

Post-Harvest Management Protocols

TOMATO

Tomato (*Solanum lycopersicum* L.) is one of the most important horticultural crop plants and a well-established model system for fleshy fruits, fruit development, and ripening. Tomatoes are a great source of phytonutrients, including vitamins, carotenoids, and polyphenols, and are consumed fresh as well as in many cooked and processed products.

Tomato is widely grown vegetables both for fresh market and processing. Being highly perishable it is essential to maintain a continuous supply to avoid glut or scarcity, price fluctuations, losses to the farmers and hardship to the consumers. Selection of suitable variety is important for production of fruits with longer storage life and better quality.

In Tomato, ethylene triggers the onset of the ripening process, and ethylene is also required for normal, full fruit. During fruit ripening, tomatoes undergo dramatic changes in color, texture, flavor, and aroma. Commercially, tomatoes destined for the fresh market are picked at different ripening stages, depending on the proximity between production and marketplace, and vary from green and firm to almost ripe for local markets. Long-distance transportation of tomatoes involves storage at low temperatures to limit post-harvest losses and to extend shelf life.

MATURITY INDICES

The minimum maturity for tomatoes intended for cold storage is "Mature green 2" when the seeds are not cut and when the fruit is sliced, and there is jelly in at least one locule. Better flavor and overall quality can be obtained by harvesting at the mature green. Tomato is ready for harvesting 73 – 75 days from planting, depending on the variety. