

# ***PRODUCTION TECHNOLOGY OF TOMATO***



**Lectured by:**  
**Dr. AVANISH KUMAR SINGH**  
Teaching Associate

**Course Instructor:**  
**Dr. S. K. Singh**  
Assistant Professor

**DEPARTMENT OF VEGETABLE SCIENCE**  
**Chandra Shekhar Azad University Of Agriculture &  
Technology, Kanpur**

# TOMATO

**Botanical name:** *Solanum lycopersicum*

**Family:** Solanaceae

**Chromosomal number:**  $2n=24$

**Origin:** Peruvian and Mexican regions.



## INTRODUCTION

- Tomato is one of the most popular and widely grown vegetable in world.
- Its many forms are adopted to wide range of soils and climate.
- It has many other uses tomato seeds contain 24% of oil is used as salad oil and in the manufacture of margarine.
- Green tomatoes are also used for pickles and preserves.

# History:

- In 1828 Britishers introduced tomato to India through Royal Horticultural Society, Calcutta and afterwards it spread to other parts of the country.
- In 14<sup>th</sup> -15<sup>th</sup> century it is considered as the highly poisonous food.
- In 16<sup>th</sup> century Italians and Romans started use of tomatoes.
- Father of tomato : Dr. C. M. Rick
- Linnaeus 1753 placed the tomato under the genus '*Solanum*' and gave *Solanum Lycopersicon*.
- In 2005-2006 the scientific name of tomato was changed to *Solanum Lycopersicon*

## Origin and distribution:

- Evidences first tomato cultivation was compiled and evaluated by Jenkins(1948).
- First known record of tomato is in the year 1554 in south America.
- Cultivated tomato originated from Peru, Ecuador, and Bolivia. Domesticated place of tomato lies in Mexico.
- The ancestor of cultivated tomato is cherry type (*Lycopersicon esculenta var cerasiformae* - cherry tomato).
- From Mexico is distributed to Spain, Europe, Britain, France etc.

# Common Names

- Tomate (Spain, France)
- Tomat (Indonesia)
- Faan ke'e (China)
- Tomati (West Africa)
- Jitomate (Mexico)
- Pomodoro (Italy)



# Nutrients in tomatoes

- Tomatoes contribute to a healthy ,well balanced diet.
- In tomato total sugar content is 2.5% in ripe fruit and ascorbic acid varies from 16-65mg/100g of fruit weight, total amino acid is 100-350mg/100g of fruit weight.
- They are rich in minerals, vitamins, essential amino acids, sugars and dietary fibres.
- Tomato contains much vitamin B and C, iron and phosphorus.
- Composition of tomato fruit per 100g of edible part
- Minerals - 0.6g                      Nicotinic acid - 0.4g
- Vitamin A - 320I.U                  oxalic acid - 2mg
- Vitamin C - 31mg                    phosphorus - 36mg
- Thiamine - 0.07mg                  Iron - 1.8mg
- Riboflavin - 0.01g                  Calcium - 20mg

## Importance and uses

- Tomato is one of the versatile crop in the world because of its fast and wide climatic adaption and it is universally treated as “protective food”.
- The pulp and juice are digestible ,mild apparent,a promoter of gastric secretion and blood purifier.
- Also reported to have a antiseptic properties against intestinal infections and aslo fought against the cancer of mouth ,etc.
- It stimulates torpid liver and is good in chronic dyspepsia.
- According to kyzlink etal(1981),tomatine content in small hard tomato is 300mg/100g of edible part and 150 mg/100g in larger green fruits .
- The solanine content of the pulp made from unripe tomato is much lower ,similar to peeled potato (5mg/100g of edible part )

- Its ripe fruits are utilized on a large scale in the preparation of a variety of processed products, such as puree, paste, ketchup, sauce, soup, syrup, juice, drinks, and canned whole peeled fruits.

## Health Benefits Of Tomatoes

• Tomato is one of the versatile crop in the world because of its fast and wide climatic adaption and it is universally treated as “**protective food**”.



### HEALTH BENEFITS of *EATING TOMATOES*

- ◆ *Control blood pressure*
- ◆ *Good for heart*
- ◆ *Make bones stronger*
- ◆ *Cure constipation & indigestion*
- ◆ *Manage Diabetes*
- ◆ *Good for Vision*
- ◆ *Prevents urinary tract infections*
- ◆ *Good for Skin*

BODYANDBEANS.COM

## Pigmentation in Tomato:

- Red color is due to lycopene.
  - Yellow color is due to carotenoid
  - Tangerine is due to pro-lycopene.
- 
- antioxidants
- At temperature below 10<sup>0</sup>C tomato did not develop red or yellow colour where as at temperature between 10-25<sup>0</sup>C, red and yellow pigments developed and finally red colour was suppressed above 30<sup>0</sup>C.
  - If the temperature lower than 30<sup>0</sup>C was restored, red colour again developed and at the temperature above 40<sup>0</sup>C, lycopene was destroyed and no red colour development took place.

