Scientific cultivation of Tomato (*Lycipersicon esculantum*)

KRISHI VIGYAN KENDRA, LOHIT IN NAMSAI DISTRICT, ARUNACHAL PRADESH

Tomato occupies a prime position in list of protective foods since it is a rich source of minerals like calcium (48 mg / 100g), sodium (12.9 mg), trace elements, copper (0.19 mg), vitamins like vitamin A (900 IU), vitamin C (27 mg), vitamin B complex (thiamine), essential amino acids and healthy organic acids like citric, formic and acetic acids. The attractive red colour of fruit is due to lycopene and yellow colour is due to carotenes. Peculiar flavour of tomato is due to presence of ethanol, acetaldehyde and a number of volatile flavour components found in fruit. Different forms of tomatine, a steroidal glycoalkaloid, are identified from various parts of plant. Tomato is a good appetizer and its soup is a good remedy for preventing constipation.

Varieties

Quiet a large number of varieties differing in their climatic requirements, growth habit, fruit quality, resistance to pest and diseases are developed for specific purposes like fresh market, processing, long distance transport etc. A brief description of important varieties are given below:

Variety	Special features
Avinash	Semi determinate. Fruits firm, round and nipple tipped.
RCT-9 (ICAR, Imphal West)	Determinate, Fruits medium large, oblate Tolerant to leaf curl viruse. tolerant to moisture stress condition.
RCT-11 (ICAR, Imphal West)	Semi-determinate, resistant to fruit cracking, good transport quality. Fruits round firm with nipple tipped.
Arka Alok (BWR 5)	Bacterial wilt resistant, determinate. Fruits square and oblong.
Pusa Early Dwarf	Determinate, Fruits flat oblate.
Sioux	Indeterminate. Fruits small and round

Pusa Uphar	Determinate. Fruits round with thick pericarp, suitable for processing.
Pusa Ruby	Indeterminate. Fruits flat round and suitable for processing.
Pusa Sadhabahar	Suitable for high and low temperature regimes.
La Bonita	Determinate, Fruits oblong with thick pericarp, suitable for long distance transport.
Mu kthi (LE 79.5)	Bacterial wilt resistant, semi determinate. Fruits round to flat round.
Pant Bahar	Resistant to Verticillium wilt and Fusarium wilt. Indeterminate. Fruits flat round and suitable for processing and storage.
Hisar Anmol	Resistant of leaf curl, determinate. Fruits flat round, medium size.
Narendra Tomato 2	Determinate, suitable for transport and processing. Resistant to nematode
VC 48-1 (AAU, Jorhat)	Bacterial wilt resistant, determinate fruits pear shaped and clustered.

Climate

Tomato is a day neutral warm season crop, which cannot tolerate frost. Cool and dry weather is preferred by the crop and optimum temperature is 21-28^{0}C during day and 15-20^{0}C during night. Night temperature is more critical than day temperature. High temperature results in exerted stigma, dryness of stigma, burning of anther tip, poor pollen dehiscence, low pollen viability and slow pollen tube growth leading to low pollination and fruit set. Incidence of viral diseases also will be more at high temperature. Optimum temperature for colour development of fruit is 21-24^{0}C. Development of colouring pigment, lycopene will be hampered above 27^{0}C Seed germination and pollen germination are adversely effected below 10 Based on night temperature requirement for fruit set, tomato varieties are classified into three.

a) Normal set varieties: Set fruits at 15-20^0 C.

b) Hot set varieties: Set fruits above 20^0 C – eg : Philipine, Punjab Tropic, Pusa hybrid 1.

c) Cold set varieties: Set fruits below 15^0 C – eg : Pusa Sheetal, Avilanche.

Tomato cannot withstand water logging. Hence well drained fairly fertile soil rich in organic matter is preferred. It is moderately tolerant to acid soil having pH 5.5 and ideal pH requirement is 6-7^0 C.Sowing time and seed rate.Under mild climatic conditions, where there is no danger of frost, three crops can be raised in a year. In the hills, seeds are usually sown in March-April. In plains is grown during June to November. Under Kerala condition, seeds are sown in September and transplanted in October.

Seed rate

Open pollinated var iety: 400-500 g / ha

Indeterminate F2 hybrid: 125-175 g / ha.

