae (Apiaceae)
    Carrot, parsley,
13. Rutaceae: Curry leaf Murraya koenigii (Munaga)

II. Vegetables classification based on plant parts used: According to parts used for consumption

1. **Leafy vegetables:** Amaranthus, Cabbage and Palak
2. **Fruts :** Tomato, Brinjal, Bhendi, Peas, Beans, Cucurbits
3. **Flower parts:** Cauliflower and Broccoli
4. **Under ground parts:**

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a) **Stem tubers:**Potato and colocasia
b) **Root tubers:** Carrot, Sweet potato and Tapioca

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c) **Bulbs:** Onion and garlic

The cultural requirements of crops in each group are not same i.e tomato, bhendi and cucurbhits. Hence this method is also not of much value.

III. Classification based on season of growing:

1. **Kharif season** –June to September – Cucurbits, Brinjal, Okra
2. **Rabi season -** October to January – Cabbage, cauliflower, Beet, Peas, tomato
3. **Summerseason –** February to May – Brinjal, Chilli, cluster beans, Bottle gourd

IV. Classification based on method of cultivation:

This is a very convenient method. In this method all the crops that have similar cultural requirements are grouped together. Therefore it is possible to recommend general cultural practices for all vegetables, which are grouped together. Some groups like cucurbits, cold crops, bulb crops are not only have similar cultural requirements for the group but the crops in each group belong to same family. The groups like greens, salad crops, bulb crops, the parts edible in each group are also same.

Therefore this system of classification has been found to be more satisfactory in understanding the principles of vegetable growing than any other methods.

According to this method the vegetables are grouped in to 13 groups (**Table**)

Group No.	Group name	Examples
Group 1	Perennial vegetables	Asparagus, Coccinea
Group 2	Greens	Spinch, Palak
Group 3	Sald crops	Celery, Lettuce
Group 4	Cole crops	Cabage, Cauliflower
Group 5	Root crops	Beet root, Carrot, Radish
Group 6	Bulb crops	Onion, Garlic, Leek
Group 7	Potato	
Group 8	Sweet Potato	
Group 9	Peas and beans	Pea, cowpea, French bean
Group 10	Solanacious vegetables	Tomato, Brinjal, Chilli
Group 11	Sweet corn, Okra	
Group 12	Cucurbits	Bottle gourd, Pumpkin
Group 13	Yam, Tapioca	

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LECTURE-3: Tomato – origin – species- importance – growth habits of tomato – varieties – climate and soil

Botanical name: ***Licopersicon esculentum***
Family: **Solanaceae**
Chromosome no 2n = **24**
Origin: **Peru, Ecuador – Bolivia**

The word tomato issaid to have derived from **Zitomate** or **Xitotamate** used to denote “plants for food”.

Origin and distribution:

Cultivated tomato originated from Peru, Ecuador, Bolivia. Domesticated place of tomato lies in Mexico. The ancestor of cultivated tomato is cherry type (***Licopersicon esculenta var cerasiformae*** **-** cherry tomato).From Mexico is distributed to Spain, Europe, Britain, France etc.

Species:

Tomato belongs to the family solanaceae. The genus Lycopersicon differs from Solanum by the absence of spines and anther tips are narrow and exhibit longitudinal divisions. The genus Lycopersicon was divided into two sub genera.

1. Eu lycopersicon.
2. Erio persicon.

Eu lycopersicon is characterized by red fruited edible species with carotinoid pigmentation and they are annuals. Cultivated tomato is included in this. The species included are **1.** Cultivated tomato - ***Licopersicon esculentum*** and.

2. Small fruited tomato- ***Licopersicon pimpinellifolium***

Eriopersicon is characterized by green fruited species, anthocyanin pigmentation. The species included are peruvianum, hirsutum, persicae and glandulosum, cheesmanii.

Growth habit:

Tomato can also be classified depending on the growth habbit.

1. **Indeterminate**: terminal buds ends with a leafy bud and continue it vegetative growth. **Ex:** Pusa ruby.
2. **Determinate fruits:** terminal buds ends with floral bud and further its vegetative growth is checked and are called as Self topping or self pruning types. **Ex.** Pusa Early Dwarf
3. **Semi-determinate:** have semi dwarf growth andit is between determinate and indeterminate. Number of nodes between two consecutive inflorescences will be around one. **Ex:** S-12, Roma.

Importance and Nutrition value:

The tomato is one of the most important **"protective foods"** both because of its special nutritive value and also because of its widespread production. It is the world's largest vegetable crop after potato and sweet potato, but ittops the list of canned vegetables. Tomatos are used for soup, salad, pickles, ketchup, puree, sauces and inmany other ways.

Tomato is a major source of vitamins and minerals. It is widely used as

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salad vegetable. In England, it referred as **"love of apple'** or **'love apple'**. In India it is commonly referred as **'poor mans orange'** (Ascorbic acid 15 mg to

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20 mg /100g edible portion).It is also rich in Citric acid and Mallic acid.Glutamic acid is an amino acid mostly present in tomato. Tomato contains many important minerals like Na, K, Ca, Mg, P, K, Fe, Zn, Boron. The alkaloid present in tomato is called **tamatin** and the coloured pigment is called **Licopene**. Lycopene content is high at 70^0 F or 21^0 C.

Varieties:

In certain varieties of tomato, the vegetative growth automatically stops, giving rise to bushy growth. They are called self pruning varieties. Certain varieties like Pusa rubi, Pusa early dwarf, Marutham, Arka vital, Pusa 120, HS – 10, sweet 72, S-12, Co I are suitable for cultivation in **plains**. Varieties like Sioux, Best of all, Pusa early dwarf are suitable for **hilly areas**. Varieties like Roma and Punjab chuharra are suitable for **processing.** Varieties released by IIHR Arka Abha, Arka Abhizit, Arka Ahuthi, Arka Aloukik, Arka Meghali, Arka Sourab, Arka Sourab, Arka Srasika, Arka vartnan, Arka vikas, Arka visal.

Pusa Sheetal: cold resistant variety
Best of all: Mid season variety
IVRI -2 : variety developed from IVRI, Varanasi
Floradade: it is a variety brought from Florida
SL – 120 : resistant to nematode and released by IARI, New Delhi.
S-12: Evolved by PAU**,** Luthiana, fruit round to flatish with persistant pedicel suitable for summer crop all over the India.
Sioux: American variety, resistant to growth cracks

Hybrids:

S.No	Hybrid	Parentage	Characters
1	Pusa rubi	Sioux X Improved meeruti	Indeterminate
2	Pusa Early Dwarf	Improved meeruti X Red cloud	Determinate and slightly furrowed
3	Pusa Red Plum	L. esculentum X L. Pimpinellifolium	

Co 1, Co -2 – released from TNAU, Coimbatore. Co3 it is a mutant of Co1
Gulmohar (MTH 6) – released from Maharastra hybrid Seed Company
Punjab chuharra, Ox heart, Punjab kesari, Pusa early dwarf, Pusa rubi, Pusa red plum, Pusa sada bahar, Sweet – 72, Roma, Yasvanth 2 are other hybrids..

Climate:

Tomato is a warm season vegetable require a long season optimum temperature is 21 to 24^0 C.Temperature and light intensity effect the fruit set,pigmentation and nutritive value. Optimum temperature for seed germination is 30^0 C. Maximum fruit set occurs at a night temperature of 15 to 20^0 C. High temperature (38^0 C) accompanied by low humidity and dry winds adversely affect the fruit set. Tomato has a yellow pigment Carotene and red pigment (at ripened stage) called Lycopene and at very high temperature

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formation of Licopene is inhibited.

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Soil:

Tomato can be grown in a wide range of soils from sandy to heavy soils. A well drained, fairly fertile loam with fair moisture holding capacity is ideal for growing a good crop of tomato. Tomato is highly susceptible to water logging. Well drained soils are highly necessary. The preferable pH range is 6 to 7. If the soil is acidic i.e pH 5.0 or lower liming is advocated.

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LECTURE-4 : Tomato – nursery raising-transpanting – spacing-manuring-irrigation – intercultivation-harvesting- different stages of maturity-physiolgical disorders-cuses and control- yield

Seed sowing:

It is grown almost the year round. In north India seed sowing is done in November and transplanting during the month of January.In case of South India sowing is done in the month of August. In case of Summer sowing is done in the month of March; it is transplanted in the month of April- May.

Seed rate:

Seeds are very light in weight. 400 to 500 g of seed sufficient to raise nursery and transplant in one hectare.

Nursery practices:

Tomato is a transplanted crop. Seeds are sown in the area of 225 m^2 . A raised bed prepared by well decomposed FYM is mixed @ 3 kg FYM per m^2 of nursery bed.A fertilizer dose of 0.5 kg N, P, K per bed is also mixed in the soil.

Seeds are treated with fungicides and 40% formalin solution at 500 ml / m^2 area of nursery bed sterilisation. 10% formaldehyde is also used for fumigation. After fumigation the beds are covered with polythene for 24 hours.Seeds are sown 4 to 5 days after removal of polythene sheets. In line sowing 7.5 cm distance is kept between the rows. The beds are covered with straw or polythene till the seeds germinate. Seedlings are protected against wind, exposure to sun and excess rainfall. Fungicides are sprayed weekly to avoid of damping off. Nursery can also be grown in poly house. The seedlings should be hardened before setting them into field.

Transplanting:

Seedlings are transplanted at 25 to 30 days and 10-15cm height, on the evening of sunny day. Whole day transplanting is done in a cloudy day. In some of the areas tomato is directly sown.Direct sowing is reduce the infestation of root knot the nematode, bacterial wilt and damping off. The seedlings are transplanted at the side of ridge later earthing up is done to keep the plant in the middle of the ridge.For indeterminate varieties and hybrids, row to row spacing of 60 to 120 cm and plant to plant distance from 45 to 75 cm is adopted. In case of determinate types spacing is 45 to 60 cm x 30 to 40 cm is adopted.

Nutritional management:

Nitrogen is the most important nutrient. Deficiency of nitrogen reduces endogenous auxins and blossom end rot disease increase with increased levels of nitrogen. Phosphorus is essential for rapid root development.

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Deficiency of phosphorus leads to the development of purple colour on the underside of leaflets. Potassium is involved in the synthesis of proteins and

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organic acids. Deficiency leads to yellowing at the margins of leaf. A high level of potassium improves the shape of fruit.

In general NPK @ 75 to 150 kg: 60 kg: 60 kg per ha has been recommended for various tomato varieties. The quantity of Nitrogen to be applied varies greatly depending on the variety as well as soil conditions. Nitrogen is the best applied in the form of NH_4SO_4, Urea, CAN and Ammonium chloride. Besides the above inorganic fertilizers combination of well decomposed FYM and groundnut cake is recommended. FYM is to be added @ 20-25 tons per ha at the time of last ploughing and incorporated into soil. Regarding the inorganic chemical fertilizers half N, entire P and K should be applied as basal dose, half N is given in 2 to 3 splits. 30, 45, 60 days after sowing.

Micro nutrients like B, Zn also need to be applied and lime is essential under acidic soil.Availability of Boran is considered to be essential fro production of lorge size fruit with high vitamin content and prevent fruit cracking, while Zinc for higher ascorbic acid content and tolerences to diseses.

Irrigation:

Tomato is a deep rooted crop. Roots will grow to a depth of 120 to 150 cm and it has some drought tolerance. They require adequate moisture for their fair growth. Excess as well as insufficient moisture is harmful. First irrigation is given immediately after transplanting afterwards care should be taken not to apply to much water as it makes the plant to run and drops the blossom. However light irrigation should be given at 3 to 4 days interval in summer 10 to 15 day interval in winter.Furrow irrigation is the most widely used. Drip irrigation is fairly recommended as it can save more water compared to furrow irrigations.

Intercultural operations:

Tomato is subjected to **pinching**, the lateral shoots are pinched to improve more bushy growth but little foliage is to be kept. Frequently shallow hoeings are necessary to improve the yield it also reduce the weed growth. Mulching should be done 15 to 20 days after planting. 2 to 3 weeding before flowering encourages good crop growth. Application of a weedicide, basalin or pendimethalin @ 1 kg a.i. / ha plus one hand weeding at 45 days after transplanting was recommended. **Staking** is very essential for indeterminate group of varieties because it improves yield and quality protection of fruits. In pest and diseases, easy harvesting and easy spraying of chemicals.

Harvesting:

Stage maturity at which tomato should be harvested depends upon the purpose for which they are used and the distance of transportation.

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1. **Immature:** means before the seeds have fully developed and before the jelly like substance around the seeds are fully formed.

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2. **Mature green:** fully grown fruit shows a brown ring at stem scar. It has light green colour at blossom end and seeds are surrounded by jelly like substance.
3. **Turning or breaker stage:** 1/4th of the surface at blossom end shows pink.
4. **Pink stage:** 3/4th of the surface shows pink.
5. **Hard ripe:** all the surface turn to pink or red but flesh is firm.
6. **Over ripe**: fully coloured and flesh is also soft.

For distant market mature green stage fruit can be harvested and for a local market, they can be harvested at hard ripe stage. Fruits at fully ripe or over ripe stages are utilized with in 24 hours for processing.

Grading:

Fruits are graded based on size as Super A, Super, Fancy and Commercial according to IIHR.

Yield:

Depends on various factors on an average an open pollinated variety will give 300 to 500 Q per ha. Hybrids can give up to 1000 Q per ha.
Storage: tomato can be stored either in mature green or breaker stage of maturity. Fruit remain firm up to 21 days when kept at 20^0 C for the cultivars like Florida MH and Floradade. Temperature of 10^0 C cause moderate chilling injury and Alternaria root rot.

Physiological disorders in Tomato:

1. Blossom end rot: it is more serious, ground discoloration starts. In blossom end of the fruit. Black spot develops to encompass ½ to 2/3 rd portion of the fruit. Later the tissues shrink and skin becomes dark grey to black. It may lead to secondary infection by fungus and unfit for consumption.
Causes: use of Ammonium sulphate, imbalance of Mg & K; deficiency of calcium
Remedies: cultural practices that concern soil moisture and maintain uniform moisture supply. Transplanting in early April instead of early June. Foliar spray of
0.5% $CaCl_2$. Apply Nitrogen in the form of Urea.

2. Fruit cracking: occurs for middle of the May. Reduced transpiration has increased cell turgidity and contributed to tomato fruit cracking. Reduced transpiration occurs even in summer when fruit are grown in green house. Cracking also occurs in rainy season when rains fall in long dry spell. Presence of water on the surface of fruit is more conducive in cracking than high soil moisture.
Boron deficiency in the soil also causes fruit cracking.
They are two types of cracking.

i. radial cracking: occurs mostly at ripe stage.
ii. Concentric cracking: it is common in mature green stage.

Remedies: use of resistant cultivars like Sioux, Punjab chuhara. Picking of

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the fruit before the full ripe stage. Soil application of Borax @ 10 – 15 kg per ha. Regulation of soil moisture. Misting (spray of cool water).

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3. Puffiness: commonly known as hallowness. Tomato puffs, puffy tomatoes, puffs and pockets. As the fruit reaches about 2/3rd normal site outer wall continues to develop normally but remaining internal tissue growth is retarded. Fruit become lighter in weight and partially filled. Very high or vary low temperature and low soil moisture conditions will lead to puffiness.

4. Cat facing: a large scar is formed at the blossom end portion of the fruit. Such fruits have ridges and furrows and blotches at blossom end.
Reasons: low temperature, faulty pollination, application of nitrogen during transition from vegetative to reproductive phase.
Remedies: balanced fertilizer application; regulation of temperature.

5. Sunscald: when fruits and leaves are exposed to the sun, there is appearance of yellow, white patches on green and ripen fruits. These patches may have secondary infection of fungus and start rotting varieties with sparse foliage will suffer more sunscald especially in the month of May and June.
Remedies: prefer the varieties having more foliage and follow appropriate cultural practices.

6. Flower and fruit drop: higher incidence of flower and fruit drop is resulted because of fluctuations in temperature poor water management and soil moisture.
Remedies: good package of practices should be followed. Moisture stress should be avoided. Spraying of planofix or NAA @ 1 ml in 4.5 lt of water. Control of fluctuations in temperature.

7. Blotchy ripening: greenish yellow; maintain balance between Nitrogen and Potassic fertilizers.

8. Bronzing or internal browning: also known as grey wall. Characterized by death of tissues with in the fruits associated by vascular browning variety EL 235673 is found resistant to this disorder.

9. Green back: stem and portion of the fruit turns green. At high temperature ripening is inhibited and green band is expected. Reduce temperature by artificial means.

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PRODUCTION TECHNOLOGY OF VEGETABLES AND FLOWERS

LECTURE-5 : Brinjal- importance –varieties-climate and soil-seeds and sowing-manuring- irrigation-intercultural operations-harvesting - yield

Botanical name: ***Solanum melongena***
Family: **Solanaceae**
Chromosome no 2n = **24**
Origin: **Indo-Burma region.**
Common name: **egg plant**

It is a non-tuberiferous species of solanum. In India it might have spread to African and European countries. It is main vegetable in plains areas of India and almost available throughout the year. 8% of total area under vegetables in the country is occupied by brinjal. ***Solanum auriculatum*** is immune to little leaf.

Importance and Nutritive value :

Brinjal is a stable vegetable high in nutritive value. It is rich in minerals is Ca, Mg, P, K and Fe. It is also a good source of Vitamin A and C. Bitterness in Brinjal is due to presence of glycoalkaloids.Glycoalkaloids content vary from 0.4 to 0.5 mg per 100 g of fresh weight. Purple variety has higher copper content and polyphenol oxidase activity where as iron and catalase activity is the highest in the green cultivars. Amino acid content is higher in purple variety.

Uses:

Used as cooked vegetables. Used in pickle making, dehydration in dustry. Frut is employed as a cure for toothache. Excellent remedythose suffering from liver complaints. Green leaves of brinjal plant are good appetizers, aphrodisiac and cardiotonic. It also beneficial in vaata and kapha. In unani system roots are used to alleviate pain.

Growth habit:

1. Based on growth habit brinjal can be classified as below:
i) ***Solanum melongena var esculentum;*** fruit is long, round and oval.
ii) **Solanum melongena var serpentine** known as snake brinjal. Fruit is extra ordinarily long. Leaves are prickly.
iii) **Solanum melongena var depressum:** plant is extensively short and dwarf.

2. Classification on the basis of fruit shape:
i) Pusa purple long (PPL): long brinjal
ii) round brinjal – pusa purple round
iii) oval brinjal – pusa kranti.

3. Classification on the basis of fruit colour:
Purple brinjal: they have no anthocyanins. Eg: PPL.
Green brinjal: more of chlorophyll. Eg: Arka kusumakar.

Botany:

Leaves are alternate, solitary, flowers are stalked, leaf

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oppressed.Calyx is five lobed, corolla is gamopetalous, fruit is **berry** and berries are variable in shape and colour.

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Flowers in brinjal are of different styles.
a. long style **b.** medium style **c.** short style **d.** pseudo short style.
Brinjal is self pollinated.
Only **long style and medium style flowers** will set fruits. Entire plant surface is covered by 'hairy layer called 'tomentum'
Long styled flowers: they have a big ovary, stigma is swollen, long anthers.
Medium styled flowers: it has medium, long style, anthers are of same length, ovary is also medium sized.
Short styled flowers: they have rudimentary ovary.
Pseudo short styled flowers: ovary is rudimentary. Style should be shorter than the anther. No swelling of anther is observed.

Varieties:
Brinjal varieties are grouped on the basis of colour and shape of fruit.

1. **Long fruit varieties:** ex. **Pusa purple long**: evolved as a selction from mixed batia. **Pusa purple cluster long**: is an early maturing variety.
2. **Long green varieties:** arka kusumakar, arka shirish, Krishna nagar green long.
3. **Round purple:** ex: **Pusa purple round**: is resistant to fruit borer and little leaf of brinjal. Selection-6, suphala, arka navaneet, krihsnanagar purple round, pant ritu raj, vijaya hybrid, shyamala.
4. **Round green:** banarasi gaint, round striped.
5. **Roundish white:** some varieties under this group have purplish tinge with white stripes. Ex: Manjeri, Visali.
6. **Oval or Oblong fruited varieties:** Junagad oblong, Bhagyamati, H_4., Pusa anmol (**Pusa anmol** is a hybrid variety between **pusa purple long and hyderpur**).
7. **Cluster fruited varieties:** fruits born in cluster. Ex: pusa purple cluster, arka kusumakar, **Bhagyamathi (APAU variety).**
8. Spiny varieties: H-4, Manjeri.

Hybrids:

S.No	Hybrid	Parentage
1	Pusa Anmol	Pusa purple long X Hyderpur
2	Arka Navaneet	IIHR22-1 X Supreme

Climate:
Brinjal is the warm season crop. It is susceptible to severe frost. It requires a long warm season, before fruit maturity. Optimum temperature is 22 to 33 ^{0} C. Late round varieties are more tolerant to frost than early long varieties. Under very cool seasonal conditions, the ovaries are split leading to the development of abnormal fruits.

Soil:
Brinjal can be grown on a wide range of soils. The ideal soils should be a deep, fertile and well drained. The pH should be not more than 5.5 to 6 for better growth and development. Light soils are good for a healthy crop but

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heavy soils are suited for higher yields.

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Time of sowing:

In plains crop is grown in three seasons, summer crop is sown during February - March and rabi crop is October to November. In hills seed is sown in April-May and the seedlins transplanted in May-June

Seed rate: seed rate varies from 375 to 500 g per hectare.

Nursery practices: nursery practices are almost similar to Tomato.

Transplanting:

Seedlings are of 8 to 10 cm height with 2 to 3 true leaves are ready for transplanting. Seedlings should be hardened before lifting for transplanting. The summer crop may be transplanted on ridges and furrow system for effective use of water. Hardening of seedlings is achieved by withholding water for 4 to 6 days before transplanting. Light irrigation should be given on due day of nursery pulling. Seedlings are pulled without any injury to the root. At the time of transplanting soil around the seedlings is pressed firmly. Distance of transplanting depends on soil fertility, climatic conditions and varieties. Long fruited varieties are transplanted at a spacing of 60 x 60 cm. Round fruited varieties at 75 x 75 cm.

Manuring:

Brinjal occupies the land nearly 6 to 8 months, about 25 to 30 tons of well decomposed FYM is incorporated in the soil before transplanting. NPK @ 100, 80, 60 kg per ha is generally applied, ½ of nitrogen full quantities of P and K is applied at the time of transplanting while the remaining quantity of nitrogen may be applied either twice or thrice depending upon soil conditions at 30 days, 45 days after transplanting.

Irrigation:

Brinjal is a **shallow rooted** crop it needs frequent irrigation. The crop is irrigated at 3 to 4 day interval during summer season 12 to 15 days during winter season. However during rainy spells irrigation is not needed. Brinjal is generally irrigated by furrow system of irrigation. Drip irrigation is recommended to improve water use efficiency and also to reduce weed growth.

Inter culture:

Generally manual weeding is done to remove weeds. Shallow cultivation is followed to put down the weed growth. Weeds can be controlled by applying herbicides like fluchloralin @ 1.5 kg a.i. / ha.

Harvesting:

Fruits are harvested when they attain good size and when thesurface is bright and glossy appearance. If the fruit is too immature we press the fruit the pressed portion springs back.

Yield:

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In case of open pollinated variety 200 to 500 Q per ha. Hybrids 300 to 700 Q per ha.

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Storage:

under ordinary conditions the fruits can be stored for 1 to 2 days in summer, 3 to 4 days in winter at temperature of 7.2^0 C at 85 – 90% RH. The brinjal fruits can be stored for around 10 days.

Grading: three categories

1. super 2. fancy 3. commercial.

Packing: fruits are packed loosely in gunny bags, net bags, wooden trays and bamboo baskets.

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LECTURE-6: Chilli - importance –varieties-climate and soil-seeds and sowing-manuring- irrigation-intercultural operations-harvesting - yield

Botanical name**: *Capsicum fruitiscens* – Bell pepper**
***Capsicum annum* - Chilli**
Family **: Solanaceae**
Chromosome no 2n = **24**
Origin: Bell pepper **from South America**
Chilli **from Peru**

Chilli is also called as pepper.

Importance and nutritive value:

Green chillies are rich in proteins 2.9 g per 100 g. Ca, Mg, P, K, Cu and S. vitamins like Thiamine, Riboflavin and Vitamin C. Chillies are the major ingredients in curry powder.

In powdered from it is mixed in red or cayenne pepper. Chilli pulp is pickled in strong vinegar or brine. Extracts of chillies are used in the production of Ginger beer and other beverages. Cayenne pepper is incorporated in poultry feeds, green chillies are rich in **Rutin** which has pharmaceutical use. Pungency of chillies is due to **capsaicin**. The pigment (colour) in chillies is due to **capsanthin** also contains many other oleoresins.

Botany and floral biology: Genus capsicum 20 wild species have been reported at only few are cultivated.

1. ***Capsicum annum*** (sweet pepper and chilli): it has blue anthers, milky white corolla.
2. ***C. baccatum:*** it has yellow or brown spots on corolla. Its cultivation is restricted to South America.
3. ***C. fruitescens:*** tobacco pepper. It has blue anthers. Milky yellowish white corolla.

Chilli Varieties and hybrids:

Andhra Jyothi or G5 (G2 x Bihar variety): released from Lam Guntur. Fruits are short and called as Gundu types.

Bhagya laxmi (G4): selection from thohian chillies grown largely for green chillies.

Sindhuri: Tall growing and less pungent variety suit for green chillies

Baskar/ CA -235: released from Lam, Guntur. It is a cross between G4 x yellow anther mutant.

Prakash (LCA 206): developed from RARS, Lam Guntur.

Hissar sakthi: multiple resistant variety developed at hissar.

46 A: Medium, early prolific and pungent variety of IARI **(N.P means New Pusa)**

Arka lohit: highly pungent variety released from IIHR, Bangalore.

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Hybrids:

S.No	Hybrid	Parentage
1	Pusa Jwala	Pusa Red X N.P 46 A
2	Pusa sadabahar	Pusa jwala X IC 31339
3	Punjab lal	Perennial X long red
4	Kiran (x235)	G4 X anther mutant

Bell pepper Varieties:

Arka basant: released from IIHR, Bangalore. It was improved from the variety Soroksari, suitable for both kharif and rabi.
Arka gourav: pureline selection from golden caliwonder released from IIHR, Bangalore. Fruits are 3 to 4 lobed. Good for kharif and rabi.
Arka mohini: selection from variety known as Taitan. Fruits are 3 to 4 lobed becomes red on ripening. Suitable for both kharif and rabi season.
California wonder: an introduction from US. Fruits are 3 to 4 lobed.
Yolo wonder: plant is dwarf and as medium flesh thickness.
Pusa deepthi: released from Katrain. Suitable for both **kharif and rabi.**

Climate:

Chilli is grown in both tropical and sub-tropical areas. It can grow up to 2000 msl altitude. For vegetative growth it requires warm humid climate. For fruit maturity it requires warm dry weather. It requires a well distributed annual rainfall of about 800 – 1200 mm. Heavy rainfall leads to poor fruit set and high humidity leads to fruit rot. The crops continue to develop at high temperature but root development is retarded at a temperature of 30^0 C. Fruit development is adversely retarded at 38^0 C. Average night temperature favours high capsaicin content. Day length of 9 to 10 hours light stimulate plant growth. In general capsicum is grown at low temperature conditions than chillies.

Soil:

Chilli can be grown on a wide variety of soils provided. They are well drained, well aerated and rich in organic manure. In ill drained soils plants shed their leaves and turn sick. Cannot tolerate water logging conditions. Sandy loam soil with adequate irrigation and manuring can support better crop of chilli.

Black soils also preferable to grow chillies as rainfed crop.Strongly acid soils and alkaline soils are not suitable. Chilli can be grown in saline soils. Seed germination and plant vigour affected by salinity.Ideal pH 6 to 7.

Time of sowing:

Chilli seeds are sown in nursery beds during May-july. Sowing is little early in the north east India. In south states where rainfed cultivation is in voge chillies can be in may-june and September to October. In hills it is sown during march to april.

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Seed rate:

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1 to 2 kg seed is required to raise seedlings for hectare. Chilli seed bed are some times made in the dimensions of 3 x 3 m, it can accommodate 6000 seedlings and requires about 50 g of seed. However, generally nursery of chilli is prepared by following method. Selcted area is ploughed to a fine tilth. Nursery bed should be prepared to a size of 6 m length 1 m width with a 15 cm raised. Raised beds are preferred than flat beds because on flat beds root development is poor and incidence of damping off is more.

Well decomposed FYM @ 20 to 25 kg per bed is mixed thoroughly in seed beds in one month advance. Seeds are treated with fungicides like Capton 2 to 3 g per litre used to prevent. Seed borne diseases. Seeds are sown preferably 5 cm lines. Paddy straw used for mulching. Mulching is. removed as soon as seeds start germination. Phytolon 0.25 g per litre solution is used to drench the nursery beds at fortnightly intervals against damping off.

Transplanting:

Seedlings ready for transplanting 35 to 45 days. Short thick stem seedlings are preferred for better establishment. In older seedling topping has to be done one week prior to transplant. Early seedlings are transplanted singly different spacing 30 x 30 cm 45 x 30 cm, 45 x 45 and even 30 x 20 were tried in chillies. Spacing varies with variety, rainfall, seasonal conditions etc. Immediately after transplanting field should be irrigated.

Manuring:

It needs good fertile soils supplied humus. Excess nitrogen lead to increase the vegetative growth and delays maturity. 10 to 15 tones of well decomposed FYM need to be applied in the last ploughing. Besides that 75 kg N, 75 kg P, 55 kg K per ha is to be applied. Entire quantity of FYM, Phosphorus, potassium and half of nitrogen is to be applied at the time of field preparation. Remaining half nitrogen is to be given as top dressing in two equal splits at one month interval of transplanting.

Irrigation:

first irrigation is given just after transplanting for better establishment in the soil. Second irrigation is given 10 days after transplanting. During this time gap filling can be taken up. After wards irrigation is given as per the requirement. Generally 8 to 9 irrigations have given depending on rainfall, soil type, humidity and temperature.
Method of irrigation adopted is ridges and furrows.

Interculture:

Chilli is a slow growing crop cannot compete with aggressive weeds hand weeding or hoeing or application of herbicides need to be done in order to ensure weed free conditions. Frequent shallow conditions are under taken to facilitate soil aeration and proper root development. However deep cultivation should be avoided because, it damages roots. Herbicides like Alachlor 2.5 kg per ha can be used on chillies.

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Harvesting:

Flowering begins 40 to 60 days after transplanting depending upon variety climate, nutritional status of plant. Roots starts ripening about 3 months after transplanting and picking may go on for 2 to 3 months. Commercial chilli variety yield 10 – 15 Q per ha. dry pods in rainfed conditions and 15 to 20 Q per ha in irrigated conditions. Hybrids can give up to 400 to 500 Q per ha. Green chillies can be stored for about 40 days at 0^0 C and 95 to 98 % RH. Dried chillies can be kept for a month in dry places well protected from insect pests.