## Area and Production:

	Area	Production
<b>World</b>	7.8 million ha	193 million tonnes
<b>India</b>	7.8 lakh ha	19.7 million tonnes
<b>Uttar Pradesh</b>	12.8 thousand ha	8.4 lakh tonnes

Source-FAOSTAT(2018)

- In India the leading states are- AP, MP, KN (NHB Database 2017-18).

## **Export Demand:**

- Pune, Bangalore, Nasik and Amaravati are major exporting areas.
- The European markets prefers red color, cherry tomato.
- The Gulf markets prefers oval/ round, medium sized fruits.

**Importers:** Pakistan, UAE, Bangladesh, Nepal, Oman.

## Taxonomy:

- Tomato belongs to family solanaceae and genus lycopersicon.

The genus include 12 species,all native to south america.

- Muller (1940) divide the genus lycopersicon into sub genus Eulycopersicon (red fruited) and Eriopersicon(green fruited type).

- Bailey (1949) classified tomato into two species,*L.esculentum* and *L.pimpinellifolium*.with 5 botanical varieties.

# Botanical classification of cultivated tomato according to fruit shape and plant spread by Bailey (1949)

1. *L. esculentum. var. commune*



common round fruited tomato

2. *L. esculentum. var. grandifolium*



Potato leaves type

**3. *L. esculentum*. var. *cerasiformae***



alamy stock photo

small fruited cherry tomato

**4. *L. esculentum*. var. *validum***



upright tomato

**5. *L. esculentum*. var. *pyriformae* (pear shaped tomato)**



## Botanical Description

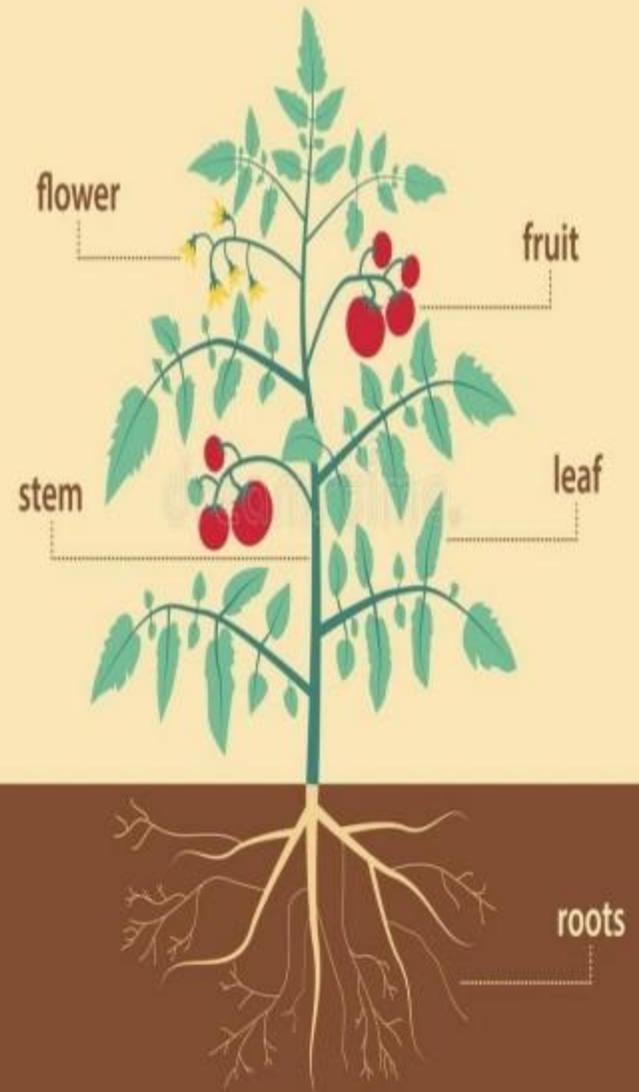
Cultivated tomato is an annual herb

**Roots:** Tap root system having depth of 50cm or more.

**Stem:** Growth habit is erect. Plant height is 2-4 m. The stem is solid, coarse, hairy and glandular.

**Leaf:** leaves are compound pinnatifid with small leaflet. The petiole is long clasping. The main leaflet is shortly stalked, 5 to 7cm long, ovate to oblong with margin irregularly toothed.

## TOMATO PLANT



## Fruits:

- Fleshy berry, globular to oblate in shape and 2-15 cm in diameter.
- The immature fruit is green and hairy.
- Ripe fruits range from yellow,orange to red.
- It is



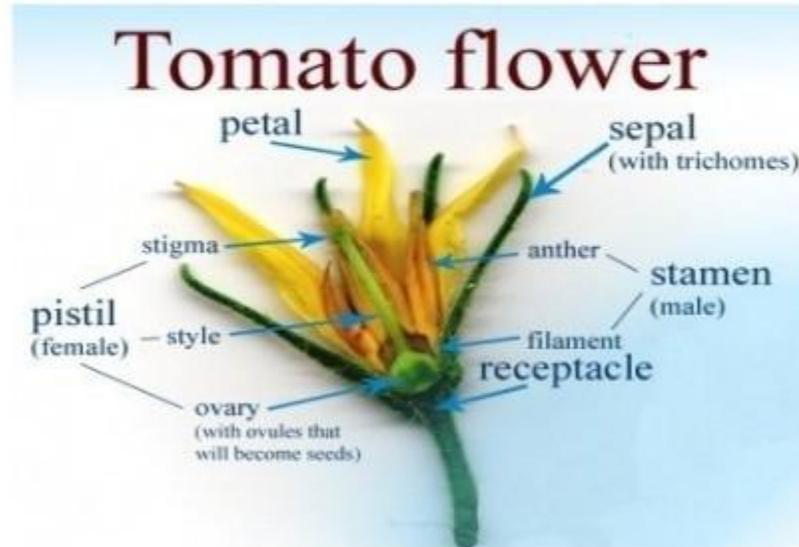
**Berry (All of most of pericarp is fleshy)  
e.g. tomato (*Lycopersicon esculentum*)**

e.g. tomato (λγκοπερσίσιον εσκληντικόν)

πειλά (νι) οί ποσι οί βερίσι οί μελί

## Flowers:

- flowers are borne in small forked raceme cyme.
- They vary in numbers from 5 to 12 each flower is borne on short pedicel which is constricted at the middle
- flowers are pendent,perfect,hypogynous.



**Seeds:** Numerous, kidney or pear shaped. They are hairy, light brown 3-5mm long and 2-4 mm wide.

## According to the growth habit, tomato is characterized by two types **Determinate type and Indeterminate**

### **Determinate**

- Bushy in nature.
- Self- topping occurs.
- Flower cluster occurs at every node.
- Early maturity can be seen.
- Staking is not required.

### **Indeterminate**

- Erect in nature.
- Self- topping does not occurs.
- Flower cluster occurs at every 3<sup>rd</sup> node.
- Late maturity can be seen.
- Staking is required.

## **VARIETIES:**

### Selection of varieties

- High yield.
- Free from cracking.
- Disease resistance.
- High percentage of no. of fruits.
- Good shelf life & TSS.

## **IMPROVED VARIETIES**

Arka Vikas

Pusa Ruby

Arka Ahuti

Arka Sourabh

Arka Ashish

Arka Abha

Arka Alok

Arka vikas

Arka shreshta

Meghali

Roma

Sankranthi

Nandi

Vybhava

## **HYBRIDS**

Arka Ananya

Arka Rakshak

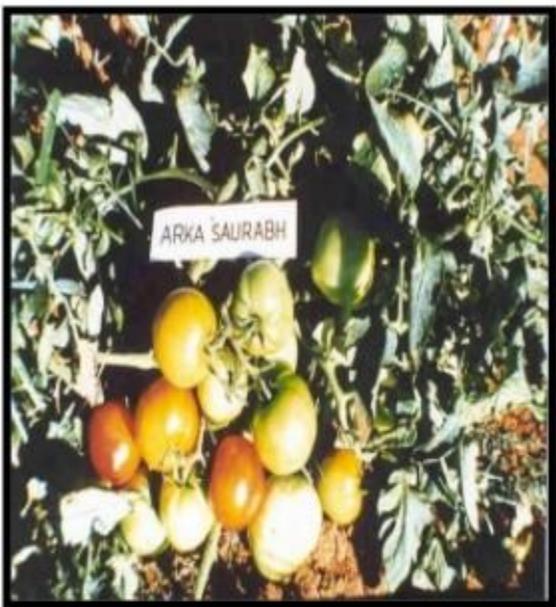
Arka Samrat

- Selection of tomato varieties have been in plenty suitable almost all parts of the country. Some of the sought after varieties are given below.
- **Sioux-** Highyielding dwarf, spreading
- **Pusa red plum-** Table variety, determinate (IARI)
- **Pusa early dwarf-** Suitable for kharif and rabi(IARI)
- **Co-1-** Semi spreading dwarf, fruits in cluster (TNAU)
- **Co-2-** Mutant of Co-1.
- **S-12-** High yielding, variety from PAU
- **PKM-1-** Round fruits with green shoulder
- **Pusa Ruby-** Indeterminate, flat fruits (IARI)
- **Pusa Gaurav-** Good for processing (IARI)

