

Tomato

Botanical name: *Lycopersicon esculentum*

Family: **Solanaceae**

Chromosome no. (2n) = **24**

Origin: **Peru, Ecuador – Bolivia**

Introduction:

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 it tops the list of canned vegetables. Tomatoes are used for soup, salad, pickles, ketchup, puree, sauces and in many other ways.

Tomato is a major source of vitamins and minerals. It is widely used as salad vegetable. In England, it referred as "**love of apple**" or '**love apple**'. In India it is commonly referred as '**poor man's orange**' (Ascorbic acid 15 mg to 30 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, Ca, Mg, P, K, Fe, Zn, Boron. The steroidal glycoalkaloid present in tomato is called **tomatin** and the coloured pigment is called **lycopene (red colour)**. Lycopene content is high at 70°F or 21°C.

Origin, taxonomy and botany:

Cultivated tomato originated from Peru, Ecuador, Bolivia. Domesticated place of tomato lies in Mexico. The ancestor of cultivated tomato is cherry type (*Lycopersicon esculenta* var. *cerasiformae* - cherry tomato).

Tomato belongs to the family Solanaceae. The genus *Lycopersicon* differs from *Solanum* by the absence of spines in pinnatifid leaves, anther tips are narrow and exhibit longitudinal dehiscence. The genus *Lycopersicon* was divided into two sub genera.

1. *Eulycopersicon* is characterized by red fruited edible species with carotenoid pigmentation and they are annuals. Cultivated tomato is included in this. The species included are

- a. Cultivated tomato - *Lycopersicon esculentum* and
- b. Small fruited tomato- *Lycopersicon pimpinellifolium*

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

Bailey (1949) classified tomatoes into two species, *L. esculentum* and *L. pimpinellifolium*, with 5 botanical varieties in *L. esculentum* var. *commune* (common tomato), var. *grandifolium* (large-leaved tomato), var. *validum* (upright tomato), var. *cerasiforme* (cherry tomato) and var. *pyriforme* (pear tomato). The chromosome number of all the species were reported to be $2n=2x=24$.

Cultivated tomato is an annual herb, 0.7 to 2m tall, erect with thick solid stems or spreading, coarsely hairy with strong characteristic odour. Strong tap root with dense fibrous and adventitious roots are formed. Tomato can be classified depending on the growth habit.

1. **Indeterminate:** terminal buds ends with a leafy bud and continue its vegetative growth. (Inflorescence cluster occurs at every third internode and the main axis continues to grow indefinitely.) **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. (Inflorescence occurs more frequently in almost every internode until terminal ones are formed and elongation ceases at this point) **Ex.** Pusa Early Dwarf
3. **Semi-determinate:** have semi dwarf growth and it is between determinate and indeterminate. Number of nodes between two consecutive inflorescences will be around one. **Ex:** S-12, Roma.

The leaves are compound pinnatifid with small leaflet. Flowers are borne in small forked raceme cyme. They vary in numbers from 5 to 12. Flowers are pendent, perfect, hypogynous. Stamens 6 in number and inserted on throat of corolla tube, filament bright yellow. Carpels 6, united and basal ovary typically 6 celled with a central fleshy placenta. Dehiscence of anther is longitudinal, 1-2 days after opening of corolla. If the pollen is shed as the style grows up through anther tube, self-fertilization occurs and when the stigma protrudes, chances of cross pollination through bees increase. The optimum temperature for pollination is around 21°C.

Climatic and soil requirements:

Tomato is a warm season vegetable, is grown extensively in cool season also. It requires a long season optimum temperature is 15 to 27°C. Temperature and light intensity effect the fruit set, pigmentation and nutritive value. Mild winter condition in northern plains is ideal for seed germination, plant growth, fruit set, fruit development and ripening. At low and high temperatures, there is low germination of seeds, poor plant growth, flower drop, poor fruit set, and ripening. At high temperatures, generally the quality of fruits is poor and there is high incidence of sun scald. Maximum fruit set occurs at a night temperature of 15 to 20°C. High temperature (38°C) accompanied by low humidity and dry winds adversely affect the fruit set. Excessive rains adversely affect its fruit set causing flower drop. Tomato has a yellow pigment 'Carotene' and red pigment (at ripened stage) called 'Lycopene' and at very high temperature formation of lycopene is inhibited.

Tomato can be grown in a wide range of soils from sandy to heavy soils. However, sandy loam, rich in organic matter ideal for its cultivation. 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 7 to 8.5.