Seeds are sown in an area of 200-240 m^2 will be sufficient to plant one hectare. Four to five weeks old seedlings are used for transplanting. Hardening of seedling is essential for their establishment in main field and is done by withholding irr igation for one week before transplanting, adding NaCl (400 ppm) to irrigation water or by spray of cycocel (200 ppm) and Zinc Sulphate (0.25%) + 25 ppm proline at time of transplanting.

Main field preparation and transplantingSeedlings are transplanted on raised beds or on sides of ridges. Field is ploughed 4-5 times and raised beds of 80-90 cm width or ridges and furrows are prepar ed. Spacing depends on the growth habit (determinate, indeterminate or semi determinate) of variety and var ious spacing followed are 60 x 30-45cm, 75 x 60cm and 75 x 75 cm. Usually closer spacing results in early and higher yield, but it may effect size of fruits.

Manures and fertilizers

Manure and fertilizer recommendation for tomato depends on the growth habit and productivity of variety and it var ies from state to state. In most of states, in addition to 15-20 tonnes of FYM, , N-100-125 kg, P_2O_5-50-60 kg, and K_2O 50-60 kg are recommended for one hectare.FYM should be incorporated in soil at the time of final ploughing. 1/3 N, Full P and K may be applied as basal dose either just before transplanting or 5-10 days after transplanting. Remaining 2/3 N is applied 20 and 45 days there after. Additional dose of 10 kg borax and 5 kg Zinc Sulphate, as basal dose, are also recommended for correcting fruit cracking and to increase yield and fruit quality.

Application of fertilizer in Arunachal Pradesh:

Apply FYM 25 t/ha, N 25 kg, P 80 kg, K 80 kg, Borax 10 kg and Zinc sulphate 50 kg/ha as basal dose and 75 kg N/ha on 30 day of planting during earthing up. Spray 1 ppm (1 mg in one lit) NAA (Planofix), 15 days after transplanting and at full bloom stage to increase the yield.

Irrigation

Furrow irrigation is the most common method in tomato and the crop require adequate moisture throughout growth period. Frequency of irrigation depends on the climatic and soil conditions. During summer, crop should be irrigated at 3-4 days interval. Water stress at flowering stage will adversely effect fruiting and productivity. A long spell of drought followed by heavy irrigation leads to cracking of fruits. Similarly a dry spell after regular irrigation causes blossom end rot. Drip irrigation and sprinkler irrigation are becoming more common in areas of water shortage.

Intercultural Operation

Field should be kept weed free by frequent weeding, hoeing and earthing up. Application of pendimethalin (1.0 kg a.i. / ha) as pre emergence spray along with one hand weeding at 45 DT is ideal for tomato variety Pusa Ruby. Oxyfluorfen (0.25 kg a.i. / ha) Goal (0.25 kg a.i./ha) and Basalin (1.0 kg a.i. / ha) were also ideal as pre emergence application. Mulching with straw or plastic is also effective for weed control and for regulating soil temperature.

Training and pruning

All indeterminate varieties are trained with wires, strings or stacks to prevent lodging and loss of fruits by coming in contact with soil. It is done by providing individual stack or by erecting 2-2.5 m long poles on either side of ridges for stretching G1 wire. Branches of plants are supported on poles or strings with twine. Pruning is also generally followed in indeterminate varieties to improve size, shape and quality of fruits. It is removal of unwanted shoots to enhance vigor of plants.

FLD on Tomato var.RCT-9

Harvesting

Crop starts yielding by 70 days after planting. Usually fruits are harvested with hand by a gentle twist so that the stalk is retained on plant. Intervals of harvests depend on season and it is twice in a week dur ing summer and weekly during winter and rainy days. Harvesting maturity depends on the pur pose whether for fresh market, processing, long distance transport etc. Following maturity standards are recognized in tomato:

• Mature green: Fruits fully grown, fruit colour changes from green to yellowish and cavity filled with seeds surrounded by gelly like substance. Harvested for long distance market.

• Turning or breaker stage: Fruits firm, 1/4t portion of fruit changes to pink in colour, but the shoulder still yellowish green. Harvested for long distance market.