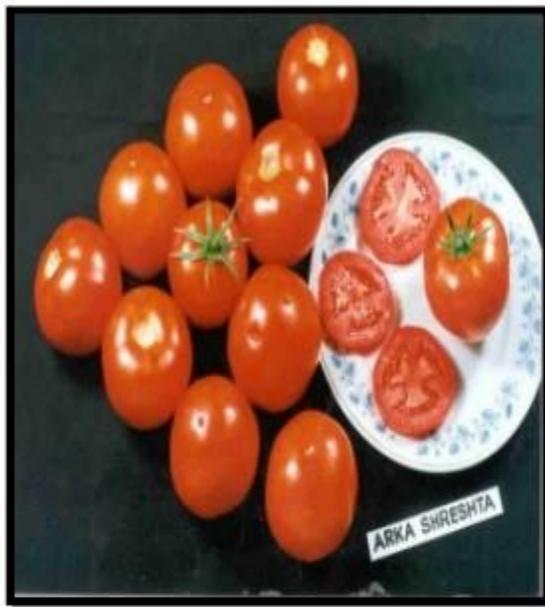
- **Paiyur 1**- Suitable for rainfed culture
- **Arka Saurabh**- Semideterminate, round fruits; good keeping quality (IIHR)
- **Arka Vikas**- High yielding table variety
- **Arka Ahuti**- Oblong fruits, TSS 5.4% (IIHR)
- **Arka Ashish**- Determinate oval fruits; tolerant to DM (IIHR)
- **Arka Abha**- Determinate; bacterial wilt resistant (IIHR)
- **Arka Meghali**- Rainfed' thick flesh.(IIHR)
- **Sakthi**- Resistant to Bacterial wilt (KAU)
- **HS 101**- Determinate; dwarf spreading, good for winter season(HAU)

- **Hisar Anmol**- Tolerant to leaf curl virus, determinate (HAU)
- **SL-120**- Semideterminate, root-knot nematode tolerant (IARI)
- **S-12**- Dwarf bushy plants (PAU)
- **Pant Bahar**- Bushy and much branched (GBPU)
- **NDT-1**- Indeterminate, large fruits.
- **NDT-120**- Determinate, good for processing.
- **Solan gola**- From Himachal (YSPU)
- **Pusa Divya**- Indeterminate F1 hybrid, profusely branched, round, yield 35 t/ha.

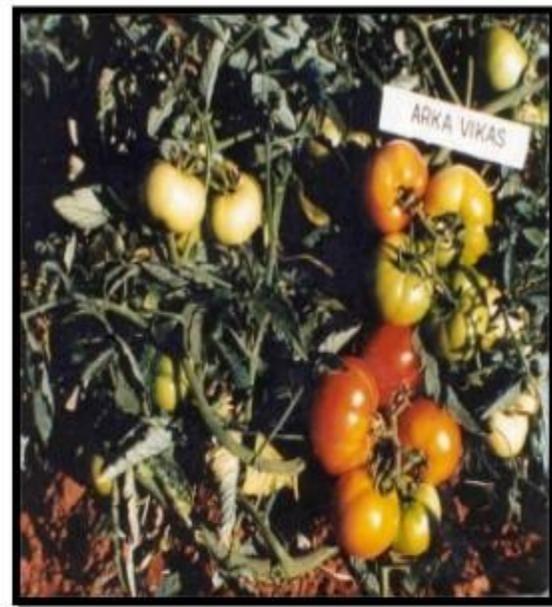
- **HS 102-** Early variety (HAU)
- **HS 110-** Late, table purpose variety, (HAU)
- **Hisar Arun-** Extremely early, large fruits (HAU)
- **Hisar Lalima-** Determinate, early, ;large fruit (HAU)
- **Hisar Lalit-** Semi determinate, root-knot nematode tolerant(HAU)



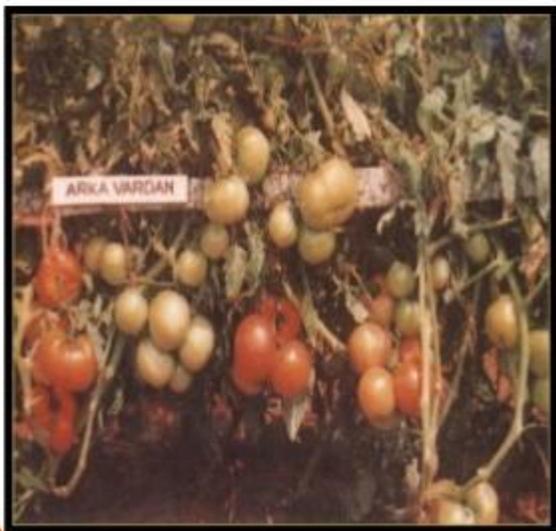
**Arka Sourabh**



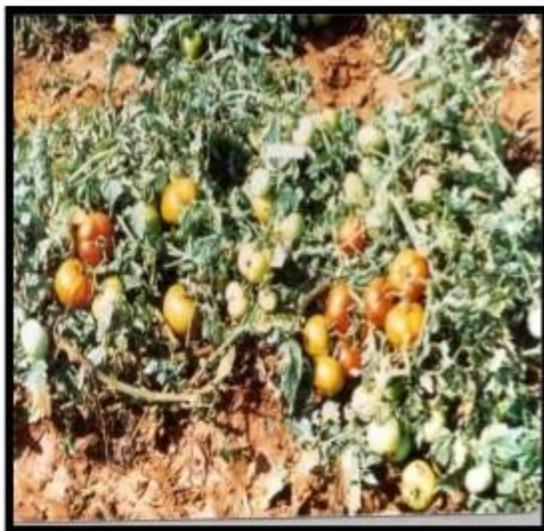
**Arka Shreshta**



**Arka Vikas**



**Arka Vardan**



**Arka Meghali**



**Arka Ananya**

## Varieties suitable for rainy season:

- Pusa Ruby,. Arka vikas, Arka Meghali, Megha

- Varieties suitable for processing:

- Arka ahuti, Arka Sourabh, Arka Ashish

- Varieties resistant to ToLCV:

- Nandi, Sankranti, Vaibhav, Arka Rakshak

- Varieties resistant to bacterial wilt:

- Arka alok, Arka Abha, Arka shresta, Arka abhijith

- Variety suitable for nematode resistace:Arka Vardana

## varieties resistant to abiotic stresses:

- **Pusa Sheetal**-low temperature;
- **Pusa hybrid 1**- High temperature.
- **Pusa Sadabahar**- high and low temperature region.

- **IAHS Bangalore released hybrids**

- 1) Rashmi: Tolerant to fusarium and verticillium wilt.
  - 2) Rupali: For high temperature.
  - 3) IAHS-88.2: Tolerant to fusarium, verticillium and root knot nematode.
  - 4) Naveen: Fresh market.
  - 5) IAHS-88-3
  - 6) Karnataka
  - 7) Rajani
  - 8) Vaishali
  - 9) Sweet heart
  - 10) Maruraj
  - 11) Gram wonder
- **MAHYCO Seeds:** MTH 4, Sadabahar, Gulmohar.
  - **Bejo Sheetal pvt.Ltd-** Meenakshi, Talstoi

## **varieties suitable for protected cultivation**

- All indeterminate varieties are suitable for protected cultivation:
- Pusa Ruby
- Pusa Sel. 120
- Angurlata
- Pant Bahar
- Pant T-3
- Hissar Lalit
- Arka Abha
- Pusa Divya

## Cultivars in some countries of the world

- Prima – Tomato cultivar from Hungary suitable for High density planting
- Poncu (1987) from Romania suitable for canning
- Verlioka reported from Moscow
- Red Rose reported from Hongkong : It has excellent taste and resistance to bursting and cracking ie : excellent transport quality.

## Climate:

- Warm season crop.
- Optimum temperature required for its cultivation is 20°C - 24°C
- Optimum temperature of 15°C -20°C for fruit setting.
- The temperature below 16°C and above 27° C are not desirable.
- Ideal temperature for development of red and yellow colour is 18°C -25°C.
- Lycopene which is responsible for red colour , is highest at 21°C-24 °C while the production of this pigment drops off rapidly above 27 °C.

**Soil:-** It grows well in all kinds of soil. For early crop, a sandy loam soil is the best, for higher yield heavy soils rich in organic matter are preferred. The pH should be 6.0 – 7.0. It is moderately tolerant to acid soil (pH 5.5)

## Disinfection of soil

- Control of Phytophthora, Pythium, RKN
- Soil solarization
- Methyl Bromide
- Formalin

## Seed rate:

For nursery Raising

OPV :300-400 g/ha.