Varieties & Hybrids:

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, sweet 72, S-12, Co-1 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 chuhara are suitable for **processing**.
- Varieties released by IIHR Bangalore are Arka Abha, Arka Abhijit, Arka Ahuthi, Arka Aloukik, Arka Meghali, 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
- **PUSA-120**: resistant to nematode and released by IARI, New Delhi.
- **S-12**: Evolved by PAU, Ludhiana, fruit round to flattish with persistent pedicel suitable for summer crop all over the India.
- **Sioux**: American variety, resistant to growth cracks
- HS-101, HS-102, HS-110, Hisar Anmol, Hisar Arun, Hisar Lalima, Hisar Lalit etc. are developed by HAU Haryana.

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	<i>L. esculentum X L. Pimpinellifolium</i>	

Co-1, Co-2 – released from TNAU, Coimbatore. Co-3 it is a mutant of Co1. Gulmohar (MTH 6) – released from Maharashtra hybrid Seed Company. Punjab chuharra, Ox heart, Punjab kesari, Pusa early dwarf, Pusa rubi, Pusa red plum, Pusa sadabahar, Sweet – 72, Roma, Yasvanth-2 are other hybrids.

A high yielding tomato F₁ hybrid “**Arka Rakshak**” triple disease resistance, Tomato leaf curl virus (ToLCV), bacterial wilt (BW) and early blight (EB), developed by Indian Institute of Horticultural Research (IIHR), Bangalore. This is the first multiple disease resistant public bred tomato F₁ hybrid released for commercial cultivation in the country. Plants are semi-determinate.

Seed sowing:

It is grown almost the year round. In north India, generally autumn and spring summer crops are taken. Therefore, seed sowing is done in November and transplanting during the month of January. In case of South India, 3 crops are taken which are sown during June-July, October-November and January- February.

Seed rate:

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

Nursery practices:

Tomato is a transplanting crop. Seeds are sown in the area of 250 m². A raised bed prepared by well decomposed FYM is mixed @ 4kg FYM per m² 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 (Thiram or Bavistin @ 2g/kg) and 40% formalin solution at 500ml/m² area of nursery bed sterilisation. During summer and rainy season, there is very heavy incidence of damping off. To protect seeds and seedlings, the beds should be treated with 10% formaldehyde. 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 7.5cm 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. Hardening is done by withholding water 4-5 days before uprooting seedlings. Adding 4,000ppm sodium chloride or spraying of 2,000ppm CCC is effective for hardening of seedlings.

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. Seeds should be sown 1.25 to 2.5mm deep. Direct sowing is reduce the infestation of root knot 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. Deficiency of phosphorus leads to the development of purple colour on the underside of leaflets. Potassium is involved in the synthesis of proteins and organic acids. Deficiency leads to yellowing at the margins of leaf. A high level of potassium improves the shape of fruit.

Well decomposed **FYM** is recommended, added @ **20-25 tons per ha** at the time of last ploughing and incorporated into soil. In general, **NPK @ 120 kg: 60 kg: 50 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. However, for hybrids, higher quantity of N is applied. A high level of N at seedling stage and moderate level at flowering and fruiting stage is required. However, high level of N in plant reduces the C/N ratio resulting in unfruitfulness. **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 Boron is considered to be essential for production of large size fruit with high vitamin content and prevent fruit cracking, while Zinc for higher ascorbic acid content and tolerances to diseases.

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 too 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 and 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:

The stage of maturity at which tomato should be harvested depends upon the purpose for which they are used and the distance of transportation. The following stages of maturity for harvesting are recognized.

1. **Immature:** Before the seeds have fully developed and before the jelly like substance around the seeds are fully formed.
2. **Mature green:** The 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:** 1/4 th 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 within 24 hours for processing. For seed production, red ripe tomatoes are ideal.

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 250 to 500 Q per ha. Hybrids can give up to 1000 Q per ha.

Post harvest management & 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°C for the cultivars like Florida MH and Floradade. Temperature of 10°C cause moderate chilling injury and Alternaria root rot.

Seed production:

Seed production in tomato can be taken up in any part of India. The agronomical practices for raising the crop for seed production are the same as for growing tomatoes for vegetable purpose. Tomato is a self pollinated crop. Natural cross pollination varies with the cultivar, weather condition, insect pollinators and isolation. The isolation distance is recommended as 50 m for foundation crop. This will avoid mechanical mixture. The crop should be examined at various stages of plant growth for detecting off-types. Production of nucleus seed is made either by raising progenies of true-to-type single plant or selecting elite plants from seed crop. The selected plants are tagged and well developed ripe fruits from these plants are collected for nucleus seed production.