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LECTURE-7 : Okra - importance –varieties-climate and soil-seeds and sowing-manuring- irrigation-intercultural operations-harvesting - yield

Botanical name**: *Abelmoschus esculentus***
Family **: Malvaceae**
Chromosome no 2n = **72 to 144 (poly ploidy)**
Origin: **South Africa**

Importance and nutritive value:

Bendi is rich in calcium, magnesium, phosphorus etc, and vitamin A, B, C.
Bendi is good for people suffering from renal colic, lecorrhoea and general weakness. Bendi has high iodine content and it has ability to control goiter.
Bendi leaves are used in turkey to reduce inflammation.
Bendi can be fried in butter or ghee.
It can be put as a sole vegetable.
The roots and stem are used for clarifying cane juice and in the manufacture of gur or brown sugar. The plants are soaked in water and resulting solution is used as clarifier in **jaggery** manufacture.
Mature fruits and stems contain fruit fibre and used in paper industry.
Ripe seeds are roasted, ground, used as substitute for coffee.

Botany:

The genus ***Abelmoschus*** is distinct from ***Hibiscus*** in having deciduous type of calyx where as are persistent in the genus Hibiscus. Fruit is **capsule**, oblong, longitudinally narrow and dehisces longitudinally. The greatest increase in fruit weight, length and diameter occurs during 4-6th day after flowering.At this stage the quality will be high usually fibre formation in the pod starts from the 5th to 6th day of formation and a sudden increase in fibre content may be seen from **9th day**. A new variety **IHR-2- 31** is however retains its tenderness up to the 10th day.

Varieties:

Abelmoshus manihot, a wild species was found to be almost immune to YVMV
Arka Abhaya: it is released from IIHR, Bangalore. Fruits are 18 cm in length, duration of crop is 120 to 130 days.
Arka Anamika: IIHR, Bangalore. It is of inter specific origin between ***Abelmoschus esculentus* x *A. manihot* sp *tetraphyllus***.
DUR – 1(seetla jyothi): released from IIVR Varanasi.
DVR – 2 (seetla uphar): released from IIVR, Varanasi, resistant to YVMV.
EMS – 8: it is a mutant derived from Pusa sawani. Pusa sawani was treated with 1 % Ethyl methane sulphonate. Final selection was made in M8 generation..
Harbajan: it was originally perkins long green (selection – 6). It was named in the memory of Dr. Harbhajan Singh.
P-7: released from Punjab AU, Ludhiana. Evolved from a cross between ***Abelmoshus esculentus*** cultivar pusa sawani and ***A. manihot*** sub species

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manihot.

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Parbani kranthi: evolved by MPAU, Parbani (Mahatma pule Agricultural University. Interspecific cross between **A. esculentus sp pusa sawani x A. manihot.**
Pusa makhmali: developed from plant introduction section, IARI, New Delhi. It is susceptible to YVMV.
Pusa sawani: evolved by Dr Harbajan singh at IARI, New Delhi. Derived from an inter varietal hybridization between IC 1542, a field resistant cultivar to YVMV and Pusa makhmali (CIC 1542 x Pusa mukhmali – Pusa sawani). It yields about 175 Q per ha.
Perkins long green: Recommended for hilly areas

Climate:

Okra prefers warm climate. It is sensitive to frost and requires frost free growing period. optimum temperature 24 to 27^0 C. seed does not germinate when the temperature is below 20^0 C. plant growth is greater in rainy season, compared to summer season. Temperature higher than 42^0 C may cause flower drop.

Soil:

It can be grown in sandy loam soils. However clay loam soil give good yield. Ideal soils should be rich in organic manure. It should be well drained and have high organic matter content. Roots are sensitive to high water stagnation pH is 6 to 6.8. It can also be grown in saline soils up to EC value of 6 milli mhos per cm.

Time of sowing:

In north India summer crop is sown in February to March. In South India generally sown in November as main crop. However rainy season crop is sown in June-July throughout India.

Seeds and sowing:

20 to 25 kg per ha is required for summer crop and 12 to 15 kg per ha is required for rainy season crop. During summer seed is soaked in water at 12 to 24 hours the field is laid out in to ridges and furrows in flat bed. Sowing can be done by broad cast, line sowing and dibbling method. Sowing of okra is done in pits in west Bengal. Spacing adopted in summer season crop is 30 x 30 cm whereas rainy season crop is sown in rows at a spacing of 60 x 30 cm.

Manuring:

Well decomposed FYM @ 20 to 30 kg per ha s applied thoroughly in soil about 20 days before sowing. Besides this 100 kg N, 60 kg each of P and K are recommended ½ nitrogen, full quantity of P and K are applied at 30 to 45 days of sowing at top dressing.

Irrigation:

First irrigation is given after seeds are germinated subsequently field is irrigated at an interval of 4 to 5 days in summer in case of rainy season there

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is no much emphasis on extra irrigation. Drip irrigation as given higher yield compared to furrow irrigation.

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Interculture:

First weeding is done 15 to 20 days after sowing. A total of3 to 4 weedings is taken. Herbicide like basalin (fluchloralin) @ 2.5 lit per ha at pre lant incorporation.

Lasolin (alachlor) 5 litres per ha as pre emergence application are recommended.

Germination commences in 13 to 15 days of sowing and it can be over in another week. The crop is thinned at 30 days after sowing to maintain plant to plant distance of 30 cm.

Harvesting:

Pods are ready for harvesting in about 45 to 65 days after sowing depending on only tender fruits are to be picked. In case of pusa sawani variety the fruits will reach 10 cm about 6 days after anthesis. In case of Punjab padmini variety the fruits will gain 10 cm length in about 5 days of anthesis. Pickings are taken at an interval of 4 days.

Yield:

it varies from 60 to 75 quintols per ha in summer and 120 to 125 quintols per hectare in rainy season. Okra can be stored just for 2 to 3 days under room temperature conditions.

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PRODUCTION TECHNOLOGY OF VEGETABLES AND FLOWERS

LECTURE-8 : Cucurbits-introduction-flowering-sex expression-and modification

Cucurbits are the lorgest group of summer vegetables crops belonging to the family cucurbitaceae. Most of the cucurbits are monocious in nature except coccinia and pointed gourd (Parval) which are diocious. A number of hermaphrodite and andromonocious cultivars are also available in some crops (melons). Fruit is **Pepo** botanically. All are susceptible to frost. The cultural requirements of all crops in this group are more or less similar.

List of cucrbitaceous vegetables:

S.No	Crop	Botanical Name
1	Cucumber	***Cucumis sativus***
2	Pumpkin	***Cucurbita moschata***
3	Summer squash	***Cucurbita pepo***
4	Bottle gourd	***Lagenaria siceraria***
5	Bitter gourd	***Momordica charantia***
6	Ridge gourd	***Luffa acutangula***
7	Sponge gourd	***Luffa cylindrica***
8	Ash (wax) gourd	***Benincasa hispida***
9	Snake gourd	***Trichosanthes anguina***
10	Pointed gourd	***Trichosanthes dioca***
11	Round (squash melon)	***Citrullus lanatus***
12	Musk melon	***Cucumis melo***
13	Snap melon	***Cucumis melo var. momordica***
14	Long melon	***Cucumis melo var. utilissimus***
15	Coccenia	***Coccinia indica***
16	Chow - chow	***Sechium edule***

Flowering:

Most of the cucurbits are monocious in nature except coccinia and pointed gourd (Parval) which are diocious. A number of hermaphrodite and andromonocious cultivars are also available in some crops (melons).

Sex expression:

The cucrbitaceous plants are generally monocious i.e they bear male and female flowers separately on the same plant.Male flowers open first and later the female flowers.Generally there are more male flowers. An female to male flower ratios goes on incrasing with the age of the plant.The lower the nodes number on which the female flowers appear on main vine the earlier is the variety.Though the sex expression and sex ratio are the varietal characters, they are modified by environment.Lower fertility, high temperature, longer light period all induces maleness.Both plant regulators (auxins and antiauxins) and nutrient at proper concentrations modify sex. GA at higher concentrations 10ppm increases the number of female flowers. Two sprays, one at 2 leaf stage again at 4 leaf stage with 50 to 100 ppm of MH or 250 ppm Etherel or 100 ppm NAA or 25 to 50 ppm of TIBA or 3ppm of Boran or Molybdonum or 20 ppm Calcium can suppress the number of male flowerds

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and increase the number of female flowers, fruit set and ultimate yield.

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LECTURE-9: Cucumber - importance –varieties-climate and soil-seeds and sowing-manuring- irrigation-intercultural operations-harvesting - yield

Botanical name**: *Cucumis sativus***
Family **: Cucurbitaceae**
Chromosome no 2n = **24**
Origin: **India**

Cucumber is a native of India C. sativus is originated in North India. C. hardwicki occurs as wild species.

Importance:

It is rich in vitamin B and C. Cucumber is known by presence of bitter principle called as **cucurbitacins**, which are chemically **tetra cyclic triterpenes**.When a bitter pollen fertilizer non-bitter ovules the resulting fruit is found to bitter. This phenomenon is called **metaxenia.**

Varieties and hybrids:

Japanese long green: released from IARI. It is an **extra early maturing** variety. It matures with in 45 days after sowing.
KTCH – 8: poinsettia x LC – 3. it is an early maturing hybrid – released by IARI regional station, katrain.
KTCH – 11: it is a **gynoecious** line, developed at IARI, matures in about 55 days.
Pusa samyog: it is a hybrid between **Japanese gynoecious line x green long naples** released by IARI.
Straight – 8: released by IARI regional station, kutrain fruit is light green in colour.
Poinsettia: originally developed in US multiplied by national research station, new delhi. **Resistant to angular leaf spot, downy mildew**.
Gemini: IIHR released variety, prolific bearer, fruits are crispy and excellent for salads

Climate:

it is a warm season crop. It cannot tolerate high cold and frost. The condition of high humidity and short day length will promote female flower production. Cucumber requires minimum temperature of 18^0 C for seed germination 20^0 C growth and development.

Soil:

For an early and good crop, it requires sandy loam soils, heavy soils will give high yield. The crop can be grown successfully grown in slightly acidic soils pH 5.5 to 6.7. The soil should be with proper drainage facility.

Time of sowing:

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Region: north Indian plains: February to march
Hills: April – May;

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South India: October to November.

Seeds and sowing:

Seed rate of 3 to 5 kg per ha.Sowing is done on raised beds or in furrows or in pits. Two seeds per hill are generally sown in both sides of bed.In case of pit systems pits of 45 x 45 x 60 cm are dug up filled with FYM, cattle manure and soil in equal proportions 3 to 4 seeds per pit are sown. Spacing adopted is 1.5 to 3 m from row to row 60 to 90 cm from plant to plant.

Manuring:

25 to 50 q per ha of FYM is to be mixed with soil or applied to the pit besides that about 100 kg N, 50 kg each of P and K per ha need to be applied. Half of Nitrogen, entire P and K is applied in the pits or at the time of sowing. Remaining quantity of nitrogen is applied at 30 days after sowing.

Irrigation:

Cucumber cannot withstand water logging over irrigation should be avoided in dry weather crop is irrigated in every 5^{th} day. Flower initiation and full bloom stage are critical. For irrigation fruit enlargement requires sufficient water. Moisture stress, during flowering results in non-viable pollen grains leading to reduced yield. Foliage becomes chlorotic or yellow. Growth is retarded. If irrigation water over flowers and inundate plants for any length of time. If irrigation water over flows and inundate plants for any length of time.

Inter culture:

Training and pruning:

Vines are trained on bamboo with the rope or wire for high production and quality. Cucumber can be trained in **bower system**. The height of Bower should be about 1.5 m and spacing is kept as 2 m x 1 m between row to row and plant to plant respectively. Japanese long green and hybrids like Pusa samyog are suitable for bower system.

Pruning of secondary shoots up to 10 nodes increase the fruit production. Field should be kept weed free throughout cropping season. First weeding may be given 15 to 20 days after sowing. Two more weedings are given at 25 to 30 day interval.

Harvesting:

Crop becomes ready for harvesting in about 60 to 70 days after sowing. Fruit takes 7 to10 days from setting to reach marketable size. Cucumber is harvested when it is till tender and green. Over mature fruit will fetches less price. Picking can be done at an interval of 2 days yield varies from 80 to 120 Q/ha.

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PRODUCTION TECHNOLOGY OF VEGETABLES AND FLOWERS

LECTURE-10: Gourds-ridge gourd and bottle gourd - importance –varieties-climate and soil-seeds and sowing-manuring- irrigation-intercultural operations-harvesting - yield

Botanical name	***Luffa acutangula* - ridge gourd** ***Luffa cylindrical* - Sponge gourd**
Family	**: Cucurbitaceae**
Chromosome no	2n = **26**
Origin	: **Spain**

The word Luff/ Loofah is of Arabic origin.

Importance andnutritive value:

Compared to ridge gourd, sponge gourd rich in carotene and fibre.Ridge gourd contain high amount of minerals.Both of them have delightous compound called as **Luffein.**

Botany: Fruits are club shaped and 10 ribbed. Fruits of ridge gourd are ribbed where as the fruits of sponge gourd are smooth.

Varieties:

Sponge gourd:

1. **Kalyanpur chikni:** developed from VRC, Kalyan pur. Average yield is 35 to 40 t/ha.
2. **Pusa chikni:** selection from Bihar collection. Released by IARI, New Delhi.
3. **Pusa sneha:** released from IARI, New Delhi. Fruits are suitable for long distance transportation. Crop is ready for 40 to 65 days.
4. **Pusa supriya:** fruits become ready for picking in about 45 to 60 days.

Ridge gourd:

1. **Arka swathi:** cross between medium fruits at IIHR – 54 and long fruit at IIHR 18. Average yield is 52 tonnes per ha.
2. **Arka sumeeth:** it is a cross between early fruiting IIHR – 54 and long fruited IIHR. Suitable for cultivation **round the year** on Karnataka.
3. **Pusa nasadar:** selection from Neemuch variety. Released from IARI, Delhi 15 to 16 t/ha.
4. Punjab sadabahar: released from PAU, Ludhiana
5. **Satputia:** it is a cultivar from Bihar, bears **hermaphroditic flowers**, fruits produced in clusters.

Climate:

it requires long and warm climate. Humid warm climate is preferable. It grows best in rainy season. Optimum temperature is 24 to 37^0 C.

Soil:

Loamy soil is the best. Soil is rich in organic manure is preferable.

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Optimum pH is 5.5 to 6.7.

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Time of sowing:

Summer crop is sown during February to March. In south India rabi crop is sown during the months of December. Rainy season crop is produced in June to July. However, in hilly regions optimum time of sowing is April to May.

Seeds and sowing:

Seed rate is 5 to 7 kg per ha. Sowing can be done either on raised beds or in pits. Spacing is 1.5 to 3 m rows 60 to 120 cm between plants.

Manuring:

Nutrients have to be applied based on soil tests.15 to 20 t/ha well decomposed FYM is to be applied at 10 to 15 days before sowing. NPK are applied in the ratio of 100, 60 and 60. Half nitrogen, entire P and K are applied at the time of sowing in raised beds of pits. Remaining nitrogen in applied 30 to 45 days after sowing.

Irrigation:

First irrigation may be given sown after planting later frequent irrigation. Once in 4 to 5 days are given. Flowering and fruit development are susceptible to soil moisture stress. Rainy season crop hardly requires any irrigation if there is good rain fall. The crop is normally raised in basin or furrow system of irrigation.

Interculture:

First weeding is 20 days after sowing another weeding is given to 30 to 45 days after first weeding.

Harvesting:

The crop is ready for first harvest about 60 days after planting. Fruits attain marketable maturity in 5 to 7 days. Pickings are taken up at an interval of 3 to 4 days.Fruits should not be left on the plant till they get over mature. Mature of just to mature are slowly picked. Average yield is 15 to 20 tonnes per ha. Fruits can be stored at 3 to 4 days at room temperature.

Botanical name**: *Lagenaria sicerarea* – Bottle gourd**
Family **: Cucurbitaceae**
Chromosome no 2n = **22**
Origin: **Malabar region of India**

Importance:

Fruit is rich in protein, thiamin, riboflavin and vitamin C. it is easily digestable fruit. Pulp is good for overcoming constipation, cough and light blindness. Used as antidotes against certain poisons. A decoction from leaf is used to cure Jaundice and also in digestion.

Bottle gourd is strictly cross pollinated.

Varieties:

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Pusa manjari: hybrid between **pusa summer prolific round X selection 11**.
Pusa meghdoot: hybrid between **pusa summer prolific long X selection – 2**

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Pusa summer prolific long: it is suited for growing as a **summer** crop.

Climate:

Bottle gourd is warm season crop cannot tolerate cold and frost. Highly sensitive to photo period, short days and humid climate favour femaleness, requires 18 degrees Centigrade, minimum temperature for seed germination and about 20 to 30 degrees Centigrade for growth and development.

Soil:

It can be grown on all types of soil. Sandy to sandy loam soils with high amount of organic matter are considered best with good drainage facility. It can be raised on river beds. Optimum soil pH is 5.7 to 6.7.

Time of sowing:

In case of plain areas	Kharif crop	: June to July
	Rabi crop	: October to November
	Summer crop	: February to March.
For hilly areas -	March to June	
For river beds -	November to December.	

Seeds and sowing:

Seed rate: **3 to 6 kg** per ha. Crop is mainly sown directly in the field on raised beds or furrows or pits. Generally 2 seeds per hill are sown otherwise. Pits of 60 cm^3 are dug and filled with well decomposed FYM along with top soil. Spacing 1.8 to 3 m row to row; 0.6 to 1.5 m plant to plant. For taking early crop of bottle gourd seeds are sown in plastic bags. Bags are filled with FYM and soil in 1: 3 ratio. Seeds treated with Capton are sown in bags. After germination plants are transplanted in February to March.

Manuring:

Well decomposed FYM @ 15 to 20 tonnes per ha is given in 20 days before sowing. Recommendations of NPK varies from place to place, 100: 50: 50 kg per ha in Punjab conditions, 32: 24: 24 kg NPK per ha under TN conditions are recommended.Entire P and K half of Nitrogen are applied to pits or furrows at the time of sowing. Remaining quantity of nitrogen is applied to 30 to 40 DAS.

Irrigation:

Summer crop requires frequent irrigations for every 3rd or 4th day. By the crop sown in rainy season, it is irrigated as per requirement. Winter crop requires irrigated once in 10 days. Moisture stress during fruit development reduces fruit size and yield. Over watering should be avoided as it will result in fruit drop. Basin and furrow irrigation is commonly used to raise bottle gourd. Drip system of irrigation was found to increase yield of about 47% compared to sprinkler and furrow system of irrigation.

Interculture:

For high quality as well as quantity of fruits, vine should be **trained** or bamboo with rope or wire in bower system. Bower system is laid as per the

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procedure described in ottle gourd.In bower system of training plant height is kept at 2.5 m planting distance 2.5 x 0.6 m.Vareties like PSPL, Pusa naveen,

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Arka bahar, Punjab long, Punjab round, Punjab komal suitable for Bower system. Bottle gourd trained on bower yields about 60 tonnes per ha. Field should be kept free of weeds through cropping season. Weedicides like fluchloralin, butachlor can be used.

Harvesting:

Crop will be ready for about 60 to 100 days after seed sowing. Bottle gourd takes about 15 days after fruit set to reach marketable stage. Fruit is harvested when it is till tender and medium in size. Pickings are taken at an interval of 3 to 4 days. Tenderness and edible maturity are judged by pressing the skin little pubescence persisting on the skin. Seeds should be soft smaller fruits generally fetch in better price on market.

Yield:

20 to 23 tonnes per ha for open pollinated variety and 60 to 65 tonnes per ha for hybrids. Fruits can be stored under 10^0 C and 60 to 70 % RH for few weeks.

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PRODUCTION TECHNOLOGY OF VEGETABLES AND FLOWERS

LECTURE-11: Gourds-snake gourd, bitter gourd and ash gourd - importance –varieties-climate and soil-seeds and sowing-manuring- irrigation-intercultural operations-harvesting - yield

Botanical name**:** ***Trihcosanthes anguina*** **– Snake gourd**
Family **: Cucurbitaceae**
Chromosome no 2n = **22**
Origin: **China**

Importance:

Young tender fruits used as vegetable. Fruit is rich in vitamin A. Crop is highly cross pollinated due to its monoecious nature. Flowers are unisexual. Female flowers are solitary. Ratio of male and female ranges from 31 : 1 to 22 : 1

Varieties: The cultivate dvarieties are two types

1. Light green – with white stripes
2. Dark green – with palegreen stripes

Climate:

Snake gourd can be grown in tropical and sub tropical climates. High humidity is favourable for growth. Snake gourd may not be successfully grown above 1500 m altitude.

Soil:

It can be grown on wide range of soils. However soil which is well drained. Rich in organic manure is suitable for snake gourd.

Time of sowing:

It can be sown in April to July and also October to November. Seeds are sown n hills near edge of raised beds or flat beds at 1.5 to 2 m between row to row 60 to 90 cm between plant to plant. 2 to 3 seeds per hill should be planted. Seed rate is 3 to 6 kg per ha.

Manuring:

10 to 15 tonnes of well decomposed FM per ha is incorporated. 60 kg N, 50 kg P and 40 kg per ha is the blanket recommendation. Half nitrogen is top dressed at a stage when the plants start bearing.

Irrigation:

It is given immediately after sowing. Afterwards light irrigation is gien every 4^{th} or 5^{th} day. Frequent irrigations are needed during flowering and fruit development stage. Any stress during this period will reduce fruit size and yield. Over watering is very harmful. Snake gourd is irrigated usually by basin or furrow method.

Inter cultivation:

Shallow cultivation is done to make the soil loose and to keep down. Weeds the vine is trained on sakes, patches, which will facilitates hanging of fruit. Fruit will be tried with some weight to encourage linear growth. Earthing up

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of individual vines is an essential operation to avoid exposure of roots.

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Harvesting:

Young tender half grown fruits are ready for harvest in about 8 weeks after planting. Fully ripe fruits are collected for seed purpose.

Yield: average yield is 13 to 20 tonnes per ha.

Storage: snake gourd cannot store well for more than 2 days.

Botanical name**: *Momordica charantia* – Bitter gourd** Family **: Cucurbitaceae** Chromosome no 2n = **22** Origin: **Indo – Burma region**

Importance:

It occupy **first rank** among the cucurbits in respect of iron, vitamin C. Alkaloid **momordicasoides** gives the bitter taste to the fruit.Fruit is rich in P, Ca and Vitamin A. Fruit is wormicidal and cure stomach disorders and has beneficial effect on the persons suffering from diabetes, arthritis, rheumatism and asthmatic complaints.Juice from leaves are used against Leismenorhhoea and eruptions and voice.Powder prepared for plants is useful against ulcers.Protein of bitter gourd inhibit the growth of HIV 1, viruses in human cell cultures.Bitter gourds can be used as fresh vegetables can be canned and picked and used as dried vegetables.

Varieties:

Arka harith: selection from Rajasthan. Collection released by IIHR, Bangalore. Yield is 130 Q/ ha in 120 days and suitable for **both summer and rainy** season.

Coimbatore long: it is a selection from National seeds corporation, New Delhi. Yield is 150 Q per ha.

Pusa do mausami: it is a selection from IARI, New Delhi. Suitable for cultivation in **both season (summer and rainy**).

Pusa vishesh: it is dwarf vine variety suitable for **picking and dehydration**. It is released by IARI, New Delhi.

Climate:

Bitter gourd can be grown in both tropical and sub-tropical climate. Warm climate is considered best.Bitter gourd cannot tolerate, frost and cold. Require minimum temperature 18^0 C for seed germination and 30^0 C for growth and development. Short day conditions will help in improving female flower production.

Soil:

For an early and good crop bitter gourd needs sandy loam soil. pH is 5.5 to 6.7 an ideal soil for bitter gourd cultivation should be rich in organic manure

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and should be well drained soil

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Time of sowing:

Summer crop is sown in February to March. In South India bitter gourd is generally sown in October to November. Rainy season crop is sown during June to July. Hills of North India. Bitter gourd can be sown in the month of April to May.

Seed rate: 4 to 6 kg per ha.

Spacing:

1.5 to 2 m between rows and 60 to 120 cm between plants. Sowing can be done on raised beds or furrows. Another method of sowing is by digging pits 60 x 60 x 45 cm and refilling them with top soil and FYM.

Manuring:

Well decomposed FYM of 20 to 25 t/ha was applied 15 to 20 days before sowing. Besides that 100, 50, 50 kg per ha of NPK. Under Punjab conditions, 20 to 30 kg per ha of NPK under Tamil Nadu conditions is generally recommended. Half nitrogen, entire P and K is applied in pits or furrows at the time of sowing. Remaining Nitrogen is applied at 30 days after sowing. Seed treatment with Boron at the rate of 3 to 4 mg per litre is also useful for high fruit yield.

Irrigation:

Bitter gourd both in rainy and summer season. Rainy season crop do not require much watering. Summer crop is irrigated immediately after planting.Light irrigation is given on every 4^{th} or 5^{th} day until flowering. Maintenance of optimum moisture during flowering and fruit development stage is highly essential. Crop is irrigated through basin and furrow system.

Inter culture:

Vines should be trained on bamboo with rope or wire on **bower system**. Training as the following **advantages** over ground method.

1. expansion of fruit area results in increased number of fruits.
2. fruits become bigger in size.
3. intercultural operations can be done easily
4. better pollination and fruit set.
5. fruit becomes attractive due to proper exposure to sun light.
6. low incidence of fruit fly or other insects and diseases.
7. spraying and resting operations can be done easily.
8. 100 per cent clean harvesting can be easily done
9. no scab or rotting of fruits.

For preparation of bowers bamboo, cement or iron poles, poles connecting wire of 16 guage are quite useful. Poles are kept at a spacing of 3 x 3 m. poles are buried up to 50 cm. apart from this a heavy stone may be kept in 1 cu m pit to tie with the corner by connecting wire. 10 guage GI wire is used to stretch and form criss cross squares at a distance of 60 cm. to prepare bower system for one ha. Following material are required 1500 x 1500. cement pole 200 kg supporting wire of 16 guage, 400 kg criss cross netting wire of 10

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guage, 120 kg jute or coconut fibre, 25 kg plastic rope.Height maintained is 2.5 to 5 m

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Spacing adopted is 1.5 m between row to row; 0.6 m between plant to plant.Variety is **pusa do mousami** is suited for bower system of training. Field should bekept free throughout cropping season.

Harvesting:

Crop takes 55 to 110 days from sowing to harvesting. Picking is mainly done when the fruits are tender and green. Pickings can be done at an interval of 2 to 3 days.

Bitter gourd fruits mature very fast and turn red. Irregular harvest may delay the formation of successive fruits effect their growth and development.Irregular harvest also decrease number of fruits per pit. Average yield of bitter gourd vary from 11Q (open pollinated) to 300 Q (hybrid) per ha. After harvesting all the undesirable fruits like pest effected, disease effected, deformed, over matured and dull coloured. Fruits should be sorted out. Fruits are washed with water and shade dried. They are arranged properly. In bamboo baskets on news papers. Fruits in baskets can be kept for 2 to 3 days.

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PRODUCTION TECHNOLOGY OF VEGETABLES AND FLOWERS

LECTURE-12: Melons-water melon and musk melon - importance –varieties-climate and soil-seeds and sowing-manuring- irrigation-intercultural operations-harvesting - yield

Botanical name**: *Citrullus lanatus*– Water melon**
Family **: Cucurbitaceae**
Chromosome no 2n = **22**
Origin: **South Africa**

Importance:

Water melon contains 95% of water and is a **richest iron** containing cucurbitaceous crop. Most of cultivars have deep pink or pale pink coloured flesh which largely out **lycopene and anthocyanin** pigments.It is relished by poor and rich, young and old as a table fruit.

Varieties:

Arka jyothi: F1 hybrid by crossing IIHR – 20 with crimpson sweet. Fruit is dark green in colour with blue angular stirpes.

Arka manik: F1 hybrid IIHR – 21 and crimpson sweet. Fruits are green with dark green stripes.

Asahi yamato: Japanese introduction released by IARI, New Delhi. Rind colour is light green and non-striped variety. It gives 22 tonnes yield in 95 days.

Pusa bedana: released by IARI, New Delhi. It is a cross between **tetra – 2 (4x) x Pusa rasard (2x)**. fruits are dark green with faint stripes. It takes 120 days for first harvest.

Sugar baby: introduction from US. Fruits are bluish black in colour. Fruits will ripe in 85 days and gives 150 Q per ha.

Climate:

Water melon is a warm season crop. It cannot tolerate high cold and frost. It requires a minimum of 18^0 C temperature for seed germination and 24 to 27^0 C for growth and development. There should be high temperature at the time of ripening for producing good quality fruits.

Soil:

Watermelon require sandy to sandy loam soil for an early and good crop.Soil should be well drained.Alluvial river beds are good for production of water melon.Soil pH: 6.7 to 7. Varieties like Jobner – 21, Jobner 18-1 are capable of growing on high pH soil.

Time of sowing:

In north Indian plains, it is sown in February to March. In south and central India, it is sown in December to January. In Rajasthan, rainy season of crop is sown in August to September.

Seeds and sowing:

Seed rate is 3 to 5 kg per ha.Sowing may be done on raised beds. Furrows or pits. Direct sowing is also practiced. 2 seeds per hill on both sides of

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raised beds and 3 to 4 seed per hill in case of river beds are sown. In case of pit

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method 60 cm^3 pits are dug. 4 seeds per pit are sown. Recommended spacing is 2.4 to 4 m between row to row and 60 to 120 cm between plant to plant.

Manuring:

Recommendation of fertilizers should depend up on soil test. FYM 15 to 20 to/ha is applied at 15 to 20 days before sowing. It is mixed thoroughtly with soil. Besides that 60:40:40 kg per ha. NPK in Punjab conditions; 100 : 80: 80 kg per ha NPK in Karnataka conditions are recommended. Half nitrogen, entire P and K are applied to the pits or furrows at the time of sowing. Rest of nitrogen is applied 30 DAS.

Irrigation:

Watermelon planted on river beds does not need any irrigation but under light soils conditions irrigation is required once in 7 to 10 days is required. Crop is irrigated in furrows or basin irrigation in India, pitcher irrigation is also used in water melon.

Interculture:

Apical shoots should be removed. Side shoots should be allowed in getting good yield and quality, only 3 to 5 shoots are allowed. Field should be kept weed free by performing 2 to 3 weeding or by applying herbicides like Trifluralin.

Harvesting:

Crop will be ready for harvesting about 100 days after sowing depending upon cultivar and season. Fruits will be ready 40 days after anthesis. **Maturity is judged by 1.** withering of tendril **2.** change in belly colour or ground spot into yellow and **3.** by thumping test, on thumping the fruit it gives a **dull sound 4.** on pressing the fruit ripe fruit will give a crisp cracking noise. Fruit is separated for vine with the help of knife. Yield varies between 40 to 60 tonnes per ha. Water melon requires careful handling as they are easily damage.
Water melon cannot be stored for more than 2 to 3 weeks.