• Pink stage: 3/4t of whole fruit surface turns pink colour. Harvested for local market.

• Light red: Entire fruit surface is red or pink but the flesh is firm. Harvested for local market.

• Red ripe or hand ripe: Fully ripened and coloured. Flesh becomes soft. Harvested for processing and for seed extraction.

Yield

Open pollinated var ieties : 20-25 t/ha.

F1 hybrids : 50 t/ha.

Grading storage and marketing

Fruits after harvesting are graded and packed in bamboo baskets or wooden boxes. Four grades specified by Bureau of Indian Standards are Super A, Super, Fancy and Commercial. Since tomato is a climatic fruit, good care should be taken to remove bruised, cracked and damaged fruits before packing in baskets. Though tomato can be stored at low temperature, commercially it is not stored in cold storages in the country due to practical reasons. Fruits can be stored for-two weeks and four weeks at 10-13^0 C when harvested at red stage and green stage respectively. Pre-cooling of fruits before storage and transportation enhances storage life.

Processing tomatoes

Use of tomato for processing is increasing day by day and a variety of products like puree, paste, syrup, juice, ketchup etc are made. Varieties for processing should have following qualities.

• Deep red colour which retains even after processing.

• Low pH – The acidity of fruits affect-heating time required for sterilization of processed product. Longer time is required if pH is high and hence a pH below 4-5 is required for processing.

• High TSS – Fruits with high TSS yield more finished products / tonne of r aw fruits and hence minimum TSS should be 4.5^0B

• High viscosity and consistency

• Firm and easy peeling

• Pericarp thickness-should be more than0.5 cm.

• Crack resistance

• Fruits size should be above 50 g and oblong in shape

Varieties like Pusa Gaurav, Roma, Punjab Chuhara, Pusa Uphar, Arka Saurabh are specially suited for processing.

Physiological disorders

1.Fruit cracking

Fruit cracking is caused both by genetic and environmental factors. Following four types of cracking are noticed tomato.

• Radial Cracking: Usually seen at ripe stage and crack radiate from pedicel end to stylar end.

• Concentric cracking: Seen around shoulder of fruit even at green stage.

• Cuticular: Seen on outer skin of fruit.

• Burst: Burst occurs at certain points on shoulder of fruit.

Factors

Boron deficiency is one of the causes of cracking in Tomato fruit.A long spell of drought followed by sudden heavy irrigation may cause cracking. Wide variation in day and night temperatures and high humidity also cause fruit cracking.

Suggestions

Irrigate the crop lightly at proper intervals to maintain proper moiyure in the field. Soil application of 10-20 kg of borax/ha during soil preparation.

2.Blossom Red Rot:

Water soaked spots of one cm or more appear at point of attachment of petals and effected portion becomes sunken, leathery and dar k coloured. This is mainly due to reduced soil moisture supply and high rate of respiration at the time of fruit development. Deficiency of calcium also causes this disorder. Balanced irrigation, cultural practices to conserve soil moisture and spraying of 0.5% calcium chloride at fruit development stage are recommended for control of blossom end rot.

3.Sun scald

Due to extreme heat, tissues on exposed fruit develop a blistered appearance leading to sunken areas, which have a light or grey colour on green fruit and yellow colour on red fruit. In varieties with heavy foliage, fruits are shaded and incidence of sun scald is less.

4. Vascular browning

When the stem is cut from the centre the vascular portion of the affected plants looks brown in colour and tissue is killed at a later stage. It is caused deu to the magnesium deficiency. It can be corrected by using 1.5% Magnesium Sulfate as foliar spray at the time when the symptom appears.

Insect Pests:

1. Tomato fruit borer (*Helicoverpa armigera*)

Symptoms:

The larvae causes damage to flowers and bore into fruit. Often, large entry holes in the fruit are evidence and extensive rotting occurs.

Control measures:

- Shaking of the plants.

- Ploughing upto depth of 10 cm before the end of augus[redacted]t reduces the survival of over wintering pupae and reduces the starting population.
- Spraying of dimethaote @ 1.5ml/litre of water.

2. Brinjal stem borer (*Euzophera particella*)

Symptoms:

Damage is caused by caterpillars which feed only on the stem and the affected plants could be seen withering.

Control measures:

- Withered plants should be uprotted and destroyed by burning.
- Frequent spraying of dimethoate (rogor/anugor/tufgor) @ 1.5ml/l of water.

3. Aphid (*Myzus persicae, Aphis* spp.)

Symptoms:

Yellowish and black mould appear in leaves.

Control measures:

Apply phorate @ 1 kg/hac as application/earthing up followed by one spray of Rogor 750ml/hac/750lit.of water.

4. Cut worm (*Agrotis segetum, Agrotis ipsilon*)

Symptoms:

Cutting young plants, holes in tubers

Control measures:

- Sort out cut worm damage tubers to avoid secondary infection in the stores.

- Use Chlorpyriphos 20 EC @ 500g/ha against cut worms.

.

Diseases

1. Early blight (*Phytophthora infestans*)

Symptoms:

Brown spots scattered over the lamina surface, concentric narrow dark lines and affected leaves dry.

Control measures:

- Plant disease free whole tubers.
- Follow crop rotation with non solanaceous crop like Mustrad, cabbage, cauliflower etc.
- Seed treatment with Mancozeb for 20 minutes before storages for soil and tuber borne diseases.
- Apply Mancozeb 75% WP @ 2.5g/liters of water

2. Late blight (*Phytophthora infestans*)

Symptoms:

Decaying leaves often emit an offensive odour. Under ground tubers decay before harvesting.

Control measures:

- Plant disease free whole tubers
- Follow crop rotation with non solanaceous crop like Mustrad, cabbage, cauliflower etc.
- Seed treatment with Mancozeb for 20 minutes before storages for soil and tuber borne diseases.
- Apply 4 to 5 times with Dithane Z-78 or Indofil M-45 @ 2.5g/liters of water and Ridomil MZ-72 @ 2.5g/liters at 15 days interval spraying just after appearance of first symptom. Interval reduces to 7 days depending upon weather condition. Strickers like Triton or Sandovit.

3. Bacterial wilt (*Ralstonia solanacearun*)

Symptoms:

Sudden wilting of the plant, plant show droopy appearance and the branches gradually turn bronzy and die.

Control measures:

- Follow crop rotation with non solanaceous crop like Mustrad, cabbage, cauliflower etc.
- Seed treatment with Mancozeb for 20 minutes before storages for soil and tuber borne diseases.
- Apply stable bleaching powder@ 12 kg/ha in soil at planting.
- 1g hin + 5g turmeric powder treated with soil/plant
- Treated soil of infected plant of 1m radius just after harvest with 10% formalin.

4. Bacterial canker (Caused by *Bacterium clavibacter michiganense* pv. *Michiganense)*

Symptoms:

Raised corky spots on fruit, dead leaflets on one side of leaf and bark peels easily from stem.

Control measures:

- Used disease free seed.
- Prepare ground early so there are no undecomposed plant residues.
- Avoid handling of affected plant.

5. Anthracnose (*Colletotrichum spp.*)

Symptoms:

These fungal diseases cause the development of dark, sunken spots or lesions, often with a raised rim, on affected falling of leaves, stem and fruit.

Control measures:

- **Pre-harvest treatment:** Spraying of

fungicides such as mancozeb from flowering to fruit set. Control of fruit damaging insect such as fruit fly.

- **Post-harvest treatment:** Treat fruit after harvest. Handle fruit carefully to avoid damage.

6. Tomato leaf curl virus

Symptoms

Leaflet rolling upwards, leathery, brittle and produce ratting sound when brushed with hand. Tuber size small and reduce number.

Control measures:

- Spray Rogor 1ml/litre of water.
- Apply Thimet 10G 20kg/hac be used along with fertilizer at the time of planting.

7. Spotted virus wilt virus (TMSV)

Symptoms:

Fruits cause ringspots, mottling, chlorotic botches and line patterns on leaves. Both leaves and fruits are distorted with dark spots or ring patterns on fruit. Wilting & purpling of leaves and necrotic lesion can develop on stems.

Control measures:

- Virus free seed.
- Uproot of infected crops.
- Removal of weed as a alternate source.
- Spraying of insecticides for control of thrips.
- Use of healthy planting materials.