Seed extraction methods:

1. Fermentation method

The ripe tomato fruits are harvested and kept for a day in wooden containers. They are crushed by hand or mechanically. No fruit juice should be allowed to drain out. Entire mass is kept for fermentation for 2-4 days (24-72 hours) at 15-24°C. Flesh will float at the top and seed will settle down at the bottom. The fermented mass is removed and the seeds are cleaned 8-10 times with clean water and later on, they are dried. Longer fermentation may damage the seed.

2. Alkali treatment

Selected fruits are cut into halves and the slimy mass containing seed scooped out in a vessel with wooden stick, the mass is treated with 300g of washing soda in 4 litres of boiling water in equal volume. When the mixture is cooled down, it is allowed to stand overnight. Next day, all the seed will settle down at the bottom. Seeds are washed thoroughly. This is the safest and best method of seed extraction.

3. Acid treatment

In this method, 250 ml of commercial hydrochloric acid is thoroughly mixed with 10 litres of slimy mass and left for 30 minutes. The pulp is stirred and seeds are washed with water, dried in sun or drier.

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% CaCl₂. 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 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).

3. Puffiness: commonly known as hallowness. Tomato puffs, puffy tomatoes, puffs and pockets. As the fruit reaches about 2/3rd normal size 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 within 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.

Plant protection measures:

Diseases:

1. Damping off and root rot
2. Late blight
3. Buckeye rot (fruit rot)
4. Early blight
5. Fusarium blight
6. Crown and root rot
7. Powdery mildew
8. White rot
9. Grey mould
10. Southern blight
11. Leaf mould
12. Grey leaf spot
13. Leaf blight
14. Verticillium wilt
15. Anthracnose fruit rot
16. Fruit rot
17. Black leaf mould
18. Bacterial wilt
19. Bacterial canker
20. Corky root
21. Tobacco mosaic virus
22. Leaf curl virus
23. Spotted wilt virus

Pests:

1. Tomato fruit worm
2. Epilachna beetles
3. Jassids
4. Tobacco caterpillar
5. White fly
6. Thrips
7. Leaf miner
8. Fruit borer
9. Aphids
10. Tomato worm
11. Mites
12. Fruit fly

Nematodes:

1. Root-knot nematodes

Brinjal

Botanical name: *Solanum melongena*

Family: Solanaceae

Chromosome no. (2n) = 24

Origin: Indo-Burma region

Common name: Egg plant

Introduction:

Brinjal can be grown in almost all parts of India except higher altitudes, all the year round. The brinjal is of much importance in the warm areas of far east, being grown extensively in India, Bangladesh, Pakistan, China and Philippines. It is highly productive and usually finds its place as the poor man's crop. In World, unripe fruit is primarily being consumed as a cooked vegetable in various ways. The white brinjal is said to be good for diabetic patients. Bitterness in brinjal is due to presence of glycoalkaloids (as solasodine). The discolouration in brinjal fruits is attributed to high polyphenol oxidase activity.

Origin, taxonomy and botany:

The brinjal, eggplant or aubergine (French name), a normally self-fertilized annual is of uncertain origin. A wild form with many small fruits, sometimes called as var. *insanum* is found on the Bengal plains of India. The cultivated brinjal is undoubtedly of Indian origin. Vavilov (1928) was opinion that its centre of origin was in the Indo-Burma region.

It belongs to family Solanaceae and known under the botanical name *Solanum melongena* L. There are 3 main botanical varieties under the species *melongena* e.g. **var. esculentum**, **var. serpentine** and **var. depressum**.

1. Based on growth habit brinjal can be classified as below:

- i) ***Solanum melongena* var. *esculentum***: Fruit is long, round or egg-shaped and oval.
- ii) ***Solanum melongena* var. *serpentine*** known as snake brinjal. Fruit is extra ordinarily long and slender types. Leaves are prickly.
- iii) ***Solanum melongena* var. *depressum***: plant is extensively short and dwarf.

Solanum is a very large genus. Among the 22 Indian species, there is a group of 5 related ones, all prickly and diploids with $2n = 2x = 24$, namely *melongena*, *coagulans*, *xanthocarpum*, *indicum* and *maccanii*.