Hybrids : 125 – 175g

## Time of planting:

Tomato can be grown in any season as it is a day neutral plant. Three crops are taken in areas which are not affected by frost.

- Kharif crop transplanted in July,
- Rabi in October- November months.

•**Seed treatment:**Seed is treated with fungicides like Captan or Cereson or Thiram 2g/kg of seed.

## Seasons:

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

- 1) **For rainy-autumn crop:** The seeds are sown in the month of June and July.
- 2) **For autumn-winter crop:** Seeds are sown in the month of Sep-Oct.
- 3) **For spring-summer crop:** Seeds are sown in the month of Jan-Feb.
  - In hills the seeds sowing depend upon the elevation of the place.
  - On lower hills, seeds are sown at Feb-March while on the higher hills in the months of March and April.

## Land preparation and Planting

- FYM @ 25t /ha is applied before the last ploughing.
- Neem cake @ 100 kg is applied before last ploughing.
- Raised beds of 120 cm width.



## **Nursery bed Preparation**

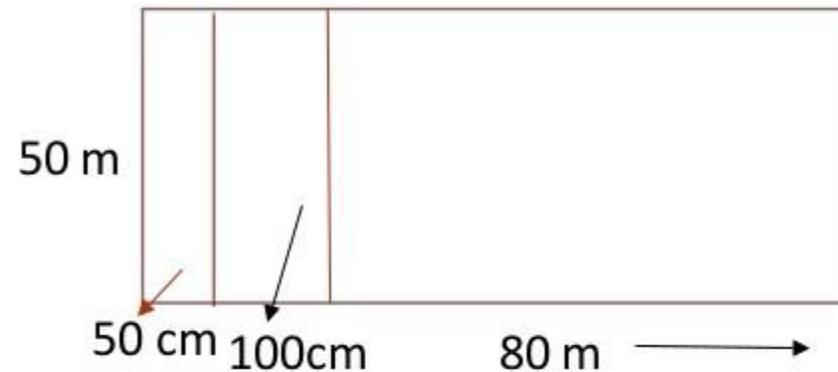
The land is first ploughed with soil turning plough followed by 4-5 ploughings with country plough or harrow.

Leveling should be done after ploughing and bring the soil into fine tilth and also provide better drainage facilities

At the time of soil preparation, raising the planting bed above ground level facilitates drainage during rainy season.



# Bed preparation



$$\begin{aligned}\text{Total no of beds} &= 80\text{m} / 1.5\text{m} \\ &= 53 \text{ beds}\end{aligned}$$

**Total length of mulch required is  $53 \times 10 \text{ m} = 530 \text{ m}$**

**1 k g mulch will cover about  $43\text{m}^2$  area**  
**total mulch required =  $530 \text{ m} / 43 \text{ m}^2 = 12.3 \text{ kg}$**

# MULCHING:

- It is used to increase the temperature,
- Suppress weed growth and
- Conserve soil moisture.



Crops	Thickness of mulch film (micron)	Increase in yield (%)
Tomato	25	45-50

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



## Quality Seedling Production

- Protected nursery
- Nursery area is covered with 50 per cent shade net
- The seedlings are raised in protrays with sterilized cocopeat
- 100 g of hybrid tomato seeds is required to produce seedlings for 1 ha
- 25 - 30 days old are ready for transplanting



## Planting materials

$$\begin{aligned}\text{Number of plants} &= \text{Area} / \text{Spacing} \\ &= 4000 \text{ m}^2 / 0.60\text{m} \times 0.45 \text{ m} \\ &= 14814.8 \text{ plants}\end{aligned}$$



## PLANTING TIME

- seedlings are ready for transplanting between 4 – 5 weeks after seeding in nursery beds. seedlings should be hardened before transplanting. This is done by withholding watering for 4-5 days so as to reduce available moisture to 20%.
- The transplanting of seedlings are done in January-February and July-august for taking two crops in a year.
- High hills -March – October.
- During winter production the plantings are done in the month of September

- Spacing : **60×45 cm** mostly under drip irrigation system for efficient use of water and fertilizers for long duration cultivation of tomato crop.
- Low pressure drip irrigation system can also be used for green house tomato cultivation.