Botanical name**: *Cucumis melo* – Musk melon**
Family **: Cucurbitaceae**
Chromosome no 2n = **22**
Origin: **China**

Importance:

Fruits are sweet, musky in flavour, fruits are rich in protein, minerals like. Calcium, Iron, Phosphorus and Vitamin A. Immature fruits are cooked as vegetable. Ripe fruits are consumed whole some. They have cooling effect defend constipation. Quality of musk melon is determined by colour, thickness, texture and absence of fibrous material along with aroma.
Softening of fruits is accompanied by the change of pectin from insoluble to soluble form.In temperate regions it is cultivated in the name of cantaloupe.

Varieties:

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Arka jeet: it was released from IIHR, Bangalore. Selection from Bati strain of UP. Fruit skin is orange coloured yields about 160 Q per ha in 90 days.

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Arka rajahans: selection from local collection of Rajasthan. It has fruit weighing up to 1 kg fine net. Fruits are white and sweet variety resistant powdery mildew. Yield is 280 Q per ha.
Har madhu: selection from UP. Released by PAU, Ludhiana. Leaves are sparsely lobed. Fruits pale yellow at maturity.
Pusa madhuras: it is released by IARI, Delhi.
Pusa ras raj: released by IARI, Delhi.
Pusa sharbati: released by IARI, Delhi.

Climate:

It requires hot and dry climate. Optimum temperature 27 to 30 ^{0} C. short days promote female flowers. High temperature, low humidity, plenty of sun shine are essential for proper ripening, high sugar content. Plants are sensitive to low temperature and frost.

Soil:

it requires sandy soils. Loamy soils are good. Preferable pH 6 to 6.8. soil should be rich in organic manure, proper drainage facility.

Sowing time:

In plains of North India best time is February to March. In south India best time is October to November.

Seed rate and method of sowing:

4 to 6 kg per ha; broad cast sowing.In case of transplanted crop 1 kg per ha is sufficient. Seeds can be directly sown in fields or first raised in polythene bags @ two seeds per bag and water daily with enough care. Seedlings will be ready for transplanting in about 30 days. In case of river beds trenches are dug at 1 m deep and specially fertilized with FYM and fertilizers other wise pits of 60 cm^3 are dug and filled with mixture of FYM and then sowing can be done. Recommended spacing 2.5 m x 1 m

Manuring:

Manures and fertilizers should be given to musk melon as per the availability in the soil FYM @ 25 to 45 t per ha is applied. It is mixed with the soil at the time of last ploughing or applied 10 to 15 days before sowing. In case of Karnataka and himachal Pradesh 100: 75: 50 kg per ha of NPK should be applied half N, full quantity each of P and K are applied in pits or furrows at the time of sowing. Remaining quantity may apply 30 DAS or visit before flowering.

Irrigation:

Pre sowing irrigation is given, if there is insufficient moisture in soil. Musk melon plants require abundant moisture when the vines are rapidly developing and up to the time the melons are grown. Crop require eleven irrigations at the interval varying 4 to 9 days. Furrow and basin irrigation is commonly adopted for watering in musk melon. Pitcher method of irrigation is also used in water scarcity areas

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Interculture:

Secondary growth up to 7th node in 3rd node in Punjab sunheri, 4th node in Punjab hybrid and Pusa madhuras, 6th node in Pusa sarbati it is to be removed in order to enhance fruit yield. First weeding. Is done 15 to 20 DAS or DAT. 2 to 4 weedings are required before the vine covers the whole area. Weedicides like fluchloralin, Nitrofen can also be used for weed control.

Harvesting, yield and storage:

Crop is already for harvesting about 90 days after sowing depending upon variety. Fruits of musk melon takes 30 days from fruit set to maturity. **Maturity is determined** by **1.** a change in outer colour to yellowish green or brown. **2.**Fruits will also slip from vine. This is due to development of abscission layer resulting in automatic detachment of the fruit from the vine when fully mature. This is called **slip stage**. Varieties like karanapur there is no development of slip in such case only indication is change in colour. For local market fruits are harvested at full stage where as for **distant markets** they should be harvested at **half slip stage** or even earlier yield varies for 10 to 15 t/ ha. Fruits can be stored at room temperature i.e. 32 $\pm$ 8^0 C up to 8 days and $\pm$ 1 ^{0} C up to 25 days.

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LECTURE-13 : Cole crops-Cabbage-introduction - importance –varieties-climate and soil-seeds and sowing-manuring- irrigation-intercultural operations-harvesting - yield

The word **cole** was originated from the word Caules means stem.They are originated single wild species wild cliff cabbage known as **"Cole worts"** ***Brassica oleracea var silvestris***. They belongs to family Cruciferae and genus Brassica.

Among the cole crops **only cabbage and cauliflower** are grown in India and khol rabi is grown in foreign countries. The vegetable under cole crops grown all over the world is **cauliflower**. In India cabbage, cauliflower grown states are U. P., Karnataka, Maharashtra, Bihar, West Bengal, Punjab and Haryana. Cole crops occupied in large area in winter with India. They are rich sources of vitamin C. cabbage juice is used as a remedy against poisonous monsoon. Some extract of these cole crops are used to cover wounds and ulcers. They are eaten raw as well as cooked. They have protective property against bowel cancer.

All brassica species contain glucosinolates, which is crushed leaves is broken down by the enzyme myrosinge giving a bitter taste.

Six varieties of *Brassica* species are.

1. ***Brassica oleracea var capitata*** - Cabbage
2. ***Brassica oleracea var botrytis*** - cauliflower
3. ***Brassica oleracea var gongiloides*** - knoll khol
4. ***Brassica oleracea var gemmifera*** - burssel sprout
5. ***Brassica oleracea var italica*** - sprouting broccoli
6. ***Brassica oleracea var acephala*** - kale

CABBAGE

Introduction:

Cabbage was described as more or less compact leaf formed head. The main stem axil of the head or true cabbage is sharp and thick.
The **head** is formed by the development of densely packed leaves around the growing point.Cabbage is classified as slow growing biennial and has distinct periods of growth cycle.

Importance:

It is used for pickling. Cabbage pickle is called as **Sauerkrat**. Cabbage soup is good and nourished.

Nutritive value:

Protein quantity is high in kale and longest in red cabbage. Carotin was present in kale.

Varieties:

There are eight groups of cabbage as detailed below.

1. **copen hagen market group**: heads are round, large and compact.

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Leaves lightly hairy bloom, stem is short. Ex: Golden acre.

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2. **flat head or drum head group:** heads are flat. Plant is medium to large. Ex. Pusa Drum Head – It is resistant to Black leg and dry rot diseses
3. **Conical head group**: heads are small pointed. This group small pointed heads includes early maturing varieties such Jersey wake field.
4. **Savoyee group:** foliage very mulch glittered and wrinkled. Leaves are twine with little bloomy. This group include chief drum head savoy.

Red cabbage: it has deep purplish red coloured heads. Yield is less. Ex: red rock, red Danish. Protein content is lowest. Highest in kale.

Early varieties:

Golden acer: IARI variety selection from Copen hagen market.

Pride of India

Late varieties:

Pusa drum head: it was released by IARI. It is a selection from an introduction EC 774.

Climate:

It requires mean annual temperature of 15 – 22^0 C. it can tolerate frost to a great extent better than cauliflower. In Nasik, ootakamand and kerala it can be grown as a kharif crop. Growth exceed arrested more than 25^0 C. seed germination is normal when soil temperature 12 to 16 ^{0} C.

Soil:

For an early crop sandy loam considered best. For late crop heavy soil clay loams and silty loams are preferred.

Land preparation:

Soil should be prepared to a fine tilth by giving 4 to 5 ploughing before planting seedlings. It is a hardy cool season crop. It is annual crop vegetable production, biennial crop grown for seed production.It was introduced to India by portugese people. Its edible parts called **head**. Head consists of thick leaves which over lap lightly around the growing bud. The **flavour** of cabbage is due to **glucoside** called **sinigrin**, which is sulphur containing compound.

Nursery:

The nursery soil is preferred to fine tilth. Raised beds are prepared to a height of 10-15 cm and an area of 60 – 80 sq. m nursery is sufficient for one acre. In nursery beds are sown in lines. Beds are covered with organic manures with increase in temperature promotes early germination, water is sprinkled.

Main field preparation:

Land is ploughed many times. 25 tonnes of FYM per ha to be spread at the time of final ploughing. If cabbage is sown directly heads are formed 25 days earlier to the crop sown by transplanting. For direct sowing two seeds per hill are drilled at spacing 60 x 30 cm but thinning is done when plants are at 10 to 12 cm height.

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Transplanting:

Maximum yield was obtained on the flat bed at the spacing of 75 x 45 cm. Early varieties are transplanted 75 to 90 cm spacing row to row and 45 cm from plant to plant. The seedlings are transplanted at 6 to 7 week old. Transplanting is done in the evening and then they should be irrigated.

Irrigation:

Irrigation is given immediately after transplanting. Later it is irrigated at 10 to 15 days interval. Starter solution is given to increase the production to an extent of 0.25 tonnes per ha. Starter solution consists urea, potassium sulphate, single super phosphate at 1:1:2. it is given twice first immediately after transplanting and second 15 days after first application.

Foliar application of Molybdenum and cobalt increases cabbage head size. It is done 1 to 2 months after transplanting. At the time of maturity of head watering should be suspended otherwise can be bursting or splitting.
Total 6 to 8 irrigations are required.

Manuring:

Azospirillum and phosphobacteria 2 kg each are recommended along with FYM. At high temperature formation of head can be improved by spraying 2 % common salt. Inter culture include hoeing, earthing up, weeding and mulching. Shallow hoeing is to be done for better soil aerator and also put to theweeds.

Intercultural operations:

Earthing up helps to produce healthy heads it is done four to six weeks after transplanting. Removal of weeds is to be done reduce intensity of need chemical trifluralin, basalin can be used for these purpose. **Mulching** with black polyethylene sheet control weed and conserve moisture is to be done.

Harvesting and yield:

Cabbage heads have a tendency burnt harvest should not be delayed once thus have attained full size still time.Harvesting is done during December to april in plain and june to july in the hills.

Early crop comes to harvesting to first sixty to eight days after transplantation but will fetch higher price the yield less. Late crop come harvested 100 to 120 after transplanting give 30 to 45 tonnes.Entire plant is uprooted the heads are detached only heads are cut leaving stump in field when the crop is meant for seed production.

Early varieties mature relatively a high temperature heads become loose at initial stages bud gradually become harder with cooling temperatures. Yields in south India are less than 25% winter is mild and duration is short. Maturity is faster in south India. Yield are optimum in north India where longer and moderate weather prevails.

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Premature seeding (premature bolting):
Production of seed stalk before formation of heads called Bolting.The failure of leaves to form a solid head are the common defects in early cabbage causing considerable loss.

Reasons:

1. Early sowing of the seed.
2. Warm winter
3. Extreme changes in temperature
4. A check on the growth of the plant on seed bed.
5. Poor viability of seed.
6. Poor soil.
7. Failure to control weed, diseases, insects pests at proper time.
8. Lack of proper management.
9. Influence of humidity.

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LECTURE-14 : Cole crops-Cauliflower and knoll-khol -introduction - importance –varieties-climate and soil-seeds and sowing-manuring- irrigation-intercultural operations-harvesting – yield – Physiological problems of cauliflower

Botanical name	**: *Brassica oleracea var botrytis***
Family	**: Cruciferae**
Origin	**: Mediterranean region**
Plant part	**: Curds**

The haploid number of Brassica oleracea is **9**. it is **triple tetraploid** (6 x 9 = **54**)

Varieties

Early Kunwari : It has bluish green leaves with waxy blooms. The curds are white and not so compact. It is the earliest cultivar released by Punjab Agricultural University.

Pusa Deepali : Released from IARI as a hot weather cultivar. It is suitable for sowing in late May in North India. Its temperature requirement is 20^0 and 25^0C during curd initiation and development. The plant has erect growing habit and a narrower frame. The curd is somewhat round, medium-sized and white to creamy white in colour.

Pusa Himjyoti : It has erect bluish green leaves with a waxy coating. The curd is pure white and retains its colour even after exposure. Recommended for the spring-summer sowings in the hills.

Pusa Shubhra : It is field resistant to black rot and curd blight.

Dania: The cultivar has been successful in the eastern region, particularly in the hills. The plants are very hardy with waxy leaves and medium deep curds.

Pusa snowball K-1: Field resistant to black rot. It has upright waxy light green leaves, self-blanched, snow-white curds.

Climate:

Cauliflower is more exactly climatic requirement than cabbage or broccoli. It is quite responsive to temperature and photoperiod and has specific temperature according to variety.The average optimum monthly temperature is 15-20^{O}C with the average maximum at 25 ^{O}C and the minimum at 8 ^{O}C. Early variety require higher temperature in short days. At relatively lower temperature the curds of early varieties become ricy, leafy, loose and yellow resulting in poor quality.At relatively lower temperature the curds of late varieties remains under sized or small, showing some signs of bolting. In hot dry weather, the curd becomes small and hard.Thus it is very essential that the early, main and late varieties are planted at proper time.

Soil:

Fairly deep loamy soils is preferable can be grown in sandy loam, Silt loams and clay loams. Soil should be rich organic matter and well drained.Cauliflower is sensitive to high acidity.It requires an average pH of 5.5 to 6.6

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Season

Sep. – Nov. : Early Kunwari
Oct. – Nov. : Pusa Katki, Pusa Deepali.
Nov. – Dec. : Improved Japanese, Pusa Shubhra
Dec. – Jan. : Pusa Synthetic, Pusah Shubhra
Jan. – Feb. : Cvs in this group are of snowball type : Dania, Pusa Snowball -1,
Pusa Snowball K-1.

Nursery:

100sq.m nursery area /ha. Apply FYM at 300 kg and 10 kg of No. 5 mixture (9:9:9) along with 50 g of Sodium molybdate and 100 g of Borax. Sow the seeds at 10 cm between rows in raised seed beds after drenching it with copper oxychloride (2.5 g/lit). transplant 30 to 40 days old seedlings at a spacing of 45 cm. Avoid land infected with 'club root diseases'.

Seed rate :

375 g /ha. Sow the seeds in raised beds and transplant 25 days (early varieties), 45 days old seedlings (late varieties) at 45 cm apart.

Transplanting:

Normally, a hardened seedling is likely to give better results and since the early crops are raised in the monsoon, 5-6 week old seedlings stand better chance of establishment. Starter solution of ammonium sulphate and superphosphate (1:2) in combination with 0.1 ppm of IBA was best and economical for early and total yield.

Preparation of field :

Bring the soil to fine tilth. Pits should be taken at a spacing of 45 cm either way in hills. Form ridges and furrows at 60 cm in plains.

Manuring:

Hills : Apply 30 t/ha of FYM and 90 kg N, 90 kg and 90 kg K as basal dose and 45:45:45 kg NPK / ha after 45 days.

Plains: Apply 15 t FYM / ha and 50 kg N, 100 kg P and 50 kg K as basal and 50 kg N after 45 days. Apply 2 kg of Departmental vegetable micronutrient without mixing with the chemical fertilizers.

Irrigation:

Hills : Once in a week during January and February.

Plains: Once in a week.

Inter cultivation:

Gap filling after 20 days of planting to maintain the population and uniform growth. Hoeing and weeding on 30th and 45th day. Avoid deep inter cultivation as it is a shallow rooted crop.

Harvesting:

When harvesting cauliflower, care should be taken to cut the curd immediately in reaches prime condition. If there is any doubt about the maturity, it is better to harvest early than late. If the harvests are late, flower

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stalk elongates and loose, leafy, reicey or fuzzy curds result. Such over-mature curds wilt rapidly after cutting. It is bets to discard any such over-

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mature curds as they will spoil the appearance of the consignment. When harvesting, the curds are cut off the stalk with a large, sharp knife.

The large leaves are then trimmed away until only sufficient jacket leaves remain to protect the curd. When transporting loose, more jacket leaves should remain than when packing in crates. In crate, jacket leaves are trimmed leaving a fringe of leaves projecting 2-3 cm above the curds. When transported loose, the jacket leaves are only lightly trimmed until they reach the market.

Yield:

When the cauliflower curds mature at a higher temperature above 25^0C, the curds are small, loose and yellow. In spite of closer spacing which is followed by the growers, the yield hardly exceeds 10 tonnes / ha. Cultivars, slightly later maturing curds between 20 and 25^0C, the yield may vary between 12 and 15 tonnes/ha. With cooler season, the midseason cultivars can yield upto 20 tonnes/ha. The highest yield, is however, obtained from Snowball the yield may go upto 25 to 30 tonnes/ha. Snowball group is the only cauliflower which is grown almost under ideal conditions in North India.

Physiological disorders in cauliflower:

1. Buttoning :

This disorder is characterized by development of small curd. Buttoning may be due to overaged seedlings, poor nitrogen supply, planting wrong cultivar, i.e., early cultivar planted late and also due to root injury by insects or by some disease. Generally, if there is any check in the vegetative growth of the seedlings, buttoning may be induced.

2. Riceyness :

Premature initiation of floral buds is characterized by riceyness in cauliflower and is considered to be of poor quality for marketing. Such disorder may result from any temperature higher or lower than the optimum required for a particular cultivar.

3. Browning :

This is caused by **boron deficiency**. It appears as a small water soaked areas in the centre of the curd. Later, the stem becomes hollow with soaked tissue surrounding the walls of the cavity. In more advanced stage, pinkish or rusty brown areas develop on the surface of the curd and hence, it is also known as brown rot or red rot. Affected curd develops a bitter taste. It can be controlled by application of borax or sodium borate @ 20 kg/ha. In case of acute deficiency, spray of 0.25 to 0.50% solution of borax @ 1 to 2 kg/ha is advocated.

4. Whiptail :

This results due to **deficiency of molybdenum**. The leaf blades do not develop properly and become strap-like. The growing point is severly

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deformed and no marketable head is formed. It occurs in acidic soil below pH 4.5. Whiptail can be prevented by brining the soil pH to 6.5 by liming with

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5-7.5 t/ha of limestone or by applying 2.5-5 kg/ha of sodium or ammonium molybdate. Foliar spray with 0.05% sodium molybdate solution is also recommended.

5. Blindness:

It is supposed to be due to low temperature when the plants are small or due to damage to the terminal bud during handling of the plant or due to insect pest like cut worms which eat the terminal bud

Botanical name	***Brassica caularapa* - Knol – khol**
Family	**: Cruciferae**
Origin	**: Northern Europpe**
Plant part	**: Knobs (**swollen portion above the ground**)**

Importance:

This cultivated for knob (swollen portion above the ground).Leaves are also used for cooking.In India it is cultivated in Kashmir. Its cultivation is limited in other states. Late varieties are used as animal fodder.

Late varieties: Some of the best varieties are wiser snscor, wiser tribe, king of north

White Vienna: is an early varieties with a duration of 60 – 80 days heads are slightly oblong and light green in colour.

Purple Vienna: little brittle enough 80 – 90 mature. Heads slightly purple and medium size.

King of north: plant height only 20 – 30 cm.Knobs are flatish round and dark green in colour, cops comes to maturity 60 -75 days.

Soil:

It is a hardy vegetable can be grown variety of soil, however well trained red loamy soil is best suited for its cultivation. pH vary 5.8 to 6.8.

Climate:

Temperature range is 10 – 20 ^{0} C is ideal. Continuous hot weather is detrimental which induce knob development.

Nursery:

Direct sowing seed rate: 2.5 to 3.5 kg per ha. Land preparation: by ploughing, harrowing and crop transplanted with a spacing of 30 x 40 cm spacing planting time vary from August to November.

Manuring:

Blanket recommendation is 100 : 60 and 40 kg per ha.

Inter cultivation : keep the field weed free.

Irrigation:

First irrigation is to be given after immediately transplanting. There after

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one irrigation is given every 10 – 15 days.

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Harvesting:

Depending on the variety 45 to 80 days after transplanting. Tender knobs but fully developed knobs should be harvested before they become fibrous. Harvesting is done 1 to 3 times for week. In preparation for the market the root is cut off. Plants are tied together and sold in bulb. Leaves are also used for green when they are tender.

Yield: about 20 – 30 tonnes.

Storage: it can be stored in 3 – 4 days under ordinary conditions. Cold storage can be stored for more number of days wrapped knobs store well with better quality comparatively un wrapped knobs.

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PRODUCTION TECHNOLOGY OF VEGETABLES AND FLOWERS

LECTURE-15 : Bulb crops-Onion and Garlic -introduction - importance – varieties-climate and soil-seeds and sowing-manuring- irrigation-intercultural operations-harvesting-curing of onion and garlic – yield-bolting in onion

Bulb crops:

The group of bulb crops includes onion, garlic, leek, shallot and chive. These belong to the family **Amaryallidaceae** and genus Allium. They are grown in India as winter vegetables.

Botanical name	**: *Allium cepa* - Onion**
Family	**: Amaryallidaceae**
Origin	**: North West India**
Plant part	**: Bulbs**

Importance:

It is consumed either raw or cooked along with spices and vegetables. Primarly the bulbs used as vegetables. The flowering shoot known as **Scape** is also used as vegetable.It is rich in minerals like phosphorus and calcium and carbohydrates.It also contains Protein and Vitamin C.

Botany:

All the cultivars of common onions are long day plants in respect of bulb formation i.e the bulb more rapidly as day length increase.The typical flavor of onion is due to presence of a volatile oil known as **"Allyl propyl disulphide"** and the red colour is due to the presence of another pigment **"Quercetain"**.

Varieties:

Pusa Red: It is selection from local red varieties, yellow colour and mild pungency. It is fairly resistant to onion thrips.

Other local varieties: Bellary Big, Bellary Red, Poona Red, Nasik Red, Patna red

IIHR varieties: Arka Kalyan,Arka Niketan and Arka Pragati

Climate:

Onion is best suited as a tropical crop. It does best where the season is mild without the extremes of heat or cold or excessive rainfall. A relatively high temperature as well as long photo period (i.e a temperature of 15.6 to 21.1^{O} C for about 10 hours a day and about 80% RH) is essential for bulb formation, where as temperature alone is more important than the length of days in seed stalk development. So most of the varieties transplanted early will bold i.e from seed stalk.

Soils:

It grows best in light soils which may be sandy loam or silt loam, but they should be avoided as they mot permit it proper bulb formation.It is sensitive to higher acidity and the optimum pH of the soil should range from 5.8 to 6.5 and the land should be prepared to fit tilt for growing onion.

Sowing season: North India - November

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PRODUCTION TECHNOLOGY OF VEGETABLES AND FLOWERS

Tamilnadu - June to October
Maharastra - October to January

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Near Bengaloore – June to October

Seed rate:

8 -10 Kg of seed is sufficient to transplant seedlings for 1Ha. 6 to 8 weeks old seedlings which are about 15 cm tall are transplanted.Fordirect sowing the seed rate has to be doubled.

Bulbs:

When bulbs are planted the seed rate is 1000 to 1200 per Ha.Blbs of about 1/2inch diameter are dibbled on one side of ridge or in plain beds.

Spacing: 20X10 cm^2 for seedlings, 30X10cm^2 for bulbs

Manuring:

25 tonnes of FYM,60 to 100 KgN, 40 to 60 Kg P_2O_5 and 60 to 80 Kg ofK_2O. FYM should be incorporated at the time of field preparation, P and K along with half of N should be applied in bands, 5 cm below the seedlings to the side before transplanting. The rest of N may be top dressed 2 months after planting.

Irrigation:

It requires 14-18 irrigations from planting to harvest depending on the season. At bulb formation stage i.e 70 to 75 days after planting irrigation is essential.Drought at this stage results in cracking of the bulb and low yield.

Harvesting and curing:

Green bunch onions areharvested when they are lead pencil thickness with a small bulb, as a direct vegetable.

As a bulb crop is comes to harvest after 4 months of planting. A well matured bulb should be harvested by putting out or digging out the bulbs.Maturity is indicated by the tops dropping just above the bulb while the leaves are still green. The outer scales on the bulbs become loose and cloured. The bulb after harvesting are left in the field under shade for 4 days for curing which helps the bulbs in storing well.

Methods of storage:

Onions are stored in special house constructed with thatched hours sides covered with bamboo stick for good air circulation the sides can be covered with the gunny cloth instead of bamboo stick in order to have better circulation.Onions are stored in open shed long spreading in a dry floor. Important floor should be avoided. Onion are stored rakes 2 to 3 layers in well ventilated rooms and is desirable for proper storage.

Bolting in onions:

Premature production of seed stalk is known as bolting when such seeds stalk are produces which produce will grow bulb purpose. It becomes a problem, the production of bolt takes at the cost reserved foods at stalks and then bulbs keep long storage. Some of the salient features of bolting are the bolts are little bit smaller in size normal inflorescence. Bolting occurred to the

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extent of 50 to 80% in the onions planted in the later part of kharif or early rabi season. Bolting may be due to one or two more factors like varietal difference,

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extremes of temperature, growth obstacles, poor seed quality, poor soil, amount of sun shine etc.

The number of bolts observed in onion after early sown bajra has less of bolting compare to other crops like beans, sunhemp etc.

Between MH 30, 40 formulation, MH 40 was found to be more effective in controlling the problem of bolting. A species of 5% MH 40 in water reduced percentage of bolting to about 3% control when are applied 2 ½ months after transplanting.

Botanical name	***: Allium sativum***
Family	**: Amaryallidaceae**
Origin	**: Central Asia and Southern europe**
Plant part	**: Cloves**

Un injured bulbs of garlic contain an amino acid called as **Allicin**. It is a odourless, colourless water soluble amino acid. On crushing the garlic bulbs, cloves an enzyme called as **allinase** break down allicin to produce alicing. The other principle ingredient responsible for typical odour of garlicis **Diallyl disulphide**. Ingredients like **diallyl tri/ poly sulphides, allyl, propyl disulphides, diallyl dipropyl disulphides** etc are present in the garlic.The typical flavor of garlic is due to the presence of Chemical **Allecin** plus **Diallyl disulphide.**

Importance:

It is used as a spice.It is important because of its medicinal properties carminative or gastric stimulant in unani or ayurvedic medicines. It is useful against flatulence the allicin has hypo cholesteralic action it reduce the cholesterol level in the blood. Garlic used in the case of TB, rheumatism, sterility, cough, red eyes etc in the form of garlic juice. The crop is other foreign exchange earner from one hectare. It has insecticidal action mainly repellent action. One per cent garlic extract protect from mosquito and flies. The extract of garlic along with chilli and ginger exhibited strong nematicidal action and it has killed the meloidogyne nematode. Garlic extract also act larvicidal properties the larvae of Culex, spodotera.Extract of garlic acts as fungicial action.It is found to inhibit growth of 200 pathogenic fungi and also control foot rot of French bean. Garlic extracts records number of records on several medicinally important fungi. It got bactericidal properties. It is found against Staphylococcus bacteria gram positive and gram negative bacteria can be effectively damaged by garlic extract. Garlic kills the colonies of food poisoning bacteria, clostridium perfringens.

Garlic differs from onion in that instead of producing one large bulb it produces small bulbs called **cloves**. This group is covered with a thin skin.

Soil:

The crop should be grown in well drained loamy soil the other

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requirement, same as that of Onion, except that the garlic develop in richer soils, under loamy soil conditions the bulbs are deformed and difficult to

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harvesting. The badly drained soils the bulbs get discoloured. Therefore good drainage is essential.

Climate:

Same condition as that of onion as required by Garlic crops. The frost hardy but excess hot drought long not tolerate, prefers moderate temperature in summer and winter. The maturity of bulb should coincide in dry period. Therefore the crop is planting during winter (September to October) and harvested when the hot season sets in. Bulbing requires longer day in high temperature. Bulbs planted in the western side are found to be larger when compared to the eastern side.

Exposure to low temperature was found to increase the size of the bulb and this can be supported by the above findings. The survival and yield is slightly higher at low temperature. Leaf growth stalks when bulb grow commences. Short day and low temperature action should coincide the vegetative growth long day condition high temperature. Yield depends on the amount of the vegetable growth by the bulbs is commence late planting adversely effects the vegetative growth and bulb yield and increasing day length from 8 to 12 hours increased the bulb weight, diameter and number of cloves and decreased the number of secondary cloves. Critical day length for bulbing is found to be 12 hours. Short day condition suppress bulb formation.

Preparation of soil:

The soil should be thoroughly prepared by repeated ploughing. Well decomposed FYM at the rate of 10 to 20 tonnes per hectare is to be applied.

Propagation: by clove or bulbils or aerial bulbils.
Tissue culture techniques as used as explants are also in practice. Propagation by aerial bulbils is preferred when closer space is adopted. Aerial bulbils are more productive compare to clones.

Season of planting:

In Maharashtra, Karnataka and AP August to November. In Northern plains of India September to November. In hilly areas, march – april. In west Bengal November.

Spacing:

The ideal spacing is 15 cm x 10 cm. the seed rate 500 to 600 kg of cloves per hectare. The sowing can be done by three methods
1. dibbling 2 furrow planting 3. broad casting.

When close spacing is adopted the size of the bulb decrease but the total yield increase. When broad space adopted size of the bulb increase but total yield decrease.

Garlic cloves are soaked in cycocel (CCC) at the rate of 1000 ppm for around 24 hours before sowing to enhance germination. Storing of bulbs induce low temperature break the dormancy and increase the yield. The temperature used for storing bulbs would be 0 to 2 ^{0} C with slight variation of maximum limit of 4^{0} C.

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Manuring:

Well decomposed FYM at the rate of 20 tonnes per hectare is applied basally. Nitrogen, phosphorus, potassium are applied at the rate of 60 kg each. Nitrogen is given two split dose one is at the time of planting second is 30 days after planting. Application of borax at the rate of 10 kg/ ha is found to increase bulb size and yield.

Irrigation:

Before planting the field should be given light irrigation. Irrigation is repeated on every 3rd during the initial stages the crop is irrigated more frequently per once in a week but afterwards the crop irrigated once in 15 days. The frequency is decrease the crop is reached maturity the harvesting time the irrigation is stopped.

Interculture:

Manual weeding is expensive and it may cause the damage to the crop. Therefore chemical herbicides like pre emergence weedicide pendimethalin @ 1.5 kg a.i/ ha. Control grasses and broad leaved weeds. Foliar application of GA_3 at the rate 400 ppm are treating the bulbs GA_3 50 ppm stimulated the formation bulblets. At inflorescence stage this treatment increase the number of cloves per bulbs and delayed leaf formation in storage. Benry amine at the rate 50 ppm induced lateral bud formation but has less effect when compare to GA_3 is reported.

Ethrel at the rate 900 to 1400 ppm was found to inhibit the plant height and storage leaf formation but decrease in the leaf width. NAA 50 ppm inhibited the formation and storage of bulbs. CCC at the rate of 1000 ppm resulted in highest yields when the bulbs are soaked before planting. The bulbs are soaked before planting. When the hormone like NAA, CCC ethrel @ 50 ppm are sprayed at 60 to90 DAP yield and yield contributing characters were found to increase.

Harvesting:

When the top turn yellowish and they show symptoms of drying and bending we can recognized that the crop is ready for harvesting the crop takes around 6 months after planting for maturation. Bulbs are carefully lifted and clean the leaves tied at the top shade dried in one week, the bulbs are cured for proper drying for about 3 – 4 day in shade for maximum one week period before storage.

Yield: yield varies depending on many factors 40 to 100 quintals per hectare.

Storage:

Garlic is fairly cured in ordinary ventilated rooms. Tied leaves are hanged in well ventilated rooms. Packing is done singly in polythene bags or small sized bags packed together. Storage temperature is kept at 0 to 1.2 – 2^0 C. irradiation with Cobalt 60 or gamma rays is recommended. Storage at 1.5^0 C and 75% RH decreases the storage loss with reference to ambient temperature treatment with ultra violet light 30 minits and storage 1.5^0 C also

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increases storage losses.

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Storage losses prolong and loss in weight an be decreasing during storage by spraying Maleic Hydrazide at the rate of 3000 ppm 3 weeks before harvest. **MH @ 2500 to 5000** ppm when sprayed 2 weeks before harvest inhibited **sprouted** in storage up to 300 days without any adverse effect on yield and also decrease the net loss during storage.

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LECTURE-16 : Beans-french bean and cluster bean -introduction - importance –varieties-climate and soil-seeds and sowing-manuring- irrigation-intercultivation-harvesting- yield

Beans and peas belongs to the family legumineseae.Most of the cultivated varieties of beans and few of peas are **vine types** except the French bean where the cultivated varieties are **bush types**.

Botanical name**:** ***Phaseolus vulgaris*** **- FRENCH BEAN**
Family **: Leguminaseae**
Origin **: Central America**
Chromosome number: **2n =22**
Also called as : **Kidney bean or snap bean**

Botany:

Generally three types of beans are recognized by their growth habit and requirement of day length.

1. **Dwarf bush types:** Day neutral plants. They have short erect stem with the main axis consisting of 4- 8 shortened internodes.
2. **Semi pole or runner types:**These are short day plants which have to 4-8 inter nodes , longer than those in bush types.
3. **Pole type:** are long day plants which have longer internodes and their number is depend upon the length of the growing season.

Varities:

1. **arka komal:** plant is bushy. 70 days for flowering.
2. blue pod medium: it is a white seed variety. It has bluish black spots on pods.
3. **bountiful:** introduction from US comes up in September to February. Brown sweedish. Seeds are. It is resistant to common disease.
4. **contender:** tolerant to powdery mildew and mosaic.
5. **Kentucky wonder**: whole variety
6. **Pant anupama:** developed from pantnagar. Bushytype
7. **Pusa parvathi:** developed by **X ray radiation** of American variety IARI

Climate:

French bean is a cool season crop. It gave good yield under mild warm season. It is sensitive to frost. French bean has the cultivars of long day, short day and day neutral varieties. Most of them are day neutral. Seeds will not germinate, very high temperature. Continuous rains, resulting in the breakage of pods.

Soil:

French bean can be grown on wild range of soils, sandy loams are best. Heavy soil gives good yield. Ideal pH range is between 6 to 7. French bean mature early on sandy soils compared to other soils.

Time of sowing:

French bean is sown twice in a year. First sowing is done in July to September and second time in January to February. In case of hills sowing is

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done from March to June.

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Seed rate:

Cultivars		**spacing**
Bush type of cultivars	-	95 kg/ha
Pole type of cultivars	-	25 to 30 kg/ha

Spacing:

Bush type- 60 x 15 cm

Pole type- 1 m x 60 – 75 cm x 30 cm

Seeds are sown 5 cm deep. Two seeds are sown at one place and one of the weak seedling is removed after completion of germination.Seeds germinate slowly, at soil temperature of 15 ^{0} C and they germinate 10 days after sowing under favourable conditions.

Manuring:

It has poor nodule formation capability, well decomposed FYM up to a dosage of 20 to 30 t/ ha is given, besides that 60 kg N, 40 kg P and K are applied. Nitrogen is applied in two splits. Half nitrogen first split is given at the time of sowing whole quantity of P and K.Second split is given at flowering stage.

Irrigation:

French bean is said to be a drought resistant crop. For better growth and yield proper supply of moisture is essential. Irrigation is required in the early phases of crop growth during blooming and pod development period.

Plants are susceptible to water stress.Irrigation at regular intervals are necessary.Lack of adequate soil moisture results in reduced percentage of pod setting, reduced length of pods, reduced number of seeds per pod and high fibre content in pods.

Inter culture:

Shallow cultivation is to be done at early stages of crop growth. Deep cultivation will disturb plant growth because of root pruning.

Cultivation in early stages helps to keep down the weeds. Large leaves form dense canopy which act as weed suppressor.

Weedicides like penta chlorethanol, alachlor can be applied. Dwarf varieties do not need support. Climbing varieties need to be supported with bamboo sticks. Single stick is fixed near each plant. The frame work consists of line of pairs of caves not less than 42 cm apart at ground level. Earthing up around the base of the plant gives additional support and encourages root growth.

Harvesting:

Pods are ready for harvest, 2 to 3 weeks after first blossom. Pods are harvested when they are young, tender and delicate. Seeds start forming when the pods are little matured. They are cooked after cutting into pieces. Mature pods contain developing seeds. These are separately picked and shelled. Green of seeds are also cooked as vegetables. Harvesting of tender parts should be done at frequent intervals otherwise it will suppress formalin and development of new pods.

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In order to obtain dry beans harvesting is done when pods are fully ripe and about to shatter. In this case whole plants are harvested either by hands

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or by machine. Harvested planted are staked for 7 to 10 days and then they are crushed either by bullocks or by machines. All possible care should be taken that seeds are not injured. Pods and grain yields of French bean vary considerably with locality, soil fertility, variety and management practices.

Average yield of bushy varieties is 4 to 5 t/ha
Pole varieties 7 to 10 t / ha
Yield of dry seeds varies from 1.2 to 1.8 t / ha

Storage: it is completely dried seeds are stored in glass container with tight podding varieties or polythene bags.

Botanical name**: *Cyamopsis tetragonolobus* - CLUSTER BEAN**
Family **: Leguminaseae**
Origin **: India**
Chromosome number: **2n =24**
Also called as : **Goru chikkudu**

Importance:

Pods of cluster bean are rich in food value they are rich in protein, minerals, vitamin A, vitamin C. tender pods are used as vegetables in south India. They are dehydrated and stored to use. It is also nutritious fodder. Seeds also feed to cattle. Crop can be used in soil improvement and medicine. Mucilaginous seed flow is valued as **Guar gum (galactomannan)**. This gumis used in textiles, paper, cosmetics and oil industries. It is useful adsorbent for explosives.

Varieties:

Durga bahar: it is a derivative of **pusa navabahar and ROC 401**. plants are erect, photosensitive, single stemmed, flowers are white, pods are long, born in clusters, seed yield is

IC 11521: it is photo insensitive variety. It is suitable for summer and rainy season.

Pusa mausami: it is good for rainy season, **photo sensitive** variety.

Pusa nav bahar: it consists of good characters of both Pusa mausami and Pusa sada bahar.

Pusa sada bahar: it is selection from local cultivar from Rajasthan, non-branching type.

Climate:

cluster bean is a hardy plant tolerant to drought grown widely in sub-tropics and tropics of India. Prefers long day condition for growth and short day conditions for flowering.

Soil:

cluster bean grows nicely in alluvial soils and sandy loams it can tolerate a pH of 7 to 8. soil should be prepared to good tilth for better plant growth.

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Time of sowing:

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cluster bean grows thrice. In an year, spring, summer and rainy season. However under mild winter a third crop can be taken.

Seed rate:

seed rate varies due to cultivar in general 30 to 40 kg per ha is the seed rate adopted.

Spacing:

45 x 15 cm is the spacing adopted. Sadabahar cultivar is given spacing of 60 x 15 cm.

Manuring:

Requirement of manures and fertilizers of cluster bean is less because it is sensitive crop. Well decomposed. FYM is applied up to 20 t/ha. Nitrogen 20 kg / ha; 70 kg/ha P and K are to be given. Nitrogen may be applied in two splits. Half quantity of nitrogen at the tiem of sowing along with total quantity of P and K. Remaining half quantity of Nitrogen is given at flowering stage.

Irrigation:

rainy season crop is grown as rainfed. In case of spring season irrigation is necessary.

Interculture:

it is a shallow rooted crop. Intercultural operations are done shallow to provide good condition for crop growth and keep down the weed. Parthenium is also controlled by the application 2,4 – D and Disodium methane arsenate (DSMA) each at 2 kg per ha.

Harvesting and yield:

it is quick growing crop. It starts pods bearing 40 days after sowing depending upon variety. Pods are picked at tender stage. Average yield of green pods is 50 Q per ha; dry seeds 10 g per ha.

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PRODUCTION TECHNOLOGY OF VEGETABLES AND FLOWERS

LECTURE-17: Beans-peas, cow pea and dolichos bean -introduction - importance –varieties-climate and soil-seeds and sowing-manuring- irrigation-intercultivation-harvesting- yield

Botanical name	***Pisum sativum* – Garden pea**
Family	**: Leguminaseae**
Origin	**: Ethiopea**
Chromosome number:	**2n =14**

Importance:

Garden pea is rich in digestable protein, vitamin A and C. it is also rich in minerals like calcium, potassium, iron and phosphorus. Fresh green pea is excellent food for human consumption taken as vegetable or in soup large proportion of pea are processed either canned, frozen, dehydrated. The straw of pea is a nutritious fooder. The pea protein is moderately **deficient** in sulphur containing **amino acids methionine, cysteine.**

Varieties:

Alderman: suitable for freezing.
Arkel: early wrinkled seeded variety introduced from England. It was tested by IARI.
Asauji: this was a selection from the material. Collected from Amritsar area made by IARI, New Delhi.
Bonneville: wrinkled seeded variety introduced from US
Early badger: dwarf early wrinkled seeded variety evolved at Wisconsin. Resistant to fusarial wilt.

Climate:

Crop grows best in relatively cooler situations seed germination takes place up to the minimum temperature of 5^{o} C. however optimum temperature for seed germination is 22^{0} C. warm weather speeds up the rate of maturity. Pea is not susceptible to cold but severe frost causes injury to freshly opened flowers and young pods. Pods grow best the regions where there is slow transition from cool to warm weather in spring.

Soil:

Pea can be grown on many types of soils from light sandy to clay soils. Highly organic soils are unsuitable for pea as their moisture reserve leads to excess vegetative growth and poor pod formation. It is very sensitive to saline and alkaline conditions.
Most favourable range of pH is between 6 to 7.5

Time of sowing:

Pea is grown generally as a rabi crop. It is sown from the beginning of October to middle of November. In the hills of South India the crop is sown from March to May. In Darjeeling it is sown from June to August.

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Seed rate:

If sowing are done in ridges and furrows method, seed rate adopted is 50 to 60 kg per ha.Seed rate also varies with growth habit of varieties for early varieties 100 to 120 kg per ha. Mid late varieties 80 to 90 kg per ha is the general recommendation.

Seeds can be sown on flat beds or raised beds either by broadcasting or behind the plough. Seeds are also drilled through poras.(Tubes attached to deshi plough).

Depth of sowing: 5 to 7.5 cm

Spacing: 30 cm x 5 cm

Manuring:

Well decomposed FYM is applied at a dosage of 8 to 10 t/ha at least 15 days before sowing. NPK should be applied in the ratio of 30: 50: 25 kg per ha. Foliar application of 0.1% ammonium molybdate is given to increase the number of root nodules, yield, TSS and number of grains per pod.

Irrigation:

Crop requires 2 or 3 irrigations. First irrigation is given 40 DAS, second irrigation at bloom stage 60 DAS.

Method of irrigation – furrow method

Inter culture:

Manual or mechanical weed central has to be taken case of chemical weed control i.e. gaining dominance because it is cheaper and less time consuming. Various herbicides recommended are lasso (alachlor) at the rate of 0.75 kg a.i./ha, basalin at the rate 2 kg a.i./ha.

Harvesting: Generally 3 to 4 pickings are to be given in the season. For good quality of pro

duce harvesting should be done either early in morning or late in the afternoon. Quality is ascertained by tenderometer or motovometer.

Usually periodical pickings 6 to 8 day interval are taken. Care should be taken not to jerk the plants till they get injured.

Harvesting is generally done by manual method employing female pickers is advisable compared to males.

Green pods are packed in gunny bags or baskets.

Yield: Early varieties 30 to 40 Q/ha

Late and Mid season varieties 60 to 70 Q/ha

Shelling percentage from 35 to 50 depending on variety, agro-climatic conditions, management practices, grain yield about 15 to 20 Q per ha.

Storage:

Fresh unshelled pea can be stored for 2 weeks at a temperature of 32^{o} F. Relative humidity is 85 to 90%. Peas can also be stored in crushed ice for about 2 to 3 weeks. However pods will freeze at – 10^{0} C.

Botanical name**: *Vigna unguiculata*– Cow pea**
Family **: Leguminaseae**
Origin **: India**
Chromosome number: **2n =22**

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Importance:

Cow pea is nutritive vegetable rich in protein, calcium, magnesium and other minerals. It is used as food both green and dry stages. It is also grown for hay, silage, Pasteur and for all types of straw and as source of protein especially lycine.

Varieties:

Arka garima: variety was bred at IIHR, Bangalore. Plants are tall, vigorous. Pods are of light weight.

Pusa barsati:

Pusa dofsali: cross between pusa phalguni x Philippines early. It is suitable for sowing both in **summer and rainy season**. It is a **photo-insensitive**.

Pusa phalguni: it is selected from Canadian cultivar. It is a bushy type and broad variety. It is a suitable for cultivation in February – March. It is of 60 days duration.

Pusa komal: it was developed from IARI, New Delhi.

Pusa Ritu Raj: it was developed from NBPGR, New Delhi. It is **photo-insensitive**. Immature grown in summer and rainy seasons.

Climate:

Cow pea is warm season crop. More tolerant to heavy rainfall compared to other pulses. It suffers from water stagnation and drought thrives between 21 to 30^0 C temperature. it is grown in rainy season as a pure crop or mixed with Jowar.

Soil:

Cow pea grows well on all types of soil and yields well on loamy soils. Time of sowing: there is two main cropping seasons. Summer crop generally sown towards the end of February. It can be continued till the middle of April. Sowing timefor monsoon crop commences from the middle of June and extends up to the end of July. It is sown in December to January in plains and varieties which are photo-insensitive can be sown both in July and February to March.

Seed rate and sowing:

In summer – 20 to 25 kg per ha. Rainy -15 kg per ha

Spacing – 60 x 15 cm – kharif or rainy season crop. 30 cm between rows and no distinct spacing between plant to plant with in a row. Seed treatment with Thiram is done at the rate of 4 g per kg of seed.

Manuring:

Being a leguminous crop, cow pea requires less Nitrogen, 10 to 20 kg Nitrogen is incorporated in the soil before sowing. Phosphorus promotes the multiplication of Rhizobia, P and K 50 to 70 kg per ha are to be drilled in the soil. Cow pea is highly susceptible to zinc deficiency is more 10 to 15 kg Zn SO_4 per ha is beneficial. Cow pea seed should be inoculated with Rhizobia before sowing.

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Irrigation:

Cow pea is shallow rooted crop. Light irrigation are advisable. Rainy season crop do not need any irrigation, except in long dry spells. Summer crop require irrigation once in a week during March to April. Early sown rainy season. Crop needs 1 or 2 irrigations in pre monsoon period. water logging should be avoided as cow pea is sensitive to it.

Interculture:

Effective control of leaves. The first 20 to 25 days of the crop is essential. 2 to 3 weeding and hoeings are required to check the weed growth. One kg a.i. Treflin is recommended for control of weeds as a soil incorporation.

Harvesting, yield and storage:

Pods are ready for harvesting after 40 to 50 DAS. Pods are picked up when they are tender and half grown. Pods of cow pea develop very quickly and if they are not picked at right stage they tend to become puffy unlike peas. Cow pea has to be more frequently picked.

A grain crop matures 75 to 125 days in Kharif planting fully matured crop is harvested left in the field further dried and then crushed. Spring and summer crop will retain sufficient leaf foliage when the pods mature. Therefore mature pod should be kept first and the plants should be harvested separately for the use of green forage. Pods should be dried and threshed. The threshed grains should be dried in the sun, so that the moisture content reaches 10% before the grains are stored in cool dry place.

Botanical name**: *Dolichos lablab* – DOLICHOS BEAN**
Family **: Leguminaseae**
Origin **: India**
Chromosome number: **2n =20, 22, 24.**

Importance:

Dolichos beans are characterized by the presence of oil glands on leaves. Dolichos bean is a good source of protein, mineral sand vitamins. However, **methionine** is the limiting aminoacid in Dolichos bean.Seeds contain **trypsin inhibitor phytic acid and polyphenol** and also contain lectin, the toxicity of lectin can be eliminated by heating.Dolichos bean is primarily grown the green pods which are cooked as vegetable.

Classification:

Two botanical varieties are recognized in Indian bean.

S.No	Field bean	Garden bean
1	*Dolichos lab lab Var. Lignosus*	*Dolichos lab lab Var.Typicus*
2	Longer axis of the seed is at right angles to the suture of the pods	It is parallel to the suture

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3	It is semi erect or bushy perennial but cultivated annual.The entire plant is	It is herbaceous vine type annual can be retained for 2-3 years in Kitchen garden.The shell of the pods is not

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	pubescence or hairy.	stichy and the entire pod can be cooked as a vegetable
4	It is grown as a field crop in South Central India	It is largely cultivated as vegetable in Kitchen garden and on a small scale inmarket gardens

Varieties:
Arka jay: released for IIHR, Bangalore, photo-insensitive variety. Fruits are long and curved, 75 to 80 days. Crop duration, plants are bushy.
Arka vijay: released from IIHR, Bangalore, photo-insensitive dwarf plants, pulpy pods, seeds are bole 80 days crop duration.
Pusa early prolific: it bears early, pods are long and thin, suitable for northern plains.Suitable for both spring and autumn crops.
DL.1428: It is a cross between Garden bean and field bean and it is called **Arthanari** in Tamil denoting its hybrid characters
Climate: Indian bean can grow both in tropical and sub-tropical climatic conditions. It is susceptible to frost, extreme hot, cool season is relatively favourable.

Soil:
It can be grown on wide range of soils but growing in the soil of high fertility status may cause luxuriant vegetable growth at the cost of pod yield.

Time of sowing:
Indian bean is sown in month of July, August. It can be sown early also, in areas where rain comes early.

Seed rate and spacing: 20 to 30 kg per ha.
Indian bean can be raised area mixed crop ragi, sorghum and castor. Vine type of Indian beans gets support if they are grown with castor.

Spacing:
100 x 75 or 75 x 75 cm is given for a pure crop, when it is mixed with ragi or sorghum. Indian bean seeds are drilled between 2 rows or ragi or sorghum. Initially 2 to 3 seeds are sown per hill and later thinned to fine healthy plant per hill. When the dolichos bean is mixed with sorghum, it twines on the sorghum stalk. Ear heads of sorghum are harvested and then the stalks are cut along with dolichos vine which increase its fodder value.

Manuring:
10 to 15 t of well decomposed FYM 13 kg N, 15 kg P, 40 kg K are applied organic manure is applied during land preparation along with half N, whole quantity of P and K. remaining half Nitrogen is top dressed at 30 to 35 DAS.

Inter culture:
Hoeing is done once oil twice control weeds and to enhance crop growth.

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Irrigation:

Occasionally light irrigation was given. Dolichos bean can tolerate dry conditions during flowering. Optimum moisture should be maintained to reduce flower drop varietal character is also one up of the reason for flower drop.

Harvesting: Green pods are available in winter till the next spring. Usually they are harvested when they are still tender. When pods are left unpleasant, tenderness is lost, seeds can be taken out for such pods and used as vegetable pods may be left till they fully ripe. Seeds from such pods are extracted dried and used as pulse. Indian bean yields on an average 5 to 8 t per ha. Pods of Indian bean can also be kept for two weeks at 0^0 C and RH 90%.

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PRODUCTION TECHNOLOGY OF VEGETABLES AND FLOWERS

LECTURE-18: Tuber crops-colocasia -introduction - importance –varieties-climate and soil-propagation- planting-manuring- irrigation-intercultivation-harvesting- yield

Botanical name	***Colocasia esculenta***
Family	**: Araceae**
Origin	**: South Central Asia**
Chromosome number:	**2n =28**

Colocasia is an important minor tuber crop.Its duration vary from 4 to 6 months. This is a plant for inter cropping.Nigeria is the largest Colocasia producer followed Cameron.

Importance: Mainly cultivated for edible root. Leaves and young leaf stalks are also cooked as used as spinach. They are used for making bhrijias and pakoras to remove acridity from leaves a pinch of braking soda is added just unfolding leaves are more tasterior. The tubers are feeled sliced cooked and taken along with condiments and adjuncts.Taro starch compete with rice starch for making face powder. Taro starch provide good raw material for alcohol production. Corms and cormels, petioles and leaves we used as vegetable. It is rich in starch especially amylase (17 – 25%). It is recommended for gastric patients. Taro flour is good for baby food. Taro fermented to give an acidic product.
Taro is fermented to give an acidic product strained and recognized as **poi**.
Corm paste from cooked taro is recognized as fufu in Africa.
It is called as **taro**, **Gaint taro, Alocasia**.

Varieties:
The traditional variety of Colocasia includes Deshi, Bunda, Benda,fisabad,bunsi, lathara, gyano no. 12, gyano no.22, gyano no 36, gyano no 40, vane no. 1,2, 3 and S 11.
In assam they are two kinds of colocasia.
Eddoe type: Colocasia esculenta var antycoram.
Dasheen: Colocasia esculenta var esculenta or globulifera

I. Eddoe type: have bigger cormels than mother.
They have many small daughter tuber attached to the mother tubers.
The daughter tubers are used for propagation material for next season.
Ex: panchamukhi.
The name of these variety are given after shape of the tuber.
Panchamukhi five tubers together.
It can be kept than more than a year.
It grow successfully about 1200 m elevation yield vary 25 to 40 tonnes per hectare. Pancha mukhi is grown mainly in Punjab. **Sahasramukhi** is mainly grown in maharashtra. **Sathamukhi: APAU** is released from Kovvuru. Konikachu produces many daughter tubers similar to poultry eggs very good cooking quantity yield 12 – 25 tonner per hectare

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II. Dasheen: This kind of colocasia produce only one main corm no daughter or side smaller tubrs. Main corms are elongated flesh having nodes and buds. Ex: **kaka kachu** of promosing variety it produces side corms and flushy with bitter tasty yield varies from 20 to 40 tonnes per hectare
Mushikuntia kachu: it is just like wooden peg and very soft. It has calcium oxalate.
CTCRI released varieties. C9, 135, 149 and 266.
C 9 it is a culinary variety of good quality. It has good amount of starch. Yield is 20 tonnes per hectare
C 266 it is a popular varietyYield is 12 tonnes per hectare.
The variety sathamukhi is superior in quality and produces oblong tubers.

Propagation:

Generally propagated vegetatively. **Cormels or daughter corms** in some cases **mother corms** also used for planting material. Large size cormels are better than the mother corms.The plant material is stored in a shady place and covered with leaves. The cormels are pre sprouted and healthy corms are selected for planting. The optimum seed size **28 g** spacing of **30 cm**. planting depth of 5 cm were found to be well.

Soil: in tropical areas it require frequent irrigation and hence soils with high water holding capacity are good to take up the cultivation of colocasia.Colocasia is grown in heavy soils and can withstand to some extent water logged conditions. The best soil pH is 5.5 to 7.0

Climate: the crop cannot withstand cooler climate or frosty situation.The crop can with stand water logging, so it can be flooded. Largely grown in north eastern parts of India where rainfall varies between 100 to 500 cm per annum.

Manuring:

Well decomposed FYM @ 12.5 to per ha along with 80, 50 and 100 kg of N, P, K per hectare are applied. Irrigation through out the life period is beneficial when rainfed cultivation is adopted increase in the number of supplementary irrigations should increase yield.

Interculture:

Weed free situation should be observed for the crop small interspaces removed in manual or weedicide. Mulching is practice with dry lands per plant material that given organic matter.

Maturity and harvesting:

Dasheen varieties take around 10 months and eddo varieties take lesser time 5 – 6 months to come to maturity. Time taken for maturity depending on variety as well place of cultivation. It is taking 3 months in cyclone and long period 12 to 15 months in Hawaii. Maturity is indicated by yellowing of leaves full of the plant of out the soil by hoe or spade.

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Yield: 18 to 20 tonnes per ha----- A.P., 16 to 20 t per ha Kerala
30 t per ha----- Tamil nadu

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LECTURE-19: Tuber crops-elephant foot yam and dioscorea -introduction -importance –varieties-climate and soil-propagation- planting-manuring-irrigation-intercultivation-harvesting- yield

Botanical name**: *Amorphophallus campenulatus* - ELEPHANT FOOT YAM**
Family **: Araceae**
Origin **: India**
Chromosome number: **2n =28**

Importance:

Elephant foot yam it is known for high yield nutritional value.It is very popular vegetable crop especially in maharastra and valleys of Tapati, purna, ambika rivers in Gujarat. It is rich in carobohydrates, minerals, vitamin A and B.It is used in many Ayurvedic medicines because of its medicinal value. It is mostly grown inter crop rather than a pure crop (Ginger and Turmeric).It takes few years to give big size yams.It can be stored for very long time without any damage.

It is an important food crop in certain communities in India. South East Asia and Pacific islands. Ramanthpur and Thiruchanur districts of Tamil nadu. It is grown as seasonal or annual although it is perennial by nature.The edible part is called **corm.**Corm is a modified stem. The **acridity and irritate** state due to presence of **crystals of calcium oxalates.**

Varieties:

They are two distinct types of yam. One has **smooth corm**. Propagated by small pieces of corm. This type of acridity but gives high yields the **other type** can be propagated by cormels or daughter corms, it is superior in quality and free from acridity. The flesh colour ranges from white to light pink.

Propagation:

Through corms around 6000 kg of tuber per hectare is needed. The seed tuber selected carefully from last year crop left un harvested for this purpose. The yam has a face or front portion with number of rings over a face a projections in the middle these rings are places from where the feature plants will arise. Yam is cut into small pieces or bit in such away that each bit has a small portion of ring. There are also carpuncles like projections which are tender buds called **Arunbu**. These are removed before planting has do not give vigorous growth. An ordinary yam gives about 6 to 8 bits per planting the cut pieces is dipped in cow dung solution to prevent evaporation of moisture. It was found that seed corm weighing 0.5 to 1 kg has been assessed as optimum.

Soil:

Soils best suited for suran are those which are like loams and sandy loams and well drained soil. It also cultivated in alluvial soils but it is not suited to heavy soils as the crop suffers from water stagnation.

A good crop can be raised on a light soil in heavy manuring and frequent

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irrigation.

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Climate:

It requires well distributed rainfall at around 100 to 150 cm. it require warm weather during vegetative development, cool and dry weather during corm development, continuous rain and water losses are harmful to its growth. They should not be great variations in the temperature.

Land preparation:

The land is laid into flat beds in surat the bed size is 3.6 x 1.8 m.In pune the ridges of 1.5 m length are made.The broad ridge method is found to be better yielder and particularly suitable for heavy rainfall areas.

Preparing the plant material:

For the first year crop selected tuberous out growth called buds or arumbo from the 4^{th} year Amorphophallus are planted. If more than per sprout one seen on a corm on health can be used.

Planting:

The crop is maintained for 4 years plant material of first is used for second year material 2^{nd} year is used for 3^{rd} year material 3^{rd} is for final year.The number of corms per bed 3.6 x 1.8 m is 80, 40, 20 and 6 for the 1^{st}, second, third and fourth year crops respectively. Final year suran is fixed with ginger and banana. Suran takes 3 to 5 weeks to emerge and hence planted at least one month before monsoon.

Spacing:

First year crop 30 cm x 30 cm second year crop 45 cm 4cm, third year crop 60 x 60 cm, fourth year crop 120 x 90 cm. Sun hemp usually taken as cover crop for giving shade in the initial stages and buried along the ridges to swines as a green manure later.

Manurring:

25 tonnes of well decomposed FYM 80, 80, 120. N,P, K per hectare was recommended for year in case of elephant foot yam. Increased application of potassium or increased oxalic acid of content in corm. Increase potassium alone increase the carbohydrate.

Irrigation:

crop is irrigated first three month at an interval of 10 days and next few months six day interval or twice a week. Around weeding are necessary for growing period. There is a good possibility of growing groundnut, methi, radish, Lucerne, etc as catch or cover crops without affecting of the yield of suran and provide additional income.

Harvesting:

Crop mature in around 7 to 8 months. Yellowing and dropping down leaves are the signs of maturity. The corms are retained in the soil even after maturity. A light irrigation a long intervals is required to prevent the

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desiccation of corms. Harvesting is done by dressing corms individually by kudali/spade.The corms of cleaned of the roots and soil with hand and water.

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The buds of the 4th corms are removed and preserved for planting of first year crop. It is best the harvest the crop as when required. crop is harvested to October – November.

Yield: 35 to 45 tonnes per ha.

Botanical name	***Dioscorea alata* - YAM**
Family	**: Araceae**
Origin	**: South East Asia**
Chromosome number:	**2n =28**

Yams are grown as crops of subsistence the constituent the important source of food in tropical Asia and America and Asia.They are rich source of **Carbohydrates**.

Importance:

The tubers of yam contain minerals, vitamins, proteins, amino acid and they have medicinal properties. The yams are consumed after roasting in the form of chips, flakes or flour. Most of these yam contains **sapogenins** (base of **steroidal drug**) and alkaloids. The main sapogenin is **diosgenin**. This is widely used in the preparation of cartico steroidal drugs and oral contraceptive pills. The flour of yam is called fufu.

Pottage: The yams are perennials but cultivated as annual for potting purpose. Some times it is replanted every year.The edible part of yam is **tubers of rhizomes**.

Dioscorea alata is known as **greater yam**, water yam, winged yam and **larger yam**.

Dioscorea esculenta is known as **lesser yam.**

Dioscorea rotundata known as **white yam**. It is an early maturity yam mostly dioecious. It produce viable seeds.

Dioscorea bulbifera: it is known as **potato yam**. This species bear a climbing stem with larger tubers female flowers occurs especially in pairs Dioscorea trifida.

Species for diosgenin:*Dioscorea floribunda, Dioscorea deltoidea, Dioscorea maxicana, Dioscorea composite*

Cultivars: CTCRI, Trivendrum released.

Dioscorea alata: **Srikisthi, Sri rupa, Srilatha**

Dioscorea rotundata: grown in west Africa and some India released variety **Srisubra, Sripriya.**

Soil:

It requires deep soil. Some species may able to spread in shallow soils also loose well drained friable soil is good for its cultivation always avoids clayey soil. The tubers may get deformed. pH is 5 to 7.

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PRODUCTION TECHNOLOGY OF VEGETABLES AND FLOWERS

Climate:

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Dioscorea species are largely tropical also grown in sub-tropical regions I performance is best temperature ranging 15 to 30^0 C and the temperature less than 20^0 C it cannot grow well longer day length condition promote vine growth, short day length condition promote tuber growth. It requires well distributed rainfall 700 to 1000 mm.

Propagation:

Propagated by vegetative means. **Tubers, tuber pieces** in seed piece. It piece should have a head a middle portion or final portion.
Size of tuber piece is influenced the yield the tuber piece should not about 56 g to obtain large sized tubers seed tubers of 112 and 150 is recommended. Species like Dioscorea floribunda can also be propagated by vine cutting treated with chemical 2, 4 – D 1 ppm, 2,4,5 – T 1 ppm.
The **vine cuttings** are found to be good also **Dioscorea rotendata**.
Fertile seeds are used as propagating material in Dioscorea hispida and also Dioscorea rotundata.

Cultivation:

Land is thoroughlty ploghed 5 to 6 times later it harrowed well pulversied and leveled and land is raisedi n flat beds per raised beds. Mound planting can also be done. Tubers are planted in deeply 10 to 15 cm.

Planting time is march to may. In general the size of seed tuber pieces in Dioscorea alata ranged between 250 g, Dioscorea esculenta 100 to 150 gm. The seed tubers are treated with solution of benlate, benomyl to prevent rotting. Greater yam spacing is 90 x 90 cm. lesser yam spacing at 75 x 75 cm. Immediately after ploughing mulching with dry grass is recommended from order to moisture loss and to minimize the weed growth.

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PRODUCTION TECHNOLOGY OF VEGETABLES AND FLOWERS

LECTURE-20: Root tubers –sweet potato and tapioca -introduction - importance –varieties-climate and soil-propagation- planting-manuring-irrigation-intercultivation-harvesting- yield

Botanical name	***Ipomaea batatas* – *sweet potato***
Family	**: Convolulaceae**
Origin	**: South America**
Chromosome number:	**2n =6x=90**

Sweet potato is very important crop in tropical and sub tropical region of the world.

Importance:

It is a staple food in several tropical countries. It is one of the **world's highest yielding crop with reference to total food production and requires low inputs**.It can be grown through out year in tropical and sub-tropical areas even marginal farmer gets some income. Asia accounts for **92% of worlds sweet potato** area and production it occupy the seventh rank world statistic, after wheat rice, potato, barley and cassava. It has drought tolerant attributes and can be grown on lands of low fertility and it has the **ability of the highest solar energy fixing efficiency**.

The creepers are used as cattle feed. The crop also are used making starch, 4% sugar and 20% alcohol producing materials.

It is a convolvulaceae for member. It is a morning glory family **n = 15.** generally is seen as **hexaploid** with chromosome irregularities are common leading to infertility.

Varieties:

State	**variety**
Bihar and UP	Pusa safed, pusa lal, rajendra sakarkand.
Maharastra	H – 268
Kerala	kemhangad local, srinandini, sreevardhini
Andhra Pradesh	H – 41, 42, H – 268, H 30
ANGRAU	Kiran and Samrat
Tamil nadu	Co – 1, 2 and 3

Kiran: it is a mid duration variety, photo insensitive variety escapes weevil infection because of its earliness. Tuber is fusiform with red skin the tissue rich in carotene with height orange colouration. In Kharif, 14 tonnes per hectare in Rabi. 17 tonnes per ha in summer 4 tonner per hectare. The crop comes to harvesting in 110 to 120 days.

Samrat: short duration variety. Photo insensitive good for summer and kharif tuber is fusiform with white and cream chromosome flush with pink tinge.

Yield: 12 to 15 tonnes per hectare. 120 days duration.

Pusa safed: produces long tubers which are whitish. It is less affected weevils. Average 30 tonnes per hectare; duration is 105 -120 days.

Kalmegh: tubers are round, light brown in colour. Yield is 20 to 26 tonnes per hectare. Duration 90 to 100 days. It is a very early variety.

Pusa lal: tubers are long with pinkish red fresh. Average 20 – 22 t per ha with 120 days duration.

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Among the red and white varieties the white variety is suppose to be less sweeter and more fibrous. The red variety is shorter in duration and has better

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quality tuber. The tuber weight varies widely depending on the variety from 100 g to 1 kg.
IARI released variety **Pusa safed.**

Soil:

Crop prefers sandy loam type of soil. It also grows on clay loam. Best soils are lateritic soil with good depth and better fertility. Cultivation of sweet potato is to be avoided. Heavy clay soils because then hinder the tuber growth and aeration will be a problem. It prefer a pH Range 5.2 to 6.5. Highly fertile soils should be avoided. Since they favour vegetative growth of vines vine growth will be luxurious at the cost of tuber growth.Harvesting becomes a problem in heavy soil. Selected soil should have good drainage capacity also.

Climate:

Prefers moderate warm climate for at least a period of 4 months. Optimum temperature range 21 to 26^0 C. Optimum temperature range is 21 to 26^0 C. Temperature less than 10^0 C will damage the tubers. Crop requires bright sunshine moderate rainfall ranging and long photoperiods promotes vine growth and reduce tuber formation. Cultivation of sweet potato can be observed 42^0 C north and crop can be cultivated above short 20 MSL. Shorter days can favour tuber development. It is one of the most drought resistant vegetable thus not stand frost.

Land preparation:

The roots of sweet potato tend to be long and tends on deep soil hence deep ploughing avoided around 15 to 20 cm depth of land preparation is sufficient. Fresh manure is not applied this crop is produced long and rough roots soil is brought in to fine tilth by discing and harrowing.

Propagation:

propagated by sprouts from **tuber and vine cuttings**. Vine cuttings are preferred when two crops are grown in succession it is faster and cheaper vine cuttings are collected from previous crop and are used for planting the succeeding crop. Cuttings are sown directly in the states like Bihar, UP and Orissa practice of taking and creeps in succession respective year is common under such situation vine cuttings are cheaper and material fence collected uniform shape tuber can be obtained. Terminal vine cuttings are better propagating material but yield is comparatively less with vine cuttings.

Sprouts from tuber:

Sweet potato can yield better when sprout tubers are used for propagation. Medium sized, healthy sprouts free from pests and diseases or branches are selected and they are planted in a nursery. **Primary nursery:** site is well prepared adequately manured provided with good drainage and it is kept raised. The tubers are planted at around 16 to 25 cm row to row 45 cm distance up to around 10 cm depth and is adequately irrigated. After maintaining the sprouts for about 45 days in primary nursery will be shifted to secondary nursery.

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Secondary nursery:

Sprouts are shifted to secondary nursery. Sprouts are shifted from primary nursery they will be maintained in secondary nursery up to the time when they reach sufficient length for transplantation secondary nursery same spacing.

Planting:

Healthy sprouts or cuttings are selected for planting time varies depnding on the availability of soil moisture and area spring season average planted February to March autumn September to October in case of Bihar and In West Bengal September and October the planting is done. In Tamilnadu, September is normal season, kerala – may. **Sweet potato is a largely a rabi season crop**.

Method of plantation: Tamil nadu ridges and furrows prepared. In kerala, raised mounds are prepared our which planting can be taken up. Cuttings or sprouts should be an 5 to 16 cm per with 5 to 7 nodes.

Two method of planting **horizontal and vertical** in case of horizontal planting are node on either exposed and middle portion is buried under the soil.

In case of vertical planting 1 to 2 buds are kept out of the soil. In Punjab, planting is preferred in Maharashtra, Bihar, Orissa and U.P vertical planting is preferred. Keeping the vines in shade from about 2 to 3 days before planting will facilitate faster vine growth besides increased in yield. Spacing adopted is 6 x 20 cmand depth of planting can be up to 20 to 30 cm in up to 40 cm.

Manuring:

Well decomposed Farm Yard Manure applied dosage of 20 to 25 tonnes per hectare. Nitrogen @ 20 kg per hectare is applied basally nitrogen same quantity is given after 30 days and 60 days after planting. Phosphorus at the rate of 60 to 80 kg per hectare is complete basal dose, potash at the rate of 80 to 120 kg per hectare is applied in two split dose, basal application and second 60 days after planting.

Irrigation:

One light irrigation is essential before planting. Three days after planting one more irrigation is a must it is called as a life irrigation because it is essential for survival after wards the crop is irrigated once in a week. Critical stage varies from north stress 40 days after planting.

Inter culture:

In early stages perfect weed free situation is provided. Earthing up of soil will control weeds and also improve physical conditions around the plant. The crop requires 3 to 4 weeding after planting. Generally normal weeding is practiced. Chemical weedicides like 2,4 – D. Alachlor, Bromuron can be recommended for application.

Harvesting:

Maturity of a crop is indicated by a change in colour of leaves. Leaves

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turn yellow gradually dry and or shed. Certain varieties comes to harvesting within 90 to 100 days and certain varieties 120 to 180 days. Tuber also

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become brittle when fully developed. The surface of a mature tuber if cut and exposed to the acer dries up soon while the immature one remain moist and turn dark in colour. Judging the correct stage of maturity crop has to be harvested. If harvested early it cause reduction in yield. If harvesting is delayed up to 8 to 9 weeks it leads to serious loss in yield.

Method of harvesting: irrigate the field 3 to 5 days before harvest work with space to uproot the crop and while doing so, avoiding mechanical damage to the tubers. The tubers after harvesting are cleaned, graded and either send to market or stored.

Storage:

Tubers should be cured before storing. Process helps in the formation of callus on the injured portions particularly where the roots have been severed. The tubers are cured at best 18^0 C at 30%. Relative humidity maintaining for 10 days. Where the these control conditions not available, the tubers are cured either room temperature or dried in the sun for about a week.

Yield:

Yield vary with variety, management, irrigation etc. under irrigated conditions the average yield 35 to 45 tonnes per hectare under rainfed conditions average yield is 10 tonnes per hectare. In India average yield of sweet potato under field condition seems to be 6 to 7 tonnes per hectare and 20 tonnes vine per hectare can also be harvested to use it as green fodder per manure.

Botanical name	***Manihot esculenta – Tapioca***
Family	**: Euphorbiaceae**
Origin	**: Brazil**
Chromosome number: **2n =36**	

It is known as Manioc, Mandioca and Yuka in Latin American countries. Tapioca in tropical Asia and Manioc in Africa. Roots or tubers contain a deadly poisonous chemical i.e. **HCN**. Cyanogenic glucosides in cassava are hydrolysed by the enzyme Beta glucosidase.Cynogenic glucosides are called **"Linamarin", "Lotaustralin**", upon sundrying cyanide derivatives disappear from slices of cassava.Tapioca is a long duration crop for about 10 months hence early variety are preferred.Tapioca tubes are used for sago industries. They are used for manufacturing industrial alcohol.

Propagation:

It is propagated by excising young green shoots.It is propagated by cuttings.It is propagated by treating with NAA or IBA promoted rooting at a concentration below 10 ppm. Stem cuttings are obtained from full grown plants of 8 to 10 months age.Cassava is a **short day plant**.

Soil and climate:

Tapioca can be grown in almost all soils. Red sandy loam s mostly

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preferred. Cassava should not be exposed to moisture stress. Moisture stress leads to poor root development. However, cassava is relatively a drought

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tolerant crop. Cassava can recover from the damage of slight moisture stress of shorter duration. Because it is a crop of long growth period. It can tolerate soil temperature of 35 ^{0} C.

Planting:

Wider spacing of 90 x 90 cm is recommended for branching types (H-97 variety). Narrow space of 75 x 75 cm is for non-branching types (H-165 variety). Two shoots per hill is found to be the best practice.

Time of planting:

It can be planted at almost any time, highest yields were recorded in April – July plantings. Starch content was the lowest in April planting and increased steadily until November planting.

Systems of planting:

Planted by horizontal or vertical planting method. By direct planting method or by transplanting method when single budded sets are employed.

Manuring:

Around 200 kg of Nitrogen, 50 to 65 kg of P_2O_5, 120 to 135 kg of K_2O per hectare is found to be the optimum dosage in case of cassava.200; 50 to 65; 120-135 of NPK is the blanket recommendation. Foliar spray of nitrogen was found to reduce HCN content.Entire P and K are applied as basal and Nitrogen is given as top dressing 3 months after planting.

Harvesting and post harvest handling:

The crop is ready 10 to 11 months (8 to 9 months) after planting. Short duration varieties can be harvested 6 to 7 months after planting. Delay in harvesting may result in deterioration in cooking quality of tubers.

High yielding varieties produce 35 to 40 tonnes per hectare in 10 to 11 months, whereas short duration one 16-17 months yield 28 to 30 tonnes per hectare.

About 70% of total cassava production is used as food either directly or in processed form. The most popular and traditional mode of consumption is in the form of cooked and mashed tubers.After removing the outer rind and inner core (thread like fibrous material in centre of tuber), fresh tubers are cut into pieces, cooked in boiling water, decanted, added salt to taste and eaten with fish or coconut gratings.

Other methods of consumption are chips fried in oil or sun dried chips which are made in to flour, used for preparation similar to those of rice or wheat flour. Pre boiled chips is a method of processing cassava tuber for storage.These chips are harder than the plain sun dried chips due to partial gelatinization. They can be stored for longer period than sun dried chips.**Sago** is an important food product derived from cassava starch. Its consumed as a convalescence food in many parts of India. Cassava starch can also be used as industrial raw material for the production of alcohol, cattle feed and bio

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degradable plastic. *Manihot dulcis varaivi* is sweet.

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PRODUCTION TECHNOLOGY OF VEGETABLES AND FLOWERS

LECTURE-21: Root crops –carrot,radish,turnip and beetroot -introduction - importance –varieties-climate and soil-seeds and sowing-manuring- irrigation-intercultivation-harvesting- yield

Botanical name**: *Daucus carota – Carrot***
Family **: Umbelliferae**
Origin **: Central Asia**
Chromosome number 2n = 18

Introduction:

Carrot is grown all over India and is used for human consumption as well as per forage and particularly for feeding. It is taken raw as well as cooked in curries and is made into pickle and sweet meats.

Black carrots are used for the preparation of a sort of beverage called **kanji**, which is a support to be a good appetite.The orange coloured varieties are rich in **carotin** a precursor of vitamin A and contains appreciable quantity of thiamine and riboflavin.

Edible portions: the edible portions of the root varies in colour and size the outer portion of the tap root is more fleshy contains more sugar than the inner core which is more pithy.

Carrot is grown in winter crop in tropical conditions. In temperate countries it is grown as spring summer crop. It is a root vegetable and has world wide distribution.From economic point of view it ranks after tomato, cucumber, lettuce and sweet corn.

Types:

They are two groups.

1. Asiatic type
2. European type

Asiatic type see suitable tropical and sub tropical. European type are suitable to temperate area. Asiatic type have more red water soluble anthocyanin pigment an dless water soluble and lycopin pigment. Vitamin A content less. In European types, vitamin A content is more.

S.No	Asiatic	European
1	They produce roots and seeds, freely in the plains	they produce good roots in plains but fail to produce seeds.
2	The Asiatic type have the root ends conical	root ends are blunt.
3	The roots are red with more anthocyanins	they produce orange coloured roots
4	produce large core heavy tops	rich in carotene and core is compa-ratively less and soft.
5	More juicy	less juicy
6	Cores are less coloured	cores are self coloured
7	Produce more core	less core
8	Early maturing and have high sugar content	late maturing
9	They are tropical and sub-tropical (annual)	temperate (biennial)

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10	No chilling requirement for seed production	chilling requirement is must for seed production

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Varieties: In India long orange coloured smooth rooted types are more popular.
For exotic types sown for taking late crop varieties like chanteney, nantes and scarlet horn are the best. Seeds of chanteny nantes half long are supplied for vegetable research station in kulu valley in Punjab. The following varieties released by IARI Delhi

1. **Nantes:** It is a European type, gives skin stumpy orange group, perfect and cylindrical. The core is tender sweet self coloured. Gets ready in 120 days.

2. **Chanteney:** European varieties it has attractive deep reddish orange. It has a tapering but distinct stump end and core sweet and indistinct gets ready in 120 days.
3. **Pusa kesar IARI: local red x nantes half long**. It is a selection from a cross between local red with nantes half long. It has self coloured central core less. Branching of root and short leafy top. A notable feature of this variety, so that the **root stay a month longer in field without any sign of bolting**. Varieties released by Punjab agricultural university.
4. **pusa meghali (temperate type) half long:** nantes pusa yamadagni and coreless are some more improved varieties are

Climate:

Carrot is cool season crop.Some of the tropical types tolerate quite high temperature. A colour development and growth of roots is affected by temperature. At the temperature of 10 to 15 ^{0} C they will produce longest roots(but they develop poor colour).At the temperature of 23.95 to 24.44 it will be produce shortest roots (colour wil be less bright up).The effect of temperature will vary with the variety and soils.At very low temperature 4 to 7^0 C colour development very poor roots become enlarged and they are tapered very little enlarge of very little top growth was observed.
Temperature on germination: Off temperature for germination 7.2 to 23.9^0 C. Optimum temperature for better growth 18.3 to 20.9^0 C.
Temperature on carotene content: Carotene content is reduced at temperature at below 15.6^0 C and above 21.1^0 C that is why carrots grown 15 to 20^0 C will develop good colour. Poor light is essential for producing carrots. The tropical types produce roots even at high temperature of 25^0 C.

Soil:

It requires deep well drained sandy loam. This type of soil is particularly good for early crop. Heavy soils will check the development of roots and cause forked lateral roots. It is grown in rainy season under heavy soil condition or black soil condition even then it will produce abnormal or forked roots. Roots impeded by rich soil strengthened or thickened with increased branching. Carrots does not grow will highly acidic soil. Maximum yield can be obtained at pH of 6.5

Seed rate:

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5 to 6 kg per ha it can be up to 6 to 9 kg per ha is the variety Premnath. Sowing time is September (best).

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Optimum temperature for germination 7.2 to 23.9^0 C. it can be sown from June-July, August, September and in hills the month of January – February.Tropical types up to September to October. Temperature types are sown from October onwards. Several successive sowing at interval of 2 to 4 weeks help to ensure a continuous harvest of marketable roots. The seeds are sown on ridges on flat land about 1.5 cm deep.

Method of sowing:

Seeds are directly sown in the field in ridges per furrow or flat bed. In rainy season, ridges and furrows are made. In Rabi season if the soil is loose, sowing is done on flat beds. If the soil is hard, sown on ridge and furrows. Seeds are thin and light there are mixed with soil or broken rice at 1:1 or 1:0.1 or 10:1 ratio. Seeds are sown to a depth of 1 to5 cm at a spacing of 30 cm between rows. (within rows 5 cm). the seeds germinate within 5 to 10 days after sowing under good moisture conditions. Thinning has to be done at distance 5 to10 cm. thinning is done at 8 to 10days after germination, the resulted spacing is 30 x 5 to 10 cm.

Manuring:

Carrot is a heavy feeder. Potassium requirement is high. For an yield of 100 tonnes per hectare, crop remove around 14 kg Nitroget, 8 kg P and 45 kg Potassium. For an yield of 200 q per hectare a crop removes 40 kg N, 225 kg P and 125 kg Potassium per hectare. Depending on soil fertility Farm Yard Manure at the rate of 30 tonnes per hectare is applied at the final ploughing and dosage of 40 to 60 kg nitrogen, 25 to 50 kg of phosphrous and 90 to 110 kg of potassium per hectare is recommended has basal dosage. Excess nitrogen reduces root quality damage the contenet of sugar, dry matter, carotene and vitamin C. fresh cowdung should not be applied it may cause forking of roots.

Irrigation:

First irrigation is given soon after seed sowing this has to be followed. Four to six days after sowing. Irrigation is given at 6 to 10 days interval.

Earthing up:

Should be done at 60 to 70 days after sowing to help in development of roots the soil is earthed up covered the top of developing roots to prevent loss of colour of tops, the tops becomes green and toxic on exposure to sun light.

Mulching:

Field is mulched with soya bean stubbles or rye mulch comparatively to conventionally tilled plots.

Harvesting and yield:

Early carrots are harvested when they are partly developed.For the purpose of distinct markets otherwise they are retained in the soil till they reach full maturity stage they should not be retained afterward. They have become puffy core becomes hard and is unfit for consumption. There are two methods of harvesting.

1. roots are dug out when they are sufficiently moist which khurpa or

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spade in black. Light irrigation has to be given before harvest, so that

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easy pulling of roots can be facilitated without damage by holding the leaves.

2. in case of Asiatic variety the roots are harvested when they attain marketable stage 2.5 to 5 cm in diameter, at the upper end after harvesting the roots they are trimmed and washed before sending them to the market. They are packed with gunny bags.

Yield: varies to the variety.
Tropical types give around 20 to 30 tonnes per ha
Temperate type may give 10 to 15 tonnes per ha

Botanical name	***Raphanus sativus* – Radish**
Family	**: Cruciferae**
Origin	**: Europe or Asia**
Chromosome number 2n = 18	

Radish is a popular root crop throughout India.Radishes are useful as inter crop or comparison planting between rows or plants or slower growth.Raddish is both annual and biennial. The edible portion is **fleshy root** it develops both primary root and hypocotyls.

Varieties:

Radish roots vary greatly in size and colour as well as the length of time for which they remain edible. The radish varieties are divided broadly.

1. European or temperate types
2. Asiatic and sub-tropical

Temperate types are smaller in size mild in taste and are mostly raised as salad crops.
A pure white thin and tender variety becomes ready in about 30 days after sowing.
Pusa himani: a long white variety released by IARI it is suitable for sowing for mid December to late February inplains and during summer in the hills.
Rapid red white tipped or scarlet globe or French break fast: globular varieties they become ready in 26 days.
Tropical types: Japanese white: roots grow better when the temperature is low, they are pure white 30 – 45 cm long mildly pungent with blunt end.
Pusa desi: Roots are of same size as though of Japanese type they have green stem end they are more pungent they have tapering root are suitable sowing early August.
Pusa chetki: roots are pure white, wild pungent suitable for sowing from March – August. Roots becomes ready for harvest within 40 – 45 days.
Pusa reshmi: roots are 30 – 35 cm long tapering white with green stem end it is suitable for sowing in the month of September.
Hill queen: it is a popular variety in North India for sowing in September onwards. The other good indian varieties are Jaunpuri. (Gaint variety more than 1 m long)
Bombay red, Chinese rose contain arka nisanth, Punjab safed, Punjab agethi.

Climate:

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Radish is tolerant to heat.The develops its flavour, texture and size, the cool season the temperature between 10 to15^{0} C are required.Varieties

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differ in their temperature requirements. The crop is grown in hot weather small rooted varieties produce tough and extremely pungent roots. They should be harvested white they are still young and small rather than allow to reach edible size the long and large varieties can withstand heat and rain much better. Plants bulb normally when the day is 10 – 8 hours long. **Bolting** is quick when the day length increases.Long days as well as high temperature produce premature seedling or formation of stalks without adequate roots.

Soil:

Raddish is grown in all types of soil but light friable soils is considered best.Sandy loamy soil with high amount of humus is ideal.It can also be grown fairly on acid soils.

Heavy soils produce rough ill shaped roots with number of small fibrough laterals which decrease market value.The summer crop is preferably grown on cool moist soils such as silty loams.

Time of sowing and seed rate:

Raddish is sown on ridges.Spacing varies with the variety. Temperate type becomes ready 25 to 50 days. Therefore they are sown very closely whereas tropical types take a long time and being larger in size they are given a wider spacing.Radish is sown on ridges on 45 cm apart and 22 cm highA small furrow about 1.25 cm deep is made on the top of the ridge with a sharpened end of stick and seed mixed with fine sand or coarse soil is sown in furrows by hand. The seed is then covered and soil is formed around it. Radish is often sown other field and vegetable crops such as wheat, grapes, onions, cabbage, cauliflower, methi etc.

Larger variety need earthing up atleast once.The first irrigation given immediately after sowing and subsequent irrigations can be applied once a week . One or two weedings in the form of earthing up or weeding manually is sufficient for the whole period of crop.

Manuring:

Radish is average of short duration judicious use of manures and fertilizers highly needed for its production. 120, 60, 120 of N:P:K along 30 kg of MgO will be generally sufficient and basal dressing of 25 to 45 tonnes well decomposed FYM is to be added when the time of soil preparation.

Harvesting:

Radish should be harvested when the roots are still tender. A few days delay of harvesting particularly temperate type may make the roots pithy and quite unsuitable for market. The roots are pulled out along with the tops and washed and then packed for the market. European types should be uprooted 20 day after sowing before they become sponger and hallow inside other types are harvested the roots are till tender and attainment of full size.

All the roots are not uprooted from the whole field at one time, but they are harvested as when they become trip enough for the market or home consumption. They are pulled out with tops by hand and wash it remove the soil to give good appearance they are sent to market loose in basket or tied in the bunches of 3 – 6 according to variety.

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Yield: The European variety yield 8000 to 12000 kg per ha

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Asiatic types yield 20,000 to 33,000 kg per ha

Botanical name	**: *Brassica rapa* – Turnip**
Family	**: Cruciferae**
Origin	**: Russia and Siberia**
Chromosome number 2n = 18	

Turnip is widely cultivated in North India for its roots.It is grown as winter vegetable. In this crop also **European, Asiatic varieties** are recommended for cultivation.

Temperature types are quick growing good in quality and possess early maturity. Temperate type requires temperate climate for seed production. **Asiatic types** are high yielding relatively poor in quality growth and slow retained edible quality is larger period compared to temperate type, they con complete their life cycle temperate as well as tropical conditions. In Punjab both types of climatic conditions prevail and therefore seed production of both the types can be done.

Yellow fleshed varieties is considered to be a hybrid between turnip and sweet (*Brassica napa*)

Varieties:

Turnip varieties also put in two groups.European or temperate and Asiatic or Tropical.Temperate varieties are sweeter and more palatable.Tropical types are more pungent and better for pickle. Tropical types are earlier and more heat resistant.

Temperate types : purple top white glow, snow ball, golden ball, early Milan red top, pusa swarnima, pusa chandrima.

Tropical types: either red or white.

Ex: **pusa kanchan:** selection from a cross of red Asiatic variety and golden ball.

Pusa swethi: it is a very early white and snow white in character.

Pusa swarnima: It is a cross between **golden ball and Japanese white** produce more yield compare to golden ball. Ready for harvesting with 60 to 65 after sowing. It is resistant to cabbage maggot.

Cranford: it is a best canning variety of turnip. Variety L-5, s. no. 66 is best suited saline sodic soil.

Climate:

It is essentially cool weather crop.It thrive well cool moist climate.It is highly resistant to frost and mild freezing temperature.Best quality turnips can be grown in the north region and hilly tracts of India.

Soil:

Crop is grown on wide range of soil types.The finest roots we produced in sandy soils.In deep loam soil, it can produce high yield.

Sowing time:

Varies according to type and tract.For Asiatic types in plain areas july to September. In hilly areas it is march. For European type in plain area

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October to December. In hill areas March.

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Seed rate:

Turnip seeds are small 500 seeds weight per gram.Two to three kg seed per hectareThe seed remain viable for four year, if kept under good storage condition. Germination varies from 90 to 95%.

Manuring:

Turnip is grown on light soils. The use of manures and fertilizers is a must and 20 – 25 tonnes FYM per hectare should be applied.Blanket dose is 60, 40 and 40 of N, P, K per hectare is to be given.Half of the nitrogen and entire phosphorus and potassium given as basa.Half of the nitrogen is top dressed when the roots starts forming. Second split nitrogen is given along with second and third irrigation.Root formation in turnip is called **knob formation**.

Irrigation:

First irrigation is applied immediately after sowing. In case the field is irrigated before sowing. First irrigation is given immediately after thinning. Thereafter irrigations are given at every 5 days interval during hot days even 8 to 10 days in cold weather.

Harvesting:

Should be done when the soil is slightly dry and roots can be lifted clean out of the soil.

Yield:

Yield varies from 200 to 450 quintals per hectare

Storage:

The method of pulling is very important factor to influence the shelf life of pocket turnip. Smooth surface tuber laster much longer than abrasion peeled tubers. In perforated polythene bags cold storage at 37^0 F is given better results. Application of **Maleic hydrazide** to the plant before harvest to prevent sprouting.

Botanical name**: *Beta vulgaris* – Beetroot**
Family **: Chenapodiaceae**
Origin **: Mediterranean area**
Chromosome number 2n = 18

The five selections of Beta vulgaris are Garden beet, Mangle, Sugar beet, Chard or Swiss chard, Foliage beets. Its flowers during second year if allowed. The flower stalks grow in height of more than one meter. Beet fruit contains two to six seeds.

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LECTURE-22: Leafy vegetables –amaranthus, palak and gogu -introduction - importance –varieties-climate and soil-seeds and sowing-manuring- irrigation-intercultivation-harvesting- yield

Botanical name**: *Amaranthus blitum***
Family **: Amaranthaceae**

Amaranthus blitum and *A. tricolor* are most commonly grown in South India.Blitum is dwarfish with small leaves and rejuvenate quickly after each cutting.It is suitable for sowing in summer.Tricolor is taller with thick stems and larger leaves.This type can be grown in summer as well as in the rainy season.

Varieties:

Two varieties green and red. The green variety is more common.

Method of sowing:

The seed is sown broadcast after mixing with fine earth for uniform distribution. **Seed rate:**2-3 Kg /Ha

Manuring:

Small quantities of Ammonium sulphate or urea can be mixed with irrigation water and applied when the seedlings are about 4 inch high to push vegetative growth.

Harvesting:

Usaually starts in about 3-4 weeks after sowing.About 5-9 cuttings can be taken at weekly interval.The fully grown side leaves are removed.The top may also be cutleaving the lower leaves to produce new shoots in their axils.

Yield: 7500 Kg /Ha in a span of 2 months

Botanical name**: *Beeta vulgaris Var. Bengalensis* - Palak**
Family **: Chenopodiaceae**
Origin **: Indo – china**

Desi palak : ***Beta vulgaris***
Vilayathi palak: ***Spinacea oleracea***
Spinach is grown in north India. Vegetable growers mostly cultivated spinach while spinach is limited to kitchen gardens.

Varieties:

1. varieties with reddish mid rib
2. varieties with greenish mid rib
3. **All green** released by IARI, New Delhi. Leaves are uniformly green given 6 to 7 cuttings at 20 days interval starting from one month after sowing 125Q per hectare. Development of seed stalk take about 75 days.