2. Classification on the basis of fruit shape:

- i) Long brinjal: Pusa purple long (PPL)
- 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

Brinjal is an annual herbaceous plant. Roots are usually tap but on transplanting it changes as fibrous as is true with tomatoes and peppers. The above ground portion of plant is erect, compact and well branched. The leaves are large, simple, lobed and the underside covered with dense wool-like hairs. Inflorescence is often solitary but sometimes it constitutes a cluster of 2-5 flowers. The flowers are large showy with the corolla purple in colour. The flowers are hermaphrodite and stamens dehisce at the same time the stigma is receptive so that self-pollination is the rule, although there is some cross-pollination by

insects. The fruit is pendant and is a fleshy berry borne singly or in clusters. There are 4 types of flowers, depending on the length of styles.

Flowers in brinjal are of different styles.

a. long style **b.** medium style **c.** short style **d.** pseudo short style.

Brinjal is a self pollinated crop.

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 selection 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, krihsna nagar 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, Vaisali.
- 6. Oval or Oblong fruited varieties:** Junagad oblong, Bhagyamati, H4., 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:

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 20 to 30°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 between 5.5 to 6.6 for better growth and development. Light soils are good for a healthy crop but heavy soils are suited for higher yields.

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 seedlings transplanted in May-June.

Seed rate: Seed rate varies from 350 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 cm x 60 cm. Round fruited varieties at 75 cm 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 in one hectare. 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. Mulching in brinjal with black polythene film reduces weed growth, increases crop growth, early bearing and total yield. Weeds can be controlled by applying herbicides like fluchloralin @ 1-1.5 kg a.i. / ha.

Harvesting:

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

Yield:

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

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 7.2⁰C 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.

Chilli

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 form 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.

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

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

Hybrids:

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 30⁰C. Fruit development is adversely retarded at 38⁰C. 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 vogue chillies can be in May-June and September to October. In hills it is sown during March to April.

Seed rate:

1 to 2 kg seed is required to raise seedlings for hectare. Chilli seed bed are sometimes 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. Selected 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 120 kg N, 60 kg P, 50 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.

Harvesting:

Flowering begins 40 to 60 days after transplanting depending upon variety climate, nutritional status of plant. Fruits starts ripening about 3 months after transplanting and picking may go on for 2 to 3 months. Commercial chilli variety yield 2-2.5 tonnes per ha. dry pods. and 7.5 to 10 tonnes per ha in normal conditions. Green chillies can be stored for about 40 days at 0°C and 95 to 98 % RH. Dried chillies can be kept for a month in dry places well protected from insect pests.

Beans- cow pea and dolichos bean

Cow pea

Botanical name: *Vigna unguiculata*

Family : Leguminosae

Origin : India

Chromosome number: $2n = 22$

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, Pasture and for all types of straw and as source of protein especially lysine.

Varieties:

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

Pusa barsati:

Pusa dofasali: 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 suitable for cultivation in February – March. It is of 60 days duration.

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

Pusa Rituraj: it was developed from NBPGR, New Delhi. It is **photoinsensitive**. 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 35^o 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 *a.i.* Summer and rainy.

Summer crop generally sown towards the end of February. It can be continued till the middle of April. Sowing rainy crop commences from the middle of June and extends up to the end of July.

It is also 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 -12-15 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:

FYM@15-20 tonnes/ha. 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, So 10 to 15 kg ZnSO₄ per ha is beneficial to apply. Cow pea seed should be inoculated with Rhizobia before sowing.

Irrigation:

Cow pea is shallow rooted crop. Light irrigation is 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 weed control in 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.* Fluchloralin 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 and 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.

DOLICHOS BEAN

Botanical name: *Dolichos lablab*

Family : Leguminosae

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 and vitamins. However, **methionine** is the limiting amino acid 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	<i>Dolichos lablab</i> Var. <i>Lignosus</i>	<i>Dolichos lablab</i> Var. <i>Typicus</i>
2	Longer axis of the seed is at right angles to the suture of the pods	It is parallel to the suture
3	It is semi erect or bushy perennial but cultivated annual. The entire plant is pubescence or hairy	It is herbaceous vine type annual can be retained for 2-3 years in Kitchen garden. The shell of the pods is not 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 in market 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 bore 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 of ragi or sorghum. Initially 2 to 3 seeds are sown per hill and later thinned to one 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 or twice control weeds and to enhance crop growth.

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 unpleasent, 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° C and RH 90%.