# Irrigation

- Water requirement of crop : 600 -700mm/ha during initial crop stage (1month) - 8lt/m<sup>2</sup>.  
Thus for 1m<sup>2</sup> area = 3.7 4 plants plants/m<sup>2</sup>.  
For 4000 m<sup>2</sup> area = 14814.8 plants

Thus 2650 x 4= 10600lt/day of water is given/4000 m<sup>2</sup>.  
After 4 months , 12 lt/m<sup>2</sup> is given

## Drip method of irrigation

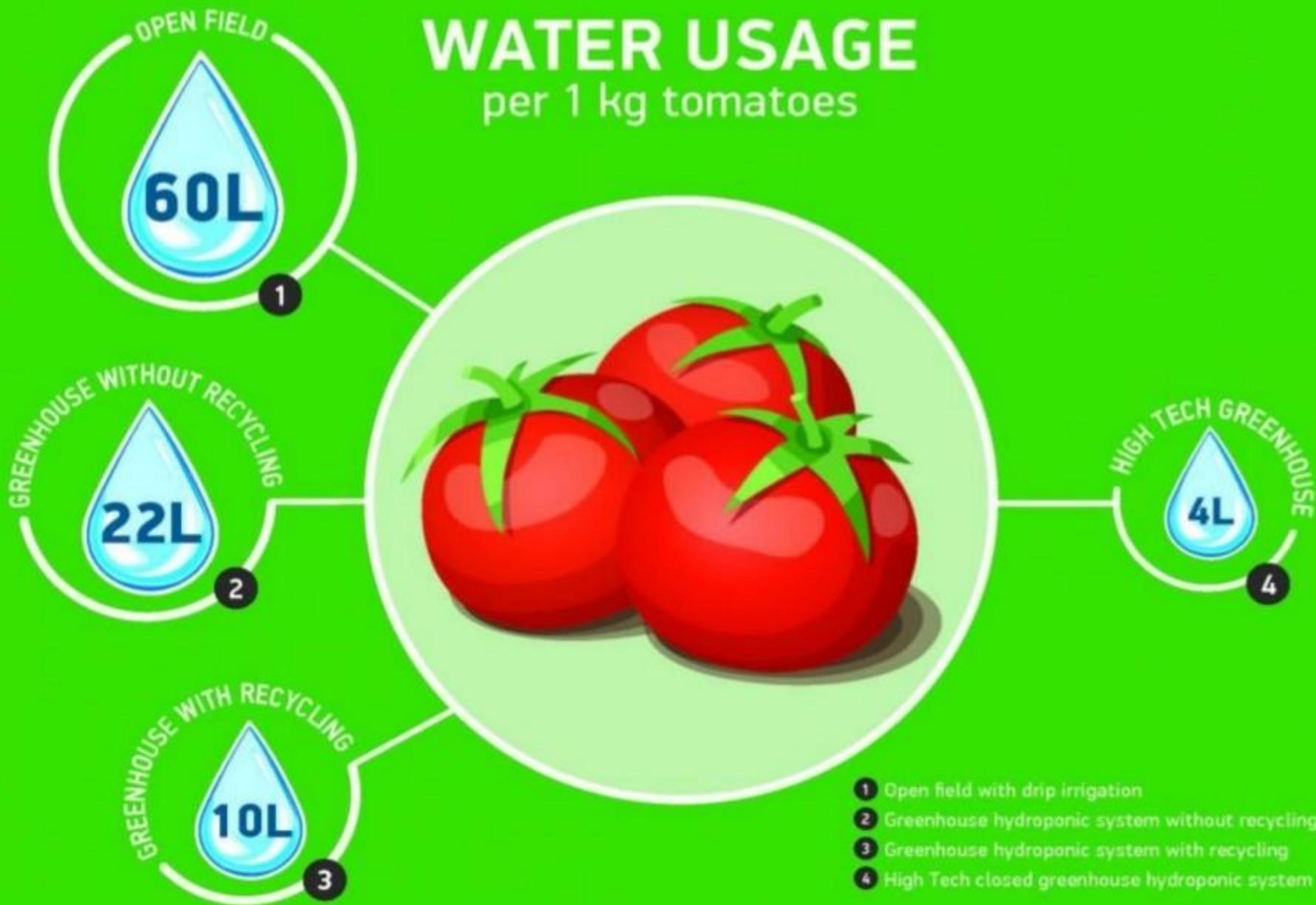
- Frequent irrigation is essential for plant growth, fruiting and yield.
- The crop should be irrigated daily.
- However during summer more irrigation is required due to higher surface evaporation.
- Drip system is highly economical and produces quality tomato.

Crops	Water saving (%)	Increase in yield (%)
Tomato	42	60



# WATER USAGE

per 1 kg tomatoes



- 1 Open field with drip irrigation
- 2 Greenhouse hydroponic system without recycling
- 3 Greenhouse hydroponic system with recycling
- 4 High Tech closed greenhouse hydroponic system

Van Kooten et al, New development in greenhouse technology can mitigate the water shortage problem in the 21st Century. Acta Hort 767, p 45-51.