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4. **Pusa palak:** IARI released produce uniform green leaves it is late in bolting and

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5. **Pusa jyothi:** evolved treating the seed of all all green 2% colchuri it produces large green tender succulent leaves. Leaves are brittle in nature they have flavour and colour it gives 6 to 8 cutting. Yield: 50 tonnes per hectare. It is grown throughout the year rich in many nutrients.
6. **Pusa harit:** evolved by hybrid sugarbeen x local palak released by IARI. It was developed to mainly to suit hilly regions. Crop require chilling a character inherited from sugar beet. Leaves are thick green and big sized. It is a late bolting variety. Tolerate alkaline soil.
7. **Jobner green:** university of udaipur popular in Rajasthan. It is a mutant variety from the popular of local collection it produces large thick tender succulent leaves. The taste is equal to all green gives yield of 300 q per hetare.

Soil:

Prefer sandy loam good drainage. Neutral pH. Cultivar Jobner green can with stand pH of 10.5. crop is regarded as highly salt tolerant and grow saline soil. Spinach is regarded as still more tolerant to saline condition.

Climate:

Prefer autumn and winter mild climate in plain. Withstand frost and some extent and warm weather. If temperature is very high, it results in bolting.

Sowing time:

Sown 2 to 3 seasons and condition are favourable. Sown through out the year. In plains spring season and rainy season are the important times of sowing. In hilly areas it can be sown even the a month of April.

Seed rate:

25 to 30 kg per ha. Beds are made irrigation channel in between. Seeds are soaked in water to hasten up germination. In general the seeds are sown by broad casting. But time of sowing is preferable. Spacing of 20 cm is kept in successive time. Germination commences within 10 DAS will complete in soon. One light irrigation after sowing is essential.

Manuring:

Nitrogen fertilizer is more important. Apply 35 to 40 to per ha of well decomposed FYM 25 to 50 kg of N, P, M are given as basal and 25 kg Nitrogen after every cutting.

Irrigation:

More number irrigations are essential in light or sand soil. Summer crops requires frequent irrigations at 3 to 4 days interval. In winter, autumn irrigations are given at 10 to 15 days interval.

Harvesting:

Starts at 25 to 30 DAS. It may continue to 15 to 20 days interval. Cut

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only green succulent tender leaves, winter crops gives more cuttings than

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summer crop varieties. Jobner green gives more cuttings compared to all. Yield varies with cultivar 120 to 300 quintals per ha.

Botanical name	**: *Hibiscus subderifa* – Gogu/ rosella / roselle**
Family	**: Malvaceae**
Origin	**: Indo – china**

Tender leaves and shoots are used as leafy vegetable.Leaves have slight as acidic taste. Besides leaves with has a great potential export particular making soft from dry calyx. Calyses yield 1 to 97% die the fresh calyses are used various preparation like curries,Confectionary and herbal drink. It has several medicine purpose. The dry contracted to use urine diseases, asthma, skin diseases. About 16% fatty oil present in seed.

Varieties: ANC 108: suitable for jute making.

Soil:

It can be cultivated in the soil in wide range of soil sandy loam to heavy clay soil.

Climate:

Warm season crop. Prefer warm humid or dry climate with a rainfall of 150 to 200 cm per year and 25 cm per month. It is grown as rainfed and irrigated crop. Spring summer crop will not stand heavy continuous rainfall. Waterlogging and frost.

Seed rate: 10 to 15 kg per ha. Direct sown crop.

Preparation of land:

Prepared by ploughing 3 to 4 times during final ploughing 60 to 100 tonnes per FYM is incorporated. Then the land is laid into ridges and furrows or flat bed.

Spacing:

60 x 70 cm.If soil is fertile spacing of 75 cm is kept between rows. When the crop is taken solely for leaves purpose 20 x 7.5 cm sufficient.

Time of sowing:

June – July or August and September.Incase of hills, March and April. Favourable conditions through out the year. Seeds are soaked water treated with 2 % Capton 1% calyx in for about 30 min

Manuring:

Well decomposed FYM @ 15 to 20 tonnes per hectare is applied or incorporated in the final ploughing. For a crop mean for calyces 250 kg of Nitrogen, 75 kg Phosphorus and 75 kg of potassium is applied. For a crop meant for leaf 40 kg N, 40 kg P and 45 kg potassium per hectare is recommended. Phosphrous and potassium should be applied basally before

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seed sowing. Nitrogen is applied in 3 splits. First split is given as basal dose. Second 30 to 35 DAS. 3rd split is given 60 DAS. It takes 90 to 125 days for

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harvesting calyces. For leaf purpose Nitrogen is applied in two splits, first before sowing and second one 20 DAS.

Irrigation:

The field is irrigated after sowing. Irrigation is given 4 to 5 days interval till the seeds emerge. Later the crop is irrigated at weekly interval.

Harvesting:

Crop is harvested at 120 DAS for calyces at 40 to 45 DAS for leaf purpose. Generally the entire plant is pulled out or otherwise several cuttings are taken. First cutting is taken 20 to 25 DAS shoots are clipped bearing 7 cm from the ground with favourable condition the interval between two successive cuttings 10 to 15 days.

Yield:

Yield varies depends on climate management etc. Generally 10 to 12 tonnes of leaves can be harvested for ha.

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LECTURE-23: Perennial vegetables – coccinia -introduction - importance – varieties-climate and soil-propagation-manuring- irrigation-intercultivation-harvesting- yield

Botanical name**: *Coccinea indica* -** Ivy gourd Family **: Cucurbitaceae** Origin **: India** Chromosome number 2n = 24

Roots stems leaves are used to cure skin disease bronchitis on diabetes.Fresh juice from leaves is administered for diabetes.The plant reduces the amount of sugar in the urine and improve the general metabolism patient.The parts of the plants (leaves and roots) are used in the treatment of diabetes even when insulin has failed.
Immature green fruits bitter due to the present **cucurbitacin B** reduces during ripening. Plant is **dioecious.**Fruit is **pepo**.

Varieties:

Basically found 2 types 1.stout type 2.slender type
when immature the fruits are bright green in colour with white stripes and scarlet red when mature. AC 5, AC 48, IIVRC 1, IIVR-C-2 are some of the improved lines which are under testing in all India coordinated vegetable improvement projects. IIHR , Bangalore has developed **IHR 5:** it has good fruit quality and bearing capacity.

Climate:

Thrive well under hot or moderately warm humid climate. It remain under dormancy during December to January when temperate godown. Neuroflushes will come when temperature raises in February and March due to this it can produce fruits once in a year some of North India parts under south and central India conditions where winter is not distinct plant growth continues and plant produces 2 to 3 flushes.
Therefore two peak fruiting seasons

1. summer season
2. rainy season.

Optimum temperature for vegetative growth is 30 to 35^0 C. It performs well under high rainfall conditions.

Soil:

Well drained fertile sandy loam is ideal for cultivation of coccinea. It performs well in light soil with good fertilizer management. It prefer soil pH between 6 and 7. optimum range of soil temperature is 18 to 22^0 C. deep soil can support the wine for longer periods.

Seeds and sowing:

Crop can be propagated by rooted stem cuttings and tuberous roots. Semi hard wood cuttings which no 20 to 35 cm long having pencil thickened are collected from older shoots.The plants from these cuttings will fruit better

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and produce early crop.Leaf cuttings are also used for propagation of

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coccinea.Planting time june to july (plain), early March (hilly region). Cuttings are treated with IBA @ 2000 ppm and then planted in the pits.

Land preparation:

Cleared off all weeds. Pandal should be erected as when the cutting start with vegetative growth. Planting is done at 2 to 3 m on either side.Pits are dug up size 30 to 45 cm^3 they are filled with 5 kg of well decomposed FYM, ½ kg of neem cake, little quantity of SSP along with top soil. Rooted cuttings are planted in the centre of the pit while planting 5 to 10% vines should be of male type they should be uniformly planted in the Orchard. It is a dioecious as well as parthinocarpy.

Manuring:

The amount of fertilizers to be applied depend upon the soil and its nutrient status. However, in general 60 kg N, 40 kg P and 40 kg K per hectare are applied. Half nitrogen entire P and K are given as basal close remaining half nitrogen is given four splits at monthly interval stating one month after planting. Well rotten farm yard manure @ 10 kg per plant and also applied just after prunng.

Training and Pruning:

Immediately after planting cuttings are staked with 2 m stakes. Plastic thread are used for training the vines are trained to climb over pandal the tip of the shoot as to before going of the pandal heading back done 2 times at 6 inches interval. This will promote the vine to start flowering and produce fruits. All the dead, diseased shoots are removed by pruning and during winter pruning should be done during summer it should be light.

Irrigation:

After transplanting per planting the first irrigation is given afterwards light irrigation is given four to five days interval hill the establishment. Irrigation schedule at 10 days interval on the black soil. Critical period for moisture is flowering and fruiting time. Proper moisture at this time should be ensure this time. Practices like weeding and hoeing should be done regularly so as to ensure proper aeration.

Harvesting and yield:

Stage of harvest is indicated by a change in colour from dark green to light green. Under mild climate conditions where winter is not severe fruits can be harvested throughout year, if winter is severe and relative humidity is more fruit yield decreases.Fully grown fruits which are still tender should be picked carefully.Generally crop gives a continuous harvest for about 9 to 10 months in an year, pickings can be taken at 3 to 4 day interval, if picking is delayed flesh around seeds become pink and such fruits fetch less price in market.

Yield:

On an average 8 to 10 kg fruits can be harvested per vine. Around 200 to 300 fruits will weight 1 kg. About 100 to 125 quintols per ha yield can be obtained

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for ivy gourd per year however yield can be enhanced up to 300 to 400 quintals per hectare under intensive management conditions.

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PRODUCTION TECHNOLOGY OF VEGETABLES AND FLOWERS

LECTURE-24: Perennial vegetables – curry leaf and drumstick -introduction - importance –varieties-climate and soil-propagation-manuring- irrigation-intercultivation-harvesting- yield

Botanical name	***Murraya koengi***
Family	**: Rutaceae**
Origin	**: Uttar Pradesh in India**
Chromosome number 2n = 24	

It's a self pollinated crop. It has an ornamental species also i.e. murraya exotica, amenable for pruning.

Importance:

Volatile oil extracted from leaves contain **Koenigin** (responsible for leaf aroma) and volatile oil from flowers contain **Murrayin.**

Varieties: two varieties are popularly under cultivation.

1. DWD – 1 2. DWD – 2.

DWD – 1 is recognized as **suvasini**, released by UAS, Dharwad. Its clone of single plant through root suckers, leaves are dark green, shiny and highly aromatic. Its sensitive to low temperature especially in winter. Bud burst is very very poor. Oil content in leaves is 5.2% and this variety can be dehydrated at 60^0 C without loss of flavour and made into powder.

DWD -2: this is seedling progeny of unknown source. Leaves are pale green in colour. Relatively less aromatic. Not very sensitive to high temperatures. Bud burst is high.

Internodal length is very high, almost 8 times more than DWD – 1.

S.NO	DWD – 1	DWD - 2
1	Released by UAS, Dharwad	Released by UAS, Dharwad
2	It is a clone of single plant	it was developed from seedling progeny
3	It has dark green leaves	It has pale green leaves
4	It is highly aromatic leaves	it is relatively less aromatic
5	It is more sensitive to low temperature	it is less sensitive to low temperature
6	Not grown if temperature is less than 16^0 C	It can grown at at temperature less than 16^0 C
7	Bud burst is more	bud burst is less
8	Less internodal length.	Eight times more internodal length.

Tamil nadu variety known as **Senna kumbu** is also under cultivation. Its leaves are having better aroma and flavour and it contains high amount of oil.

Varieties of curry leaf classified into two groups.

1. broad leaved 2. small leaved.

Small leaved varieties are more fragrant compared to broad leaved varieties and they are used for extraction of essential oil.

Propagation:

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Propagated by two methods

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1. by seed: it is commercially adapted.
2. by suckers and cuttings: ideal method

poly embryony is noticed in the seeds of curry leaf. 14% of curry leaf fruits have two seeds per fruit.4 to 5 embryos are noticed in each seed.

Nursery raising:

Two ways: 1. raised beds can be prepared over which seeds can be dibbled. 2. seeds are sown in polythene bags filled with sandy soil and FYM @ 2 -3 seeds per bag.These seedlings after around 3 months can be directly transplanted into the main field. Second method is mostly followed by farmers. **Spacing** adapted is 30 cm between row to row. After a few rows (3 – 4) 90 cm path is left over for easy spraying and weeding spraying and weeding operations.

Seed rate is 500 kg per ha.In the nursery beds the seeds germinate in 3 weeks freshly extracted seeds only should be used for sowing because they loose viability quickly.

First method of raising a nursery bed consists in adapting 90 cm spacing between successive rows. Bed is maintained with optimum moisture regularly irrigated 3 to 4 times before germination.2 – 3 times after germination beds kept weed free. In this method seedlings will be ready for transplanting after about one year.

Field preparation:

Field ploughed 3 to 4times about 20 tonnes of well decomposed FYM is incorporated in final ploughing.Main field spacing is around 1.2 to 1.5 m on either side, a closure planting of 90 x 90 cm is adapted under poor soils.Pits of 30 cm^3 are dug and filled with FYM, SSP and Folidol dust.Seedlings with 15 to 20 cm weight are transplanted in each pit, then they are irrigated.

Training :

Plants are allowed to grow up to 1 meter height then they are headed back. A number of side shoots will sprout and branching is encouraged by this operation. Plants are made bushy so that harvesting becomes easy. Generally 5 to 6 strong side shoots are maintained in 4 directions.

Pruning:

Plants are pruned to encourage leaf harvest for 4 times in an year. Generally harvesting is done when they have more number of young shiny leaves. After each pruning we get such quality leaves and those are well manured and irrigated before plucking.

Manuring:

Curry leaf requires more quantity of organic manure perhaps inorganic fertilizers. 20 kg FYM is incorporated in each pit. After each pruning another 20 kg FYM is applied around the pit. 19, 10 and 10 of NPK per ha is generally applied. Field should be kept weed free before application of manures after which its irrigated.

Harvesting:

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Leaves along with twigs are harvested. Twigs having maximum number of young leaves are only cut down. Leaves along with young shoots

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are totally cut at the end of first year. Two cuttings per year can be taken under poor fertility conditions. However under optimum conditions totally four harvests can be taken per year.

Yield:

Five tones per ha during second year and it will be doubled i.e. 10 tonnes per ha in the fourth year. After wards the foliage yield increased up to 20 tonnes per ha.

Botanical name	***Moringa oleifera* - Drumstick**
Family	**: Moringaceae**
Origin	**: North west India**
Chromosome number 2n = 28	

It is also known as Moringa.It is also known as **ben oil tree**.
Economic plant parts: pods, leaves and flowers.

Importance:

Drumstick is considered is one of the popular tree vegetable especially in south India as a home garden tree besides also being commercially cultivated on large scale for leaves flowers etc. The tender fruits and buds forms the main vegetable part of the tree and are nutritious. The crop is highly valued for its distinct appealing flavour of fruits. It is a rich sources of proteins, minerals and vitamins.Seed are also very important as they give oil which is known as ben oil or beh oil. This oil is used for illumination and soap making industry. The oil is highly prized it is used for lubricating wrist watches, computer peripherals and delicate goods. Seeds contain 38 to 40% non-drying oil which is clear odourless and never become rancit. Oil is edible and also used in the muf of perfumes and hari dressing. Left over cake is non edible and used for purifying affluent water from rivers, ponds etc along with Alumunium sulphate. The wood of the trees gives blue die and a course fibre. A paste of leaves is used as an external application for wounds. Flowers are used as tonic and diuretic. The roots of the plants are used for seasonal pickle and for flavouring ghee. In some parts of dutch east India the seeds are fried and eatened. The fruits are rich in vitamin B and vitamin C and they have medicinal properties so as to use them in the treatment of rheumatism and cardiac and circular stimulant.

Varieties:

There are **perennial and annual** types in drumstick. Perennial types are mostly suitable for kitchen garden Ex: **Jafna.**
Kodaikas, Moringii, Kuttu maringi, Palmedu, Moringi, Palamedu moringi.
Annual: they are commonly planted on commercial scale their fruit and seed.
KN 1, PKM 1 (conunce), PKM 2 its bigger size (pods).
PKM 1: it is annual type belong to Moringa. Pterigosperma released from TNAU by pure line selection the fruits are long fleshy and tasty. Tree 4 to 6 metres height, comes to flowering 100 to 105 DAP. Each tree 250 pods are pod length well 60 to 75 cm. each fruit weigh 150 grams and contain 70% edible pulp.The tree are headed back after harvest and it is cultivated 3 year

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after which fresh planting is done. Pods obtain edible maturity 65 DAS. This

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variety can be grown as inter crop is orchard during their pre bearing period.Estimated yield per hectare 520 Quintols.

PKM 2: it was evolved as hybrid between **MP 31 x MP 28**. the plants are thick growin around 4 to 8 m height each tree has around 12 branches beans flowers in clusters 3 to 4 pods can be obtained in a cluster. Start flower 100 to 120 days after planting. First harvesting is taken at 170 to 180 DAP. Each pod weight 280 grams with 125 cm length and it girth of 8 cm. seed content decrease with increase in the flesh content. A yield will be around 980 quintals per hectare.

Perennial type:

Jaffna: the fruit length is 60 to 90 cm.

Chavakacheir also a sub type in Jaffna length 90 cm

Chemmurunga: red tipped fruits.

Soil:

Drumstick grown on any soil except stiff clay soil. Sandy loam with good amount of time are mostly preferable.

Climate:

It is a tropical plant will come up will under dry and arid tract said to be drought resistant. The optimum temperature is 25 to 35 degrees Centigrade. It is highly susceptible to frost when the temperature goes beyond 40 degrees centigrade results heavy flower shedding.

Propagation:

Propagated by seeds or limb cuttings. Perennial types on commonly propagated by limb cuttings. Annual types are propagated by **seed.**The yield in perennial is used during first two years. Perennial types are to be planted at wider spacing, annual closer spacing. The **limb cuttings** 1 to 1.4 m length and which having 14 to 16 cm girth are collected from index plants and these limb cutting planted to 60 centi meter cube. **Planting time:** June to October. In case of seed propagation or 625 g of seed is required for one hectare. Limb cuttings areplanted at distanch 2.0 x 2.5 m

Pit size and planting:

Around 45 to 60 cubic centimeters pit are dug up and pits are refilled the top soil is mixed with 5 to 10 kg FYM, 25 g of SSP and 50 g of folidol dust. The pits are irrigated before planting per sowing either seed and seed per pit are sown and regular watered 15 to 20 days. Seeds germinate. Thinning is practiced seedling 15 to 20 cm height only vigorous plants are retained other or removed.

Nursery:

In case of seed propagation instead of direct sowing a nursery can also be sensed with 15 x 75 cm polythene bags. Bags are filled with mixture of sand, soil, biofertilisers and seeds are sown per bag. They are allowed for one month, till the seedling attains 30 cm height. Seeds are transplanted to the main field. Nitrogen is done in the month of Jne transplanting in the moth of July. Flowering is attained during the month of January to February and pods

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will come to harvest from March onwards. Around 75 to 100 additional plants are grown in polythene bags per the purpose of gap filling.

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Manuring:

100 grams of Urea, 60 grams of each SSP and MOP are applied for each plant and then they are sufficiently irrigated. The plants are top dressed with 100 g of Urea 3 months after the first application besides these inorganic fertlisers well decomposed FYM @ 10 to 15 Kg may be added for each tree. The manures and fertilizers are applied in ring trenches dug at 60 to 90 cm among from the tree during the rainy season.

Aftercare:

Training and pruning practices are important when seedling attain 75 to 100 cm height they are headed back this practice helps in production of side shoots, strong side shoot are allowed in all direction when the side shoots are 45 cm long they are again headed back. This helps in development of better frame work and increase the yield.

Moringa plant can fell down during heavy wind. Wind movement height rise. The soil trunk mound up 30 to 45 cm height from ground level.

Irrigation:

The basins of trees should be cleaned of all weeds mid slight sowing of soil is very useful. Basin method of irrigation is followed in drumstick. Irrigation management is important in this crop. Since the plant need optimum moisture for good growth and development. First irrigation is given to pits before sowing next irrigation after 3rd day of sowing light irrigation are given to maintain optimum moisture till the seeds are germinate. Irrigation 10 to 15 day interval in the absence of rains is beneficial however they should not be any water stagnation otherwise they will be a heavy flower drop soil should never become too dry or too wet.

Harvesting:

Annual type comes to first harvest in about 6 months after sowing or planting perennial. Perennial types which are seed propagated may come to first harvest during third year of planting. The pods should be harvested at optimum edible maturity around 60 days after pollination the pods will each this stage. Flowering and fruit bearing takes place simultaneously and continues uninterrupted for the next 2 to 3 years 1 to 2 harvestings

Yield:

Annual type 200 to 250 fruits per tree per year, during first and second year. Perennial type can yield p to 80 to 90 fruits during the first 2 years and afterwards the yield will increase up to 500 to 600 fruits per tree per year during the fifth year. The important reasons of harvest in drumstick in March to June, September to October. There is no storage method. Therefore fruits consume immediately after harvest it may be used 1 or 2 days.

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LECTURE-25: Ornamental gardening- importance- features of ornamental gardening

An ornamental garden is a place where plants are arranged in an aesthetic manner.

Importance of garden:

In modern cities with growing slums and factories gardens are essential to improve the environment and to provide healthy air for the inhabitants.They are really the lungs of the city. Gardens serve to beautify the country.Gardens are said to be the yardstick of the culture.This is true to some extent as they reflect the aesthetic taste of the people and are the chief pieces of art that confront a visitor and help him asses the cultural standards of the region.

An ornamental garden is a place where plants are arranged in a manner. Plants can be grouped together in various ways to give an aesthetic effect. Each such grouping is called a **Feature.** Any garden comprises some of all of such features and hence the features are also called the **components of garden**. Some of the important features found in most of gardens are

1. Fence: Fence is the outer most boundary to prevent tres pass and to ensureprivacy in home gardens. Fences can be created, eitherby using closely planted thorn bearing plants, hedges and shrubberies or structures where wood, bamboo, wire netting and chain links are used. Various climbers can be trained over the fences to enhance attractiveness.

Ex. *Casuarina equisetifolia* –sarugudu,*Prosophis juliflora*,*Caesalpinia pulicherima*

2. **Hedges:**are useful to divide the garden in to sections, to line the drives so as to direct the visitors to a central object.They aresown and grown in the same manner as the fence and plants are pruned to a height of 3-4 feet.

Ex.*Clerodendron, Duranta, Lantana camera, Lawsonia inermis*

3. **Edges:**These are row of plants which do not exceed one foot height. They are grown along with paths and around the flower beds.Non living materials like bricks , tiles are also used for this purpose.Live hedges are more in harmony with the garden than features. The foliage hedges are not trimmed.

Ex.*Alternanthera sps, Eupatorium cannabium, Pilea, Aerus tomentosa, Tradescantia*

4. Drives and paths: can be primarily functional facilitating easy and purposeful movement within a garden, providing access to all features with in a garden or can be included for their decorative value, usually designed to provide a visual line between separate areas. Cobbles, granite, flagstones, brick, concrete or wooden materials may be used. They should be laid with easy gradients and perfect paving and leveling.

5. Lawn: Lawn focus the background colour in the garden picture against which the colour of shrubbaries and flower beds is brought in to relief. Whether the garden is big or small it must have a lawn. In fact a lawn and a mass of flowers beyond it will constitute a garden without any other features. The lawn should be sown only to a single species of grass so as to give a

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uniform colour.

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The most common lawn grass is ***Cynodon dactylon.*** It prefers slightly acidic soils (pH 5.5 -6.0). It does not grown well undershade of a tree. ***Dichondra ripens*** a new type of ground cover that has been recently introduced can stand sun and grows well under shade. ***Festuce*** is the quick growing and finest of lawn grass.

6. Shrubbaries and shrub boarders: When the plants are grown in a row but not trimmed the feature is called border.Borders are planted to different species of plants, while hedges are generally planted to a single species.Boarders may be of herbaceous plants they are called herbaceous borders or comprises of shrubs they are called as shrubborders. The shrubborders may be grown along wall or infront of fence of tree and also to seen together but are not in the row the feature is known as Shrubery.The border of the shrubbery consists of more than single row of plants.

Ex. Crotans – *Codium variegatum pictum*, *Hibiscus rosasinensis, Acalypha marcinata,*
Cestrum nocturnum, dracera

7. Flower beds: These are also known as annual flower bedsas they are planted with annuals or herbaciousperennials which are treated as annuals. They should be planted to a single species and variety so that each bed is of single colour. A flower bed should be behind a lawn or in the middle or atleast should have a strip of lawn in front of it.

Ex. Marigold: Zimnnia, Cosmos:Petunia, Phylo: Celosia

8. Carpet beds: Plants of different colour foliage which can be clipped close to the ground are choosen for planting in an intricate design on the ground. Such a feature knownas carpet bed. The design may be conventional, geometrical ones or map or clock or a sundial.

Ex. Alternanther Sps. (Purple and green varieties)

9. Topiaries: Certain plants which can stand severe and constantpruning and which posseses small foliage and relatively short internodes can be trimmed in to globes, ovals or in to fancy shapes of animals etc. These are generally found in formal gardens.

Ex. *Thuja orientalis*, *Casuarina equisetifolia, Murraya paniculate, Polialthis longifolia*

10. Arches and pergolas: Arches can be semicircular or rectangular shaped and are used to link one part of the garden with another. Arches are constructed near the gate or over paths. Its proper place is astride a path and its purpose is to support climbing plants. Pergola is a narrow vista consisting of a series of arches connected with climbers preferably leading to some other interesting feature of a garden. Pergolas are constructed over pathways. It brings height to the flat planes of a level compound.

Ex.*Bougenville, Quisqualis indica, Vernomis, Allamonda catharties*

11. Fern house (Fernery): Plants of the humid tropical, subtropical and temperate regions cannot be grown in the open in the plains exposed to glaring sun. Such shade loving plants are grown in a structure calle the fern house. In the centre of fernery, a cement tub is constructed and is filled with water so as to increase the humidity inside and also facilitating watering of potted plants. The beauty of fernery depends on the proper arrangement of plants like ferns, begonies, anthurium, caladiums, diffenbechias, dracaons,

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palms etc.are grown pots and kept on galleries.Small pots with orchids, pilea etc., are hang from the roof.

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12. Orchids: Orchids are humidtropical and subtropical plants loving shade. These are becoming great favourites because the flowers have gorgeous colour. They often assume shapes of birds, moths, butterflies and last longer.

13. Pot galleries: Circular galleries are constructed of masonry and on the steps of which potted plants are arranged. The height of each step and pot on the lower step should be the same.The plants grown should be taller than the height of steps so that the pots and the masonry structures are both hidden behind plants and present the apperence of a mound of plants.

14. Lily pool: Aquatic plants are grow in lily pools which may be dug in the ground and abetted with stones so as to look natural or may be constructed in cement of regular shape. In cement pools there should be an inlet at the bottom and an outlet a few inches below the top of pool, so that a constant level of water is maintained.

Ex. *Nelumbium speciosum, Pistia, Nymphea, Eichornia crassipes*

15. Rockery: Plants growing on rocky situation are grown in the garden is rockery. The rockery is constructed by keeping up manured soil to a desired height and embedding rocks into it. The plants are set in the crevices between rocks. It can be raised under the tree or separately. Generally both foliage and flowering succulents as well as xerophytes are grown.

Ex. *Opuntia, Eupatoria, Agave, Coleus, Sansveria, Bryophyllum, Tradescantia*

16. Single specimens: In an extensive lawn the monatany can be broken by single beautiful tree of exiting quality without blocking the view of the other features beyond. Trees like ***Polyalthis pendulus, Aracariacolummeris, Ravenalis medagescrensis*** are useful for such a purpose.

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LECTURE-26: Planning of ornamental gardens- principles involved in layout of gardens

In planning a garden, several factors like the size of the house, and the space available for gaden, availability of water, cost of the laying the garden and its maintenance, have to be taken in to consideration. A garden is planned primarily to suit the tastes of the people of the house hold and locality. There is no rigid system in garden planning and each system is open to modification to suit the environment and other factor.

Principles involved in layout of gardens:

Initial Approach: The available land for gardening may not be with ideal shape or size. When the site appears to be hopeless a good designer will make the best use of such site. Land with Natural undulations should never be leveled. The differences with levels should be utilized with advantage.

Fencing is essential and it should look natural and should not obstruct any natural view.
Till the plants grow full size it may be impossible to visualize how a garden design will look like in the long run. The man on the spot should be given enough scope to change it to adopt to the local needs and personal taste of the owner. Only formal gardens can be drawn on paper and implement it perfectly without change.

1. **Axis:** An imaginary line in any garden. Garden is created around the axis with balance. In formal garden central line is the axis. At the end of an axis there will be a focal point. Architectural features such as bird bath or sun dial.
2. **Focal point:** There is center of attraction which is generally an architectural feature focused as a point of interest it is one of the good land scape element.
3. **Mass effect:** The use of one general form of plant material in large numbers in one place is done to have a mass effect. Such mass arrangement should not become monotonous. The size of mass should be varied.
4. **Unity:** Unity has to be achieved from various angles. The unity of style, feeling, function between the house and garden has to be achieved and unity between different components of garden as if they merge harmoniously should be achieved. For example Cacti if planted in a sea shore garden are completely out of place. To achieve unity between house and garden some creepers are trained in front porch. It covers rudeness of masonry work. For the same reason foundation planting with bushy plants near the foundation of plants can be done.
5. **Space:** Garden should appear larger than its actual size vast open spaces are kept under lawn and planting is done in periphery. If any planting is done in the center its branches should be at higher level. The lines in the garden are made to converge slightly at a distance to create an illusion of space. Paths in the garden are gradually narrowed

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as the size of the farthest trees diminish. Large lawns are alternated by

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a group of trees. If large open space has to be planted haphazardly it looks smaller than its size. The technique of creating an illusion of more space is also referred as forced perspective.

6. **Divisional lines:** It is necessary to divide or screen out a compost pit a malis quarter or a vegetable garden from the rest of the garden. Areas under cement path, shrub border will have their own natural divisional lines. Divisional lines should be artistic with gentle curves. These lines should harmonize with each other.
7. **Proportion and Scale:** Proportion may be defined as a definite relationship between masses. A rectangle having a ratio of 5 : 8 is a pleasing proportion. A simple rule in setting out a proportion is that the design should look pleasant. Scale—a narrow step leading to a wide terrace is completely out of scale. The steps should be spaced wider making climbing easier and pleasant. If a small rockery is placed at a base of large tree with thorny specimens looks ugly and it is out of scale and proportion. A tiny pool in the midst of a large lawn also looks disproportionate.
8. **Texture:** The surface character of a garden is referred to as Texture. The texture of the ground leaves of tree or shrub will determine overall effect of a garden. If we cannot lay out lawn the texture of the ground can still be improved by laying out meticulously chosen small pebbles. A Gulmohar is a fine textured tree where as *Spathodea companulata* is a coarse textured tree.
9. **Time and Light:** There are three different categories of time in a garden.
    i) Daily time: It provides different qualities and quantities of light. Morning sun is vital for all flowers. It should be considered for placing the flowering plants. It should be possible to sit in a shaded place in the afternoon.
    ii) Seasonal changes in the year: A lawn in Delhi which receives shade during early part of the day in the winter will not grow or remain patchy.
    iii) Visualizes the shape and proportion which may be attained by the shrubs and trees in the coming years. If tree grows to very large extent, the shrubs planted around it remains lanky because they will be shaded during hot days.
    iv) The pattern of shade caste by fine leaved tree or straight trunk tree like Royal palm (Oreodoxa regia) and planted in a row, on ground or lawn look very artistic.
10. **Time and colour:** A thorough knowledge is essential to select the plants depending on their flower colour or foliage colour. Colour schemes like monochromatic, analogous complementary or contrasting are laid out by selecting different plants. It is better to have masses of single colour against a mixture of colour. A bed of roses containing single colour Eg: Red or yellow or Pink has much softer tone and beauty than a bed of mixed colours.
11. **Mobility:** In temperate country the garden changes colour very shortly and contrastingly from one season to the other season, thus

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symbolizing mobility of movement. Some trees changes their leaf colour in autumn, suddenly in winter leaf fall and gives dullness. Again

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in spring the plants spring back in light with new leaves. To create some symbol of movement in our country. Trees such as Indian Almond (Terminalia catappa) can be used because it changes its leaf colour into striking red twice annually. Lagerstromia also changes the colour of leaves to coppery shade in the autumn. Madhuca indica and Ficus religiosa has new foliage of coppery red in the spring. Some times the birds with beautiful colours also brings a type of mobility. Seasonal flowers will bring in the motion and colorful butter flies. Lilly pools should be filled with coloured fish.

12. **Style:** Every garden lover has to invent his own style. A good style has to be developed by studying great garden styles of the world and grasping the underlying principles. Even more know ledged gardener will commit mistakes. A novice gardener should be cautious and critically access every feature and should try to correct mistakes rather than getting disappointed through experience and learning from others a good artistic designer can develop his own style.

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PRODUCTION TECHNOLOGY OF VEGETABLES AND FLOWERS

LECTURE-27: Types and styles of ornamental gardens-use of trees, shrubs, climbers, palms, indoor plants and seasonal flowers in the gardens

Styles of Gardening :

A gardener may think that a landscape garden can be laid out only on a gently undulated land, but it is not so. The goal in landscape gardening is to improve landscape with an idea of developing view or design. The other two familiar terms, which associate landscape gardening, are formal and informal gardens.

F**ormal gardens:** It is laid out in a symmetrical or Geometrical pattern. Everything is planted in straight lines. If there is a plant on the left hand side of a straight road similar plant must be placed on the right hand side also. Flower beds, borders and shrubbery are arranged in Geometrically designed shapes. Trimmed formal hedges Ashoka trees, Topiaries are the typical features of a Formal garden.

Informal gardens: The whole design looks informal. Features are arranged in a natural way without any hard and fast rules but here also the work has to proceed according to a well set plan. The idea behind this design is to imitate nature.

Wild garden: William Robinson in the last decade of 19th century made the idea of wild garden. His main idea was

i) to naturalize plants in shrubberies.
ii) Grass remains unmoved as in nature and
iii) Few bulbous plants should be grown scattered.

A garden enthusiast has to study the different styles available in the world to gain some knowledge. In India even though we were interested in the gardening since Ancient times there was no style to denote as Indian style of gardening.
Even the famous garden style of India i.e. Moghul garden is a replica of Ancient Persian garden.

The major garden styles of the world are

1. English garden
2. Moghul garden
3. Persian garden
4. Italian garden
5. French garden
6. Japanese garden

The Moghul, Persian, Italian and French styles fall in the category of Formal gardens where as the English and Japanese garden are classified in the informal style of garden.

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English garden: Natural ground cover in the English countryside is grass. The main idea of British gardeners is that the gardens should look like country side.
The main features of English garden that are known in India are:

a. Lawn
b. Herbaceous borders
c. Rockery

Most of the flowering annuals we see today in India with few exceptions of *Amaranthus*, Balsam, *Gomphrena*, Marigold etc were brought here by Britishers.

Japanese gardens:

Persian and Japanese gardens were based on the ideas of heaven. Japanese continued the same style of gardening and still remain popular. Japanese gardens were planned with so much of care though appear so casual.
Immutability is another strong basis of Japanese gardens. Except some seasonal changes other strong, visible changes are hardly observed in Japanese gardens. They remain beautiful even in winter. The immutability is achieved rather than going for flowers, shrubs etc, more emphasis is placed on natural elements such as simple rocks, stepping stones, streams, waterfalls, bridges. Stone lantern and so on. Three elements of Japanese gardens are:

1. water
2. stone
3. plants

Features of Japanese gardens: Ponds, Streams, Waterfalls, Fountain, Wells, Islands,
Bridges, Stone Lantern, Stones,Pagodas,Fences and Gates

Mughal Gardens: These were laid out during the rule of Mughal emperors in India. They are similar to the Persian styles. The main features of Mughal gardens are largely borrowed from Persian style.

1. site and styles of design
2. walls
3. gates
4. terrace
5. nahars or running waters
6. baradari
7. tomb or mosque
8. trees.

Baradari: It is arbour like structure made up of stone and masonry with pacca roof and raised plat form for sitting. They were provided with 12 or more doors

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and they were used to watch the dances.

Principles in laying out a land scape garden:

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LECTURE-28: Commercial floriculture- rose- importance- climate and soil – types of roses – varieties- propagation- planting – pruning- manuring- irrigation- harvesting - yield

Botanical name**: *Rose sinensis***
Family **: Rosaceae**
Origin: **Oregon and Colorado of USA**

The word Rose derived from Greek word Rhedon means scented.

Rose is commonly referred to as **Queen of the flower** because it stands first for its popularity as cut flowers.It is propagated commercially by means **Budding**.

Importance:

Rose is one of the natures beautiful creations and is universally called as the Queen of the flowers. No other flower is a better symbol of love, adoration, innocence than the Rose.

The Rose because of its utility occupies prominent place among the flower crops and is one of the oldest fragrant flower cultivated by man.

It has different types with beautiful flowers of definite shape, size, colour and most delightful fragrance. It is an important flower for its varied uses.

Perfumes and Allied products:

Rose Oil: It is an important commercial product obtained from rose petals. It has sweet fragrance, medicinal properties, hence used in ayurvedic medicines Bulgarian rose otto is largely used in perfuming soaps and cosmetics. Limited quantities of the oil are used in flavouring soft dringks and alcoholic liquors. Rose oil has got anti bacterial property.

Commonly grown species for oil extraction are ***Rosa damascene*** **(Damask roses)**

Rosa borboniana (Edouard roses) (**commonly used root stock for budding**) (highly scented) *Rosa centifolia* (Cabbage roses) *Rosa alba* and *Rosa gallica*

In India, however*, R. damascena* and *R. borboniana* are commercially cultivated for Rose oil.

Among different species R. damascena gives the maximum oil yield. Recovery of Rose oil from R. damascena is 0.06% in R. borboniana 0.04 to

To obtain good quality rose oil the flowers are to be harvested early in the morning as the percentage of volatile oil decreases with the advancing day. The flower should be harvested before 9.00 am. In dry hot weather the oil content of the open flowers decreased rapidly whereas the oil yield increased in wet cool weather.

Rose water: It is also an important commercial product from rose petals. It is used as a perfume and in medicines and confectionary. It has the property of cooling the body and is often used in eye lotions and eye drops for its soothing qualities. It is also used in drinking water and sprinkled on the guests at weddings, feasts and other social functions.

Species like R. damascena , R. borboniana , R. centifolia , R. alba, R. gallica are used for extraction of Rose water.

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Rose gulkand: Rose petals are preserved for direct consumption, by making gulkand, which is prepared by pounding equal proportions of petals and white

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sugar. It is both a tonic and laxative.Species suitable are R. damascena , R. chinensis, R. gallica, R. pomifera and other scented roses. Edouard are used for preparing gulkand.

Classification: There are many classes of present day garden roses. The main classes are as below.
Hybrid Teas: Obtained by a cross between Hybrid perpetuals and Tea roses. Hybrids are most popular type of roses. **They bear large sized and highly scented flowers**. First of Hybrid Tea is La France produced in 1867.
Polyanthas: These are dwarf plants. Small flowers of **Polyanthas were forerunners of popular large flowered Floibundas**. Their ancestry includes crosses of Rosa multiflora, Rosa wichuriana, and Bengal hybrid Rosa indica major. The first cultivar of polyanthas was La Paquerette. Other cultivars are Baby Faurax and Echo.
Floribundas: They are also known as **Hybrid Polyanthas**. These are the crosses between Hybrid tea roses and Polyanthas. They **combine beautiful forms of the Hybrid Teas** with **perpetual flowering habit of the Polyanthas**.
Grandifloras: These are crosses between Hybrid Teas and Floribundas. **Grandifloras covers large flowered and clustered cultivars** of fine form or the type which produces beautifully formed, Hybrid Tea like blooms in clusters. The first Grandiflora developed was Buccaneer. Other cultivars are June Bride and Queen Elizabeth.
China Roses: China Rose(R. chinensis) is **responsible for nearly all the present day popular roses**. China Roses bear red to nearly white flowers in small clusters. China Roses were also known as monthly roses. They are known as Bengal rose. China roses are perpetually flowering types. The so called Green rose (R. chinensis viridiflora) is included in this class.
Minatures: These are popular **Baby Roses**, with small leaves and flowers. **They are hardy and are multiplied by cuttings as well as propagated on root stocks**. Those raised from cuttings are ideal for growing in pots. Examples are Baby Gold Star, Baby Masquerade, Peon.
Ramblers: They generally produce flowers with large clusters of small single or double flowers. They are of two groups namely Wichuriana Ramblers (R. wichuriana) and Multiflora Ramblers (Rosa multiflora). Examples:
Wichuriana: American pillar, Multiflora: Crimson Rambler

Indian cultivars:

1. Hybrid Teas: Abhisarika, Akashsundari, Anupama, Anuraag, Arjun, Ganga, Dr. B.P. Pal, Golden afternoon, Haseena, Mridula, Nurjehan, Poornima, Rakta gandha, President Radhakrishnan
2. Floribundas: Akash nartaki, Arunima, Delhi Princess, Himangini, Madhura, Mohini, Sindhur
3. Polyanthas: Anjani, Nartaki, Swati,
4. Miniatures: Chandrika, Pushkala,
5. Climbers: Akash pradip, Delhi white pearl

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Plant management practices:

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Pinching: Removal of a part of terminal growing portion of stem is called pinching. This operation was found to reduce the plant height but promote axillary branching.

Disbudding: Removal of undesirable buds is known as disbudding. Keeping only the central bud and removal of others cause development of a quality bloom.

Removal of young vegetative shoots: This practice, also known as deshooting, is generally followed in Hybrid Tea roses. Young vegetative shoots developing from the axils of leaves of basal and lateral shoots are removed to allow only one terminal shoot. Deshooting in cvs. Sonia and Belinda was found to increase the flower production by 50 and 75% respectively.

Defoliation: Several attempts were also made to study the effect of leaf removal on subsequent growth and flowering of roses. Although defoliated plants produced about twice as many shoots as undefoliated, many of them were blind and the total number of flowers was less. Complete defoliation of mature and young leaves caused atrophy of almost all flower buds. Removal of only mature leaves caused about 50% blindness. Removal of only young leaves did not cause blindness.

Desuckering: Any sucker arising from stock should be removed from time to time.

Removal of faded flowers: If the spent blooms are not removed in time, there is a chance of developing fruits bearing seed. Once the hips are formed and reach the advanced stage of development, growth and flowering are severely reduced during the season. Cutting of faded flowers forced strong laterals which produced good quality flowers.

Propagation: Roses can be propagated both by **seeds** and various vegetative methods **like cutting, layering, budding and grafting**.

Seed propagation: This is adopted by breeders for developing new cultivars with desirable characters. It is suggested to stratify the seeds at 35 to 40^0 F 1.6^0 C to 4.4^0 C. **Stratification** for six weeks is sufficient for *Rosa multiflora*. In temperate regions the root stocks needed for budding can be raised through seeds.

Cuttings: Some of the vigorous cultivars can be grown from cuttings. Some of the Climbers, Ramblers, and Polyanthas are raised by cuttings. Miniatures are more widely propagated by cuttings rather than by budding.

Layering: This propagation method is limited to Climbing and Rambling roses. They can be propagated either by Ground Layering or Air layering.

Grafting: Inarching is another method of propagation of roses, but it has many disadvantages.The scion shoot should be of medium texture, free from pests and diseases and 1-3 eyes in length. Cleft grafting has been suggested for the multiplication of roses.

Budding: This is most popular and successful method for multiplying roses. **Shield or T-Budding** is the most commonly used method of budding wherein on the selected root stocks, the buds are inserted into the T shaped incisions and then tied with a suitable wrapping materials like plastic film. Budding should be preferably done as low as possible on the root stock. When the new shoot from the grafted but is about 10 cm long. The top portion of root stock

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above the union is cut off and polythene tape is removed. It takes 3-4 weeks

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for the bud to unite. The side branches of the stock are removed, which compete with the scion for supply of nutrients and water.

Root stocks: Some of the commonly used root stocks for budding of roses are as follows: Rosa borboniana (Edward roses), Rosa canina, Rosa indica, Rosa laxa, Rosa manetti, Rosa multiflora, Rosa rugosa etc.

1. ***Rosa borboniana*** (Edward Rose): This is one of the most popular root stock and **used extensively in northern plains of India**. It is found **useful for budding standards.**
2. ***Rosa indica* (var. odorata):** This is a large climbing shrub and used extensively as root stock for greenhouse forcing roses. It is easily **propagated from cuttings**. It is well **adapted to both excessively dry or wet soil conditions and can withstand high soil pH**. The root stock is also **quite tolerant to powdery mildew and insect pests**. In India, it has been recommended for Northern plains.
3. ***Rosa multiflora*** It is a native of China and Japan introduced into India in 1872. This is a widely used root stock for out door roses. It can be **easily propagated by cuttings**. It is adapatable **to wide range of soil and climatic conditions**. It does well in India in Bihar, Bengal and hilly areas.

Among the above *Rosa borboniana,* is commercially used as root stock for budding in the **plains of India**, while *Rosa multiflora* is used as root stock for budding of roses in **hilly areas**.

Soil: The ideal soil should be medium loam having sufficient organic matter, with a pH of 6.0 to 7.5. The land where the external drainage is poor and water stagnates during monsoon should not be selected for rose growing. **The land with high water table is not suitable for rose beds.**

Climate: Roses love sunshine and free ventilation. They need bright sunshine for the whole day, if not, at least for normal part of the day. The plants should be free from shades of trees and protected from the strong winds.

In the northern plains, roses flower best during winter whereas in the temperate hilly regions of the Himalayas best rose flowers are produced in summer. **Bangalore has mild climate, where roses can be grown for flowers throughout the year.**

Layout and Preparation of Beds: The plan of rose garden and design of the beds should be simple and informal. Rose beds may be of various designs. **Rectangular beds are advantageous** for maintenance. A plot size of 6.0 x
m or 6.0 x 1.65m is suggested for better management of rose plants.

Preparation of Rose beds: With the help of digging spade, the soil, up to a depth of about 30 cm, should be dug out and heaped on the ground of adjoining the beds.

If the soil is light, sandy and stony, the next 30 cm of the soil in the trench should be dug as deep as possible, pulverized and leveled in the trench itself. After that about half portion of the dug out soil, heaped on the ground surface, should be returned to the trench, worked with digging fork and leveled. This layer needs manuring with organic manure at the rate of 50-60 tonnes of farm yard manure or compost per hectare. **Super phosphate at the rate of 30 kg P_2 O_5 and Aldrin or BHC 5% dust at the rate of 100 kg**

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per hectare are to be applied and the beds are irrigated thoroughly.
Pits of 75 cubic centimeter size are dug out a fort night before planting.

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Procuring rose plants: Roots shall arise within 6.5 cm of the base of the union.The plants should bear at least two shoots arising from the union or one shoot which produces branches not more than 6.5 cm above the union. The sum of the diameters of the shoots or shoots arising directly from the union shall exceed 3 cm. The earth ball should measure at least 20 cm in diameter and 25 cm in height. In case of double budded rose, the unions shall be as close together as possible on opposite sides and shall not be more than 7.5 cm apart.

Planting:

This operation should receive very careful attention.

1. Cut away all immature, dead, inward growing or diseased shoots and unduly long, dead snags.
2. Remove all suckers growing below the point of union.
3. Reduce the possibility of loss of moisture, leaves including dried and yellow ones should be removed.
4. If the roses are delivered with shriveled bark, it is suggested to immerse the plants in water for 24 hours to plump up.
5. Immerse each plant in a suspension of 1 g blitox in 1 litre of water to lessen the risk of attack of fungi.

Depth of planting: Budded plants generally are planted so that the bud union is slightly above the ground level in the bed.In temperate countries where winters are severe, it is usually recommended that the bud union should be placed slightly below the soil.In India, better results are obtained if the planting is done with the bud union 2.5 to 5.0 cm above the soil level.

Season of planting: In the most plains of India, the season of planting is during September – October and in the hills it is during October – November or February-March.Under the climatic conditions of northern India, **October is the best month for planting.**

Planting distance: A spacing of 60-75 cm is given between plants and rows, depending upon the vigour of the cultivars. The dwarf Polyanthas are planted 45 cm apart, Miniatures 30 cm apart and climbing roses 3m or more apart HT and Floribunda at 55 cm apart. Closer spacing tends to make the plants grow erect and produce long stalks.

Gap filling: Replace the casualties with healthy plants from time to time.

Staking: **It is necessary to stake the standard roses** by fixing the points at bottom, middle and top of the main shoots.

Pruning: Pruning refers to the removal of certain portion of a plant. It is an important operation for maintenance of floriferous ness and flower quality along with vigour of rose plants. Roses should be trained to give a definite shape to the plants. The practice of rose pruning consists of two operations, thinning out and shortening of stems.Thinning out comprises removal of old, weak, dry, twiggy and diseased stems and branches from the point of start while shortening of the remaining shoots aims at cutting down of last year's growth to a desirable height.

Objects of Pruning in rose: To remove the unproductive growth, ensure production of large number of strong and healthy shoots, which will bear flowers and improve the quality of blooms.

To force the strongest shoot bud to break in growth.

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To Keep the rose bush in proper shape and size.
To allow light and air to reach the centre of plant

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To encourage growth of new healthy shoots which bear more flowers than old branches.

The rose blooms harvested after pruning the bushes have longer stems than those cut from unpruned bushes.

Pruning time:

The best time of pruning is the period when the activity of the rose plant is least and the plant is at dormant to near dormant stage.

The most usual time for pruning is during October- November in Indo-Gangetic plains after the rains are well over and the cold season is approaching.

In Bangalore, pruning is done twice a year, just before two flower shows held during Republic day and Independence day.

Hybrid Teas are pruned 42 days before flower show.

Floribundas are pruned 45 days before flower show.

Three extra days are given for the clustering habit of flowers

In and around Madras city, rose plants are pruned only once at the end of November or early December.

Where and How to prune:

Every rose stem has eyes (buds) alternating on opposite sides, usually outward and inward. **The basic rule in pruning is always to make the cut at about half a centimeter above a vigorous bud that point in the direction one desires the new shoot to grow**.

Since a bush rose is to be kept open in the center, the cut is made at an out ward growing bud whereas in case of climbing rose, the pruning is done at a bud pointing more or less upwards. Whichever bud is selected, the cut should be slightly slanting. A horizontal cut retains moisture and, therefore is liable to cause fungal growth. While making the cut, care should be taken not to make it too high above the eye as there may be chance of die back of the shoot. If the cut is, on the other hand, very near the eye, the bud may die for want of sap flow. It is absolutely necessary to cut sharp and clean. Broken tissues, bruises or hanging shreds of bark are an invitation to pests and diseases.

Types of Pruning: There are three types of pruning – light, moderate and hard.

In the **light pruning**, the healthy shoots, left after thinning of diseased and unwanted portion, are cut either at the second or third eye (bud) immediately below the flower bearing foot stalk.

Moderate pruning is done by cutting back the ripe main and lateral shoots of the previous year's growth at an out ward growing eye, at about half the length of the growth.

Hard pruning consists of keeping only three or four shoots of the last year and heading back at about three or four eyes from the base.

All weak, diseased, dead and slender growing and overlapping branches are to be completely removed.

Generally strong and sturdy plants are pruned lightly, moderate growers, moderately and weak plants relatively hard.

If the soil is sandy and the nutrient level in the soil is not high, pruning should be light. In case of heavy and fertile soils, pruning may be a little harder.

Pruning of one year old rose plants: In the first year of planting, the pruning

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is done to give a definite shape to the plants and the operation will vary according to the class of the rose. For plants in Hybrid Tea and Floribunda

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groups first of all, weak, dead and crowded branches should be removed from the base. The remaining healthy shoots should be cut back to less than half the length of the shoot.

Climbing and rambling roses do not require any pruning except the removal of weak growth and unhealthy, dead and interlaced twigs. The Polyanthas are pruned lightly whereas the miniatures are generally not pruned.

Pruning of established rose plants: The pruning of established plants is done to remove the weak, dead and damaged shoots and to obtain the large number of quality blooms by regulating the shape and size of the plants. The method adopted varies in the various types of roses.

Hybrid Teas: Hybrid Teas are always pruned harder. Remove all the dead, weak, damaged and crossing shoots from their point of origin. It is useful to retain only four or five healthy basal shoots and remove the remaining ones from their bases. Hard pruning i.e. cutting above three or four eyes from the base reduced the number of flowers per bush but increased the flower size and length of stem.

Floribundas: The main object of pruning roses of this class is the production of abundance flowers with mass effect in the bed.

This trend can be encouraged by removal of older growths at every opportunity and the young growths be shortened by about a third or half of their height. It is necessary to remove the mass of twiggy growth at the ends of the main stems.

Thus light or moderate pruning is the general recommendation of obtain higher yield of flowers.

Manuring: Roses are gross feeders. At the time of pruning, well rotten cow dung is applied. The doses would vary with soil type and its fertility status. Generally 4 to 8 kg cow dung manure per bush will be quite adequate. A hand full of bone meal should also be added along with manure. A little BHC or the Aldrin should be mixed with the organic manure to prevent the attack of white ants. Inorganic manures or fertilizers are more quick acting and small quantities of these are very effective. Nitrogenous fertilizers are more important. Phosphates also help in the production of more and better quality blooms. Indian soils are quite rich in Potash, but Potash fertilizers in combination with others give good results in some regions. **Complete Rose fertililsers such as Rose mix** are now available in the market.

Liquid manure can also be prepared by dissolving quick acting chemicals such as Nitrate of Potash and Phosphate of Potash at the rate of 30 grams each in 50 litres of water. About 5 litres of this liquid is added to each square meter at 5 to 7 days interval during the period when buds began to form until they bloom.

Foliar feeding:A foliar spray is prepared by dissolving 14 grams of the following mixture in 10 litres of water and sprayed at fortnightly intervals.

Urea	2 parts
Dihydrogen ammonium phosphate	1 part
Potassium nitrate	1 part
Potassium phosphate	1 part

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Irrigation: Roses do not like water logging but need plenty of water for their optimum growth and development. The frequency of watering will

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depend upon weather and nature of soil. Sandy soils need more frequent watering than clayey soils. In loamy and alluvial soils, such as that of Delhi, thorough watering once in seven days in summer and once in 10 to 15 days in winter is considered sufficient. In rainy season, necessary adjustment will have to be made. In between each watering, when the top soil becomes dry it is useful to stir it up with a khurpi and a hand fork. Frequent light irrigation is harmful hence, heavy drenching should be given at each irrigation. In eastern India, where rainfall is heavy, no irrigation may be required at all during the rains.In a climate like that of Bangalore, having red soil, one heavy irrigation at 5 days interval is recommended throughout the year except during the rains. When this has to be adjusted depending on the rainfall.

Harvesting: The stage at which flowers should be cut, either for decoration or for dispatch is the tight-bud stage when the buds show full colour but the petals have not yet started unfolding.If harvested at this stage, they last longer in vases or during transportation, retain colour and freshness. The optimum stage may vary slightly depending on cultivar and one has to be experienced to judge the right stage for cutting.

Loose flowers, used for making garlands, preparing perfumes and various other products and for worshipping are harvested only when they are fully open and collected in large open baskets. The flowers should be cut in the early morning before sun rise or late in the afternoon when the sun is about to set so as to avoid damage of buds due to high temperature during the day. Late harvest results in short vase life of cut flowers and low oil content in loose flowers used for preparing perfumes.

For cut flowers, the stem length should be little more than what is required and bear fairly good number of leaves. The cut should always be above a healthy outward pointing bud, a with a clean and sharp secateur. **The general rule observed by the most rose growers in cutting the stem is to allow two five-leaflet leaves to remain below the cut.** Immediately after cutting, the stem should be dipped in clean water up to the neck or base of the flower buds. Soon after cutting, the stems should be recut in water, about 2 cm above the previous cut end.

If they are not required for immediate use, the cut flowers along with stems dipped in water, in the bucket, should be stored at a cool air temperature of 4.4 to 7.2^0 C , for about 6 – 12 hours to harden the buds and enhances the keeping quality.

Yield: The yield of cut flower depends on a number of factors like cultivar, plant density per unit area, flower quality, duration of flowering, pruning, fertilization and other cultural practices adopted from time to time.

In case of Hybrid Teas and Floribundas, 13.5 long stemmed cut blooms from one square meter are obtained in open field conditions in India, as against 144 cut flowers per square meter in Europe in glass house conditions.

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LECTURE-29: Jasmine - importance- climate and soil – different species of jasmine – varieties- propagation- planting – pruning- manuring- irrigation- harvesting – yield

Botanical name	***: Jasminum sps***
Family	**: Oleaceae**
Origin	: **India**

Jasmine is one of the most popular flowers and are used for making garlands and veni for adorning the hair of women.

Species And Cultivars: A number of jasmine species are grown in India. Commercially grown important species are *J.sambac, J.auriculatum, J.grandiflorum* their brief description all as follows;

***J. sambac*:** Also called Arabian Jasmine. The flowers buds are white, with single or multi-whorled petals, used for garland-making, adorning hair and extraction of perfume. It is a bushy weak-stemmed shrub with pubescent branches.

Important varieties are:

Gundu Malli, Single Mohra, Double Mohra, Madanban, Ramabanam, Kasthuri malli.

J. grandiflorum: Also called Royal or Spanish Jasmine, Chameli, Pitchi. It is a large shrub pinnate leaves. Flowers are white, often tinged with purple. Suitable for concrete extraction.

Important clones are:

Pin type, Thrum type, J.G.1 (Bangalore), J.G.2 (Coimbatore), J.G.3 (Lucknow), J.G.4 (Tenkasi white), J.G.5 (Thimmapuram), J.G.6 (Triploid), Surabhi, CO_1 Pitchi, CO_2 Pitchi.

J. auriculatum: Also called Jathi Malli, leaves are mostly simple, usually trifoliate. The flowers are star shaped, white-scented blooms, borne in flan cymes. Black type of this is grown in home gardens.

High-yielding varieties are:

CO_1 Mullai, CO_2 Mullai, Pari Mullai, Long point, Long round, Medium point, Short round other important species of floricultural importance are;

J. multiflorum

Also called Kakada, Tundam. Resistant species, not scented, very ornamental.

J. arborescens

Also called tree Jasmine, Muta, Bela. Large shrub with fragrant white flowers.

Planting: Jasmine is perennial in nature. The plants remain in the same spot for many years. They are generally planted during rainy season. Pits of 45 cm^3 are dug at least one month before planting, the pits are filled with 2 parts of well-rotten cow dung manure and one part each of fresh earth and coarse sand. In termite – prone all as, dry leaves may be burnt in pits or a handful of BHC may be added to filling minture. Pits should be irrigated to settle the minture. Well-rooted, healthy and strong plants are planted in pits (one in

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each). Soils with proper drainage and irrigation facilities and sunny condition are ideal.

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Planting distance plays an important role in flower yield. To get the highest yield, recommended distances are:

J. auriculatum, 18 x 1.8 m
J. grandiflorum, 1.5 x 1.5 m
J. sambac, 1.2 x 1.2 m

Climbing species are spaced to a wider distance, which depends on the purpose and choice of growers.

Pruning: Pruning is essential to get optimum yields and to keep the bushes within manageable size. The first pruning is done in the year following planting and thereafter once a year. The bushes are pruned during December – January every year. Irrigation is stopped 15 days before pruning and pruned to a height of 75-90 cm. from ground level.After pruning the soil around the bushes is dug upto a depth of 15 cm and a diameter of 60-75 cm all around leaving 30 cm of area close to the bush undisturbed. The dug basins are exposed for a week. After this manures and fertilizers are applied and irrigated sparingly (once in week) at initially and increased after the apperence of flower buds (once in 4 days).

Manuring: Many commercial growers use early organic manure by mining one part each of horse and donkey manaure and tank silt. The minture is applied @ 10 kg / plant / year. A fertilizer doze of 100g : 150g : 100g of NPK over a basal doze of 10 kg FYM / pH / year is ideal for getting minimum flower yield may be obtained if Mg (40 kg/ha), Zn (10kg / ha) and B (5 kg/ha) are applied along with NPK fertilizers.

The N_2 doze can be reduced to half (50 g / pH / yr) if applied as foliar spray in equal dozes beginning feem first week of February at fortnightly intervals. In *J. auriculatum,* 120:240:240 g of NPK is recommended / plant / year. In *J. sambac*, 90:120:240 g NPK / pH / year is recommended and most beneficial at Coimbatore. For *J. multiflorum*, 120 g N2 / plant / year is recommended at Bangalore.

Irrigation: Moderate watering is good for jasmine. It is more essential during flowering. During blossoming, the water should be applied twice a week if there is no rain and once a week during out of the months. Seen after the cessation of flowering, watering is to be completely stepped until pruning and fertilizer application. With the advancement of cold weather, the plants begin to shed the leaves. After pruning and manuring, watering is resumed. In *J. sambac* flowers come in phases. Each phase lasts for 7 days during which the blossoms are put forth in perfusion. There is an interval of about a month between one bloom and the commencement of the next with the close of each flowering phase, watering is completely stopped for weeks together till the appearance of fresh flowering buds.

Piking: Unopened but fully developed flower buds should be picked in the morning and marketed immediately.

Yield: Pari malli – 10,000 Kg / Ha Jathi malli – 11,000Kg / Ha
Gundu malli – 6200 Kg/ Ha

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LECTURE-30: Chrysanthemum- importance- climate and soil – classification – varieties- propagation- planting – pinching- manuring- irrigation- harvesting - yield

Botanical name**: *Chrysanthemum indicum***
Family **: Compositae**
Origin: **Europe and Asia**

Chrysanthemum is a popular flower crop of commercial importance. Chryos means Golden; Anthos means flower meaning Golden coloured flower.

Importance :

1. In Japan Chrysanthemum is regarded as a symbol of Royalty
2. It is known as **Queen of East**
3. In India it occupies a place of credit both as a commercial flower crop and as an exhibition flower.
4. It's erect and tall growing cultivars are suitable for background planting or as cut flowers.
5. Dwarf and compact growing ones are suitable for pot culture
6. Decorative and pluffy bloomed small flowered cultivars are ideal for garland making and hair decoration.
7. Extra large bloomed cultivars have a great exhibition value
8. Species like *Chrysanthemum cinerareifolium and Chrysanthemum coccineum* are cultivated as sources of Pyrethrum an important insecticide.
9. Ryori Giku is a yellow flowering culinary type which is eaten as delicacy in Japan after frying.

Cultivars: There are innumerous numbers of cultivars; in Japan more than 50 thousand; in Britain more than 60 thousand; in India more than 500 cultivars are available.

Exotic cultivars:

1. **Spray cultivars:**

i) White : Ex: Arctic white spider
ii) Yellow : Celebrate
iii) Pink : Blue marble

2. **Standard cultivars:**

i) White : Giant India Napolis white
ii) Yellow : Bright Golden Anne
iii) Pink : Cessandra

3. **Pot cultivars**

i) White : Mountain snow
ii) Yellow : Golden crystal
iii) Pink : Always pink

Indian cultivars:

1. **Large flowered cultivars**

i) white : snow ball, Beauty

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ii) yellow : Chandrama, Super Giant

2. Small flowered cultivars for pot culture

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i) white : Mercury
ii) yellow : Aparajitha

3. Small flowered cultivars for cut flowers

i) white : Birbal Sahani
ii) yellow : Sujatha
iii) mauve : Apsara, Neelima

4. Small flowered cultivars for garland

i) white : Sharad shobha
ii) yellow : Freedom

Classification of chrysanthemum: Several countries classified Chrysanthemum based on number, size, form and arrangement of disc and ray florets.

The classification of National Chrysanthemum Society of America is given below:

1. **Division A:** It includes classes 1 to 8. Ray florets are flattened to concave or convex. Visible portions are never tubular

i) Section 1: It includes classes 1 to 3. Disc is prominent composed of many disc florets

Class 1: **Single:** Ray florets in a single row at right angle to the stem. Disc flat to slightly rounded.
Class 2: **Semi double:** Ray florets in more than one row at right angle to the stem, but may curve downwards at the tips.
Class 3: **Anemone:** Ray florets variable and *equal in length*. Prominent disc can be seen. It may range from flat to hemispherical in form.

ii) Section2: It includes classes 4 to 8. Disc is not apparent. Disc florets may be concealed or entirely absent.

Class 4: **Pompon:** Bloom globular, flat or small button type. Ray florets broad and incurved. Disc is not prominent
Class 5: **Incurve:** Bloom is globular.Ray florets smooth, narrow to broad and incurved and they don't have open centres Ex: Snow ball
Class 6: **Reflexing incurve:** Bloom is globular, less compact than incurve. All mature florets not completely incurving or reflexed. The lower florets are reflexing to give a skirted effect. Ex: India-napolis.
Class 7: **Decorative:** Ray florets short and broad, long and pointed. Bloom are more flattened.Ex: Princess Anne
Class 8: **Reflex:** Bloom is globular, ray florets reflexed and gracefully overlapping. Ex: Coronation Pink.

2. **Division B:** It includes classes 9 to 11.
Tubular ray florets coiled and straight, hooked at distal end.

Class 9: **Spoon:** Ray floret is tubular distal potion is open and sppon like disc is apparent
Class 10: **Quill:** Ray florets tubular either closed to the tip and pointed or open and spatulate. Disc is not visible.

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Class 11: **Spider:** Ray florets long and tubular, distal portion shows definite coils.Disc is not apparent.It has four sub classes namely a) thread b) fine c) medium d) coarse tubed

3. **Division C:** It includes classes 12 and 13. Ray florets flattened or tubular Disc may or may not be present includes two classes 12 and 13.
Class 12: **Lacinated:** Ray florets may be lacinated or feathered at the tips.
Bloom form may be any of the classes from 1 to 11 Ex. Jack Straw
Class 13: **Brush or Thisle:** Ray florets are fine tubes.
They grow almost parallel to the stem in a brush or thistle like manner.

In India, chrysanthemums were classified into two broad groups, namely **large flowered and small flowered.**

Large flowered cultivars are usually grown as standards with 1-3 stems, bearing a single flower each and **Small flowered cultivars** are grown as bushes with multiple branches bearing a very large number of blooms per plant.

Soil: Chrysanthemum has shallow fibrous root system. This is very sensitive to water logging. It is prone to attack by diseases such as root rot and wilt, if there is lack of aeration.Physical, Chemical and Biological states of soil are therefore an important factor effecting growth of plants.Clay and Clay loams retain too much of moisture and thereby hinder the proper aeration resulting in rotting of roots.When dry, such soils become too compact and damage tender roots.Sandy soils on the other hand, dry too quickly and require frequent irrigation and also suffer from loss of nutrients due to leaching, though root growth is enhanced due to the plenty of aeration.**Sandy loams** retain sufficient moisture and provide optimum aeration essential for proper root growth and hence ideal for chrysanthemum growing.

Climate: Chrysanthemum is a cool season crop. It is grown throughout the world.**Light** and **Temperature** are two important environmental factors influence growth and flowering.The former is dominative in autumn flowers and later in summer growing cultivars.Chrysanthemum is short day plant requiring short days at the time of flowering and long days for vegetative growth.As far as light is concerned, both photoperiod and intensity are known to have major effects.It is found that chrysanthemum flower when day length decreases and this leads to their classification as **short day plant**.In general they require high light intensity. Plants grown under reduced light become taller and have thin stems and larger leaves.Flower buds in chrysanthemums have been found to initiate and develop above a critical temperature below which only vegetative growth occurs. Most of cultivars needs warm nights at the time of flower bud initiation.For flower bud initiation minimum temperature of 60 ^{o} F (15.5 ^{0} C approximately equals to 16^{0} C) is required.

Land preparation: Land is brought to fine tilth by repeated ploughings, harrowings and planking.Entire prepared land is made into flat beds on light textured soils, raised beds or ridges and furrows in heavy textured soils.Before last Ploughing 15 tonnes of well decomposed FYM are applied to enrich the soil organic matter. It is thoroughly incorporated into the soil by

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subsequent ploughing and harrowing.

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Propagation: There are three methods of propagation in chrysanthemum. Seed propagation: Mostly meant for establishment of crop for development of new varieties in Breeding programme. However for commercial cut flower production, seed is not used for propagation.

Vegetative propagation: Chrysanthemum is propagated vegetatively by Cuttings and Suckers.

Cuttings: Soft wood cuttings are obtained from laternal branches immediately after the completion of flowering. The terminal 8 to 10 cm long portions of laterals are simply cut from the left over plants and lower leaves of cuttings are stripped off.

Then the 1/3rd portion of cuttings should be inserted into soil of the rooting beds. In due course of time, adventitious roots are formed from cutting underground. These cuttings are said to be rooted cuttings, which should be lifted from nursery beds at the time of planting in the main field (in July).

Suckers: Healthy suckers are obtained from healthy chrysanthemum crop of previous year. As soon as harvesting of cut flowers is over the left over plants are subjected to heading back to a height of 20 cm above ground level in the month of January and February.In due course of time the suckers will be arising from the adventitious buds present on the stem underground.As soon as they are long enough the suckers are cut to their base and are subjected to rooting in nursery beds (rooting beds)In rooting beds the suckers will produce roots at their bases and are said to be rooted suckers.These rooted suckers should be lifted from nursery at the time of planting in the main field.

Planting time:

June – July i.e. onset of South West monsoon.

Spacing: 35 cm x 20 cm

Method of planting: Rooted cuttings should be placed in a small planting hole made in the field at desired planting positions up to the point where it was there inside in the nursery. Then the soil is firm around the base of cutting such that no air pocket is left around the root system. Planting should be followed by light watering.

Gap filling: Immediately after the establishment of rooted cuttings in the main field, observe for the casualties. Replace the same with healthy fresh rooted cuttings.

Mulching: Mulch the inter spaces with any locally available mulching material like paddy husk, groundnut shells and saw dust and dry leaves to a thickness of 2.5 cm

to check weed growth, to conserve soil moisture and to moderate soil temperature.

Earthing up: As soon as the plants are about 10 to 15 cm height, earthing up the soil around the base of plant is to be done to provide support to growing plant.

Watering: Immediately after the establishment, the crop should be irrigated twice a week, depending upon the soil and climatic conditions. Care should be taken that water should not be stagnated in the field. Before harvesting of flowers, irrigation helps in enhancing the keeping quality of cut flowers.

Staking: Individual laterals should be provided with stakes individually i.e. Multiple Single Staking. Staked portion should be cut just below the level of

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flower bud at the time of bud opening so as to avoid the disturbance to the development of flower.

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Manuring: Fully decomposed FYM is applied @ 15 tonnes per hectare as basal application. Nitrogen @ 50 kg per hectare; Phosphrous @ 160 kg per hectare; Potassium @ 80 kg per hectare should be applied as basal dose at the time of land preparation. Another 50 kg Nitrogen should be top dressed 30 days after planted.

Regulation of growth and flowering in Chrysanthemum: Chrysanthemum plant is left to grow naturally continues to grow tall until the natural break bud is produced at the end of a solitary branches. Side shoots develop later in the leaf axils and break bud shrivels. This side shoots continue growth to about 45 cm producing the first crown bud at the tip of primaries. First crown bud is characterized by a large number of ray florets with large sized coarse and ragged flowers. Second crown bud is produced at the tip of secondary branches. They are characterized by the small sized more intensively coloured, few ray florets, symmetrical and well shaped.

Regulation of flowering:

1. **Stopping or Pinching:** If the plant is stopped when it is 15 cm tall before even the break bud stage, the side shoots appear in leaf axils earlier by 2-3 weeks (first pinching is done at 4^{th} week after planting).

The second pinching is done at (7^{th} week after planting) by removing the first crown bud at the end of each lateral growth or by pinching the primaries before the crown bud has appeared. It will delay the flowering and produce second crown buds on secondaries.

Methods of pinching depends on nature of bloom to be obtained.

If only one bloom per plant is required no stopping is needed.

But if 3 or 6 stems are needed per the plant stopping is resorted too.

The tip of the main stem measuring 3 to 5 cm is removed. This stopping will encourage the lateral shoots (breaks) to develop from the leaf axils.

Three strong laterals are attained and others removed.

Deshooting: (Thinning out): When apical growing portion of main stem is removed number of laterals are produced from the leaf axils on the main stem. When all of these laterals (primaries) are allowed to develop, the size of the flower produced on this primaries is decreased. Keeping in this view three strong laterals are retained and others are removed. The laterals retained for flowering should preferably consists of one central stem and two on either side of it.

Deshooting is also practiced from time to time by removing all side shoots before they attain the size of 2.5 cm. The aim of deshooting is to divert the food materials to the retained laterals.

In singles, Koreans and sprays deshooting is restricted to prevent the plant from being too much crowded.

Disbudding:

First crown bud develops at the end of each lateral which contains maximum number of ray florets and will give the largest bloom, though may not be the best bloom. This is retained on all other growth arising from leaf axils is removed. Sometimes, the crown bud in laterals is stopped to obtain second crown bud which arises from leaf axils.

In many cultivars the second crown bud produce flowers of more

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intense colour, harder in texture, more symmetrical in crowd. However in most

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cultivars, the first crown bud produces largest bloom. Disbudding stops as soon as flower buds appear.

In chrysanthemum if all the buds in one stem are allowed to bloom, the flowers become smaller in size. Therefore in large flowering cultivars only one bud or stem is allowed to bloom and others are removed. The ideal time for disbudding is when buds surrounding the central bud have developed. However in singles, Koreans and sprays no disbudding is practiced.

Desuckering:

All suckers that are arising from the adventitious buds present on the stem below the ground should be removed as and when they are produced. The practice of desuckering does not influence the flower number, but enhances the size and quality of flowers by diverting the nutrients to the flower bud.

Staking:

Laterals that are obtained after deshooting, should be staked with small split bamboo stakes inserted in the soil with a few to give support and also to see that this are spread out from each other. When buds start showing colour the bamboo stake is cut just below the basal level of bud so that it does not obstruct the bud in developing into a perfectly shaped flower.

Harvesting:

In general Chrysanthemum comes to flowering in about 80 to 90 days after planting (i.e. pre blooming period is three months). The early planted crop comes to flowering by July – August and late planted crop blossoms in January February. Early planted crops takes longer time to come to flowering than late planted ones. Flowers can be cut at an interval of 4 to 5 days in the beginning and once in three days during the peak period of production.

Fully opened flowers are harvested during cooler times like mornings

Standard chrysanthemum can also be harvested at unopened stage when only a few outer ray florets unfurl. The bud opening solution for this type is an absolute necessity. The ideal bud opening solution is 200 ppm, 8 HQC and 2 per cent sucrose (1-15%).

Grading:

Cut flowers are made into several grades depending on stem length and strength, colour and diameter of flowers. Pompons are graded into 250 – 340 grams bunches having several stems. Standards are generally graded into groups of 10 to 12.

Yield:

The average yield of loose flowers for garland making is about 7.5 to 15 tonnes per hectare. In case of spray cultivars about one lakh flowers are obtained from an area of one hectare.

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LECTURE-31: Crossandra and marigold- importance- climate and soil – varieties- propagation- planting - manuring- irrigation- harvesting – yield

Botanical name*: **Crossandra infundibuliformis***
Family **: Acanthaceae**

It is also known as Kanakambaramu or Firecracker because of cracking sound during opening of seedpod.

Importance:

Flowers are commonly used for hair adornment, though not fragrant, flowers are very popular because of its attractive bright colour, light in weight and good keeping quality. These are used for making garland either alone or in combination with Jasmine flowers. Crossandra flowers in combination with Jasmine flowers give fragrance and contrasting (striking difference) beauty. It can be grown in home gardens, rockery gardens and for land scaping as an herbaceous border.

Variety: Crossandra varieties are available in a range of colours. Apart from the orange, pink, red and yellow and double coloured blue types with white throat also exists.
Orange, Delhi, Lutea yellow and sebacaulis Red are the common cultivars grown.

Propagation: seed or cuttings can propagate Crossandra.

Seed:

The seeds mature in small ears similar to those of wheat. Seeds attain physiological maturity at about 55-60 days after flowering. The seeds can be stored for 6 months with seed treatment it either captain or Bavistin @ 2g/kg of seeds. Seedlings will be ready for planting when they have 4-5 pairs of leaves. To raise one hectare of crop of Crossandra about **22.5kg** seed is required. (9kg/Acre).

Stem Cuttings:

Crossandra may also be propagated vegetatively. The stem cuttings are rooted under mist chamber. The cuttings are transplanted in the field when sufficient numbers of roots have developed. It is preferable to treat the seedlings or rooted, cutting with nematicide and fungicide before transplanting.

Soils:

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Crossandra can be grown in almost all types of soils. However, well-drained loamy soils rich in organic matter with a pH of 6-7 are well suited.

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Alkaline and saline soils are not suitable as plant develops deficiency symptoms like chlorosis and lead to improper growth of the plant and poor flower production. This crop should not be cultivated in nematode infested soils.

Climate:

It is a tropical plant and cannot tolerate low temperatures and frost conditions. It grows luxurious when temperature is around **30^{0C} .** It flowers profusely during cool months of the year; plants can also be grown under partial shade.

Planting:

The soil is ploughed 3 to 4 times to bring the soil to a fine filth. Well rotten FYM @ 25T/ha should be applied at the time of last ploughing. Furrows and ridges are opened at 60 cm. Apart. Rooted seedlings or cuttings are planted 30 cm apart on one side of the ridge. The seeds are sown in May-June and transplanted during August-September.

Irrigation:

Depending upon climate and type of soil immediately after planting irrigation is necessary. It required irrigation once in 4-5 days.

Manures and Fertilizers:

For increased growth and flowering in Crossandra application of N, P, K and FYM and Zinc Sulphate is also recommended.

Apply 33.4 kg N, 60 kg K per hectare. Entire P and K should be apply in the ferrous before planting. **1.** 3 Months after planting

N – should be applied in 2 split doses

2. 8-9 months after planting

Zn So_4 0.5% foliar spray once in 60 days.

Fe deficiency a common problem in Crossandra.1% Fe_2 So_4 + 2% urea spray once in every 30 days. Seed yields and reduce chlorosis.

Inter-culture:

Flowering in Crossandra commences 2-3 months after planting and continues to bears flowers through out the year flower production may drop during rainy season. Providing partial shade to the plants has been found to be beneficial to maintain the health of plants and obtain higher yield of flowers. During initial growth period the weeds are kept in check by manual method by using Khurpi or hand hoe. Timely application of fertilizer, irrigation, weed control, earthing of plants are required to maintain a good healthy crop. After the flowering is over, removed of dried spikes and branches will help in increased flower yield year round.

Harvesting:

Crossandra can be flowered 2 – 3 months after planting. Crossandra flowers open in sequence from the base of the spike. Two flowers are

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diagonally opposite the spike open at the same time. It takes about 2 days for (Joining opposite corners of a square or rectangular) complete opening of

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the flower. Therefore picking of the flowers is done therefore alternate days in early morning hours. Depending on the length of the spike it takes nearly **15 – 25** days to complete flowering on a spike. Flower picking is done by pulling corolla out of calyx. In some plants flowers are picked along with the ovary. For local market flowers are packed in cloth or polythene bags. Crossandra flowers are very light and on an average about **15,000 flowers make on kg.**

Yield:

The flowers yield increases as the plants grow producing more number of laterals. Though Crossandra is reported to be perennial and lasting 2 or 3 years, it may be better replace every year to maintain healthy and fresh looking plants, capable of producing higher yields. 5.7 to 10 T/ha from earlier healthy crop.

Botanical name:	***Tagetus erecta* - African marigold**
	***Tagetus Patula* - French marigold**
Family	**: Compositae**
Origin	: **Central and South America and Mexico**

Marigold is one of the most popular flowering annuals cultivated in India. It is gained its popularity amongst gardeners and flower dealers on account of its easy culture wide adoptability, wide attractive colours, shapes, size and good keeping quality. In Andhra Pradesh Marigold is extensively used as loose flower for making garlands in religious and social functions.

Importance:

1. It is useful for floral decorations and floral arrangements.
2. Used in mixed herbaceous borders and bedding, cut flower, pot culture.
3. For religious offerings and French marigold is most ideal for rockery, edging hanging
   Baskets and window boxes.
4. Both leaves and flowers are equally important from medicinal point of view leaf paste is
   Used externally against boils and carbuncles. Leaf extract is good remedy for earache. Flower extract is considered as blood purifier, a cure for bleeding piles and is also a good remedy for eye diseases and ulcers.
5. Oil extracted from Tagetus can find a use in the perfume industry.
6. Extracts used as **natural dye**.
7. African marigold represents "**vulgar minds**" where as French marigold is a symbol of "**Jealousy**"
8. Marigold is also known as **friendship flower** in the United States.

Species, Types and Cultivars:

There are about 33 species of the genus Tagetus. Among all the species the following two species are important and suitable for

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commercial cultivation.

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1. **African Marigold: - (Tagetus erecta):** The plant is tall and hardly. Flowers are single to fully double and large size globular heads. Flower colour varies from lemon yellow-to-yellow, golden yellow or orange. (90cm tall, erect, branched). It is a diploid, 2n=24. From commercial point of view African marigold is in greater demand as compared to French marigold.

   Ex. Giant double African yellow, Giant double African orange (Early orange and Early yellow are commercially cultivated in West Bengal and Orissa).

   Cracker Jack, Zinnea gold, Gold coin, Yellow supreme, Man in the moon.
2. **French Marigold: (Tagetus patula):** Plant is dwarf bushy, flowers are small either single or double. Flower colour varies from yellow, orange, reddish brown, golden yellow to bicolour. Foliage is dark green with reddish stem. (30 cm tall bush). It is tetra ploid 2n=48.

Important cultivars: yellow boy, Harmony boy, Red brocade, little devilbicolour, little devil yellow, Butterscotch, Royal Bengal, Queen Sophia, and Tangerene.

Dwarf varieties of African Marigold: Apollo, Aztee, Golden age, Spun gold, Spun yellow, Guys and Dolls, Happiness, Dolly, Pot -o- gold.

Important varieties of French Marigold: They are easy to grow and bloom earlier than African types. Sparky, Spanish brocade, flame, flaming of fire, orange flame and star of India. The important varieties of **triploid varieties** are showboat; sever star *(T-erecta x T-patula)* most of them are used as pot mums.

Important improved Indian varieties:

1. **Pusa narangi Gainda** – Cracker Jack x Golden Jubilee – Suitable for garland.
2. **Pusa basanti Gainda** – Golden yellow x Sun giant – Suitable for pots and beds in garden.

Propagation: Marigold is (commonly) generally propagated either by seed or by herbaceous cutting.

Seed: Seed rate for marigold varies from **0.8 – 1 kg / Acre (2-2.5 kg / hector**).

Seed propagation is very common because readily available and germinate quickly marigold seeds are sown in raised seedbeds or pots or seed pans. During preparation of nursery bed 8-10 kg of well-decomposed cow dung manure per m^2 of bed is thoroughly mixed with the soil. The width of the seedbed should not be more than 1.2 meters and height should be 15 cm. During the winter, the beds are covered with a layer of straw to accelerate the germination process. Seeds are sown thinly without over crowding. Seeds germinate well at temperature from **18 to 30 ^{0} C**. Seeds take about 5-7 days for germination.

Sowing time:

Marigold can be raised **thrice in a year**, i.e. rainy, winter and summer season.

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Season	Seed sowing time	Trans planting time
Rainy	Mid – June	Mid – July
Winter	Mid – September	Mid – October
Summer	Jan – Feb	Feb – March

By cuttings (Herbaceous): -

Cuttings are generally used for perpetuation of a particular plant (or) cultivars. About 6 – 10 cm long cuttings are made from the apical portion of shoot and kept for rooting. Herbaceous cuttings each with one or two pairs of leaves are inserted in sand medium either in seed pan or nursery bed. Before putting the cuttings in rooting medium the basal portion of the cuttings is treated with Seradix B – 1 or Rootex – 1 to encourage profuse and early rooting. Regular watering should be done to keep the bed in moist condition with in 8 – 10 days, rooting is observed in the cuttings, which are later used as planting material. Varieties like Giant African yellow, Giant African Orange **does not set seed** therefore these are usually multiplied by herbaceous cuttings.

Soil and Climate:

Marigold can be grown in a wide range of soils, except water logging situation. However a deep fertile soil having good water holding capacity well drained and near to neutral in soil reaction ($P^{H:}$ 7.0 – 7.5) is most desirable. An ideal soil for marigold cultivation is fertile sandy loam.

It requires mild climate for luxuriant growth and flowering. High temperature effects the growth besides reducing flower size and number. In severe winter plants and flowers are damaged by frost. Therefore depending on environment planting is done. The environmental conditions after seedlings are transplanted greatly influence growth and flowering. Mild climate during growing period (14 – 28 ^{0} C) greatly improves flowering while higher temperatures (28 – 36 ^{0} C) adversely affected flower production.

Selection of Site:

A sunny location is ideal for marigold cultivation. Under shade marigold plants produce more vegetative growth and do not produce any flower.

Transplanting of Seedlings:

One-month-old seedlings with 3 to 4 leaves are fit for trans planting. Watering of nursery bed one day prior to up rooting will lessen the damage to root system. Trans planting should be done in well-prepared land and soil is pressed around root zone to avoid air pocket. After temperature a light watering with rose can should be done.

Spacing:

An African marigold – for seedling plants 40 x 30 cm spacing should be given while for rooted cuttings 30 x 20 cm is found to be ideal. French

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marigold – 20 x 20 cm or 20 x 10 cm.

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Irrigation:

Depending on soil and weather conditions, the crop should be irrigated at least once in a week during winter and once in 4-5 days during summer. It takes about 55 – 60 days to complete vegetative growth and enter into reproductive stage. At all stages of vegetative growth and during flowering production sufficient amount of moisture in soil is essential. Water stress adversely affects normal growth and flowering.

Manures and Fertilizers:

FYM/cow dung @ 20 T/ Acres (50 T/hector) should be applied during wind preparation. Besides 40 – 80 kg of K_{20} per acre should be applied (100 – 200 kg N, 200 kg P_2 and 200 kg of K_2/hector). Half of the N, entire dose of pad K should be applied as basal dose, preferably one week after transplanting and rest half nitrogen should be applied one month after the first application.

Intercultural Operation:

In marigold control of weeds is an important operation of the weeds are not removed in time, a great loss would occur in terms of growth and productivity and weeding should be done 3 to 4 times during the crop period.

Pinching:

In tall cultivars of African marigold plants first grow up wards to their final height and later on produce a terminal flower by apical dominance. After the formation of terminal flower bud, axillary's branches develop which also bear flowers. However if the apical portion of the shoot is removed early, large number of axillary shoots arises resulting in well-shaped bushy plant bearing more number of uniform sized flowers. Removal of apical portion of shoot is known as 'pinching' it is observed that pinching 40 days after transplanting enhances flower yield. However Giant double African yellow and orange do not require pinching, as the plants are bushy and branching type.

Harvesting:

Marigold flowers are plucked when they attain full size. Harvesting should be done either in the morning or evening hours. Field should be irrigated before harvesting of flowers so that the flowers keep well for longer period after harvest. The plucked flowers are collected in polythene bags, jenny bags or bamboo baskets for carrying to market.

Yield:

The yield of flowers in African and French marigold varies cultivars cultural practices adopted, spacing and fertilization etc. An average the yield of French marigold and African marigold varies from 8 to 12 T/hector and 11 to 18 T/hector respectively. Normally 10 – 15 T/hector flower Giant African yellow may give 25 T/hector.

Seed:

African marigold – 120 – 150 kg/Acre 300 – 375 kg/ha

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French marigold 400 – 500 kg/Acre 1000 – 1250 kg/ha

Seeds should be collected from winter only.

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LECTURE-32: Tuberose - importance- climate and soil – classification based on petals- varieties- propagation- planting - manuring- irrigation- harvesting - yield

Botanical name	***Hyacinthus indicus***
Family	**: Amaryillidaceae**
Origin	: **Mexico**

In India, the commercially cultivation of tuberose is certain confined mainly to west Bengal, Karnataka, Tamil Nadu and Maharastra. However, it is adopted to the North Indian climatic conditions and grows well in Utter Pradesh. At present total area under the tuberose cultivation in the country is estimated to be about 20,000 hectare.

Soil: The tuberose grows in a wide range of the soils. Its cultivation can also be extended economically in almost unproductive soils affected by salinity and alkalinity. Loam and sandy loam soils having the pH range from 6.5-7.5 with good aeration and drainage are considered for its cultivation. The soil should be rich in organic matter and retain sufficient moisture for proper growth, according to Rameshwar, heowy soils, where rice is cultivated, should be preferred to light red soils. For cultivation in pots, a mixture of garden soil, FYM and leaf mould in the proportion of 2:1:1 should be used.

Climate: Tuberose grows in mild climate without extremes of high or low temperatures even though it can be grown under a wide range of range of climate conditions. In India, the commercially cultivation of tuberose is mainly confined in warm, humid areas with the average temperature range from 20^{o} to 35^{o}C. For its urnuriant growth, it requires high humidity and a temperature around 30^{o}C. Temperature above 40^{o}C reduces the spike length is quality of the flowers. Very low temperature and frost also damages the plants and flowers. Tuberose grows well in sunny situation.

Planting:

Tuberose is generally planted is February – March in the plains and in April – May in the hills. In a two-years field trail on a medium fertile clay soil, the best time for the planting was reported between 14 & 29 June, the percentage of saleable bulb produced was about 85. in Southern pats of India, however, Nambisan and Krishnan suggested to plant the bulb in the month of July – August. Investigation on effect of time of planting of bulbs in the month of April recorded the highest yields of was also recorded by Mukhopadhyay and Banker (1981). Sequential planting may be practiced to obtain flowers almost throughout the year if the temperature is not very low in the winter months. Replanting is necessary after 3 years.

Propagation:

Tuberose is mainly propagated through vegetatively by means of bulbs, seeds if produced, are difficult to germinate and are seldom used for raising plants. Although not very common, propagation may also be done by the division of bulbs. To get virus-free the material or for a very rapid

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multiplication is done through tissue culture.

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Seed propagation:

Under favourable climatic conditions, seed settings is observed only in the single flowered cultivar. Seeds are sown in well prepared growing medium containing leaf mould and garden soil in equal propagation. Moisture and garden soil in equal proportion. Moisture and temp of 80^{o}F (26.6^{o}C) is supposed to be optimum. The seeds are sown in rows 10cm apart and 1.5cm deep in heavy soils and 2.0m in light soil. Moisture can be maintained by spreading the much on bed. Seeds start germinated within 10 to 50 days after sowing. After the seedlings have attained a good growth, these are transplanted in pots or ground were they are allowed to grow.

Vegetative propagation:

Bulbs: This is most commonly used practiced commercially for the multiplication of tuberose. However care should be taken in the selection of suitable bulbs. Spindle-shaped bulbs free from diseases and having an average diameter of 1.5cm or above should always be preferred to conical flat bulbs. The maximum production of bulbs can be planting them early and to grow as late as possible.

By division:

Tuberose also responds to his method of propagation i.e. By using bulb segments. The success however on the size of bulbs and it was reported that only the segments from large bulbs (sum or more in diameter) regenerated well. Bulbs are cut into 2-3 vertical sections, each containing a bud and a part of the basal plate. Each of these sections is treated with fungicide and planted vertically in a rooting medium with their tips just showing above the surface. A moderately warm temperature, slightly higher than for mature bulbs should be maintained.

Planting distance:

Planting distance influences the yield and quality of flower and bulb obtained per unit area. Higher plant density has been found to produce greater yield of spikes, flower and bulbs was grown at planting rates of 24,36 and 48 bulbs 1m^2 on soil with high or medium ridges or on flat soil. In West Bengal suggested spacing of 10-15cm between the bulbs and 25cm between the rows. The planting of bulbs at a distance of 20x20cm with a population of 250000 plants / ha. Rameswar (1976) the suggested a spacing of 30 to 38cm between rows and 15 to 20cm between bulbs, accommodating 40,000 to 50,000 bulbs per acre for cultivation of tuberose in Bangalore. The planting was done at a distance of 20 x 25cm sharga (1977) recommended spacing of 30cm apart.

Harvesting of flowers:

Tuberose is harvested by cutting the spikes from the base of for table decoration or the individual flower is picked from the spike for making garlands and other floral ornaments. Picking of flower should be done in cool hours of the day either in the morning or evening. Harvesting in the next morning leads to a weight loss to about 40 percent. Four to five persons can harvest about 60kg flowers in 2 to 25 hours.

The flowers spike for table decoration should be cut when the first pair of flowers fully open, with a sharpe knife and placed immediately in water. The small clasping leaves on the flowers stalk should be retained for a longer

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life of the flowers.

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