## Use of growth regulators and chemicals:

<b>Chemicals</b>	<b>Common name</b>	<b>Doses(mg/litre)</b>	<b>Effective</b>
2,Chloroethyl phosponic acid	Ethephon	200-500 whole plant spray	Flowering induction, better rooting and setting of plants
2,Chloroethyl	cycocel	500-100	Flower bud, stimulate pigment formation and increase fruit set
2,4 Dichlorophenoxy acetic acid	2,4-D	2-5 seed treatment, whole plant spray	Increase fruit set, earliness and parthenocarpy
3 Indole butyric acid	IBA	50-100	Increase fruit set
3 Indole acetic acid	IAA	Foliage spray	Increase fruit size and yield
Naphalene acetic acid	NAA	Spray oil	Higher fruit set, yield
Parachlorophenoxy acetic acid	PCPA	50mg foliar spray	Higher fruit set under adverse climatic condition
6-4Hydroxy methyl 8 methyl gibberline	GA	50-100 foliar spray	Elongate shoot growth and increase fruit yield

## Cultural Practices of Tomatoes

- Weeding
- Staking (30 days after planting.)
- Training
- Desuckering
- De-leafing
- Fruit Pruning

## Weed control

The normal method of weed control is to give two hand hoeing in the first and third fortnight after transplanting and an earthing up operation during the seasonal fortnight.

The application of pre emergence herbicides like metribuzin at 0.35kg/ha, fluchloraline 1.25kg/ha controls the weed population and increases the yield of tomato.

Recently the use of pendimethalin @1.0kg/ha as pre emergence application at three days after transplanting was found very effective in suppressing the weeds.

## Staking

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

## **Training systems:**

- Single stem
- Two stem
- Three stem
- Spacing: 60 x 45 cm

**Two stem**



**Three stem**



**Training**



## Desuckering



## Truss hooks



# Pruning:

- Start pruning 30DAT
- Prune the plants to two stems by removing the lateral suckers
- Helps maintain balance between vegetative growth and fruit production
- Perform every 8-10 days



## Harvesting and Post harvest management

- Harvesting of tomato fruits is carried out either at breaker stage or at half red depending upon the market preference.
- First harvest starts at 60 days after planting.



In indeterminate cultivars ,fruits can normally be harvested 70 – 100 days after planting. While determinate cultivars may begin fruit at 70 days depending upon the environmental conditions

**1.Immature green stage:** Fruits are green but have attained the normal size. The seeds are not fully developed and not covered with jelly like substances. The fruits are harvested at this stage when they are to be transported over a long-long distance.

**2.2. Mature green stage:** the fully grown fruits with a brownish ring at stem scar, removal of calyx, light green colour at blossom end changes to yellowish green and seeds are surrounded by jelly like substances filling the seed cavity. Harvested for long distance transportation and ripen after reaching the market

**3. Turning stage (breaker stage):** 1/4th of the fruit especially at blossom end shows pink colour. These fruits are harvested for local market.

**4. Pink stage:** 3/4th of the surface shows pink colour .

**5. Hard ripe stage:** Nearly all red or pink with firm flesh

**6. Over ripe:** Fully coloured and soft. Suitable for processing and ensure desired quality and red colour in product.

# Maturity indices of tomato classified by USDA



**GREEN – STAGE 1**



**BREAKERS – STAGE 2**



**TURNING – STAGE 3**

**PINK – STAGE 4**



**LIGHT RED – STAGE 5**



**RED – STAGE 6**



# Grading

Tomato fruits are graded based on

1. Colour
2. Size
3. Degree of ripening/stage of maturity

- Pack the fruits separately according to grade before sending them to market.
- The Bureau of Indian standards has specified four grades, viz. super A, super, fancy and commercial.



## Storage

- The tomato can be stored in low temperature and evaporative cool storage.
- The best storage temperature is from 12° C to 15° C. When stored at freezing point, the fruits show low temperature injury.
- Mature green fruits can be kept for as long as 30 days at 10° C to 15° C. ripe tomatoes can be kept for 10 days at 4.5 ° C.
- The recommended relative humidity is 85-90 %per cent.
- Tomato can be stored under normal conditions for 7-10 days.

# Yield

- Generally most of the varieties are ready for first picking in 75-85 DAT.

Crop	Yield (Tonnes/Ha)	
	Open field	Green House
Tomato	50	150

(Source: Singh *et al.* 2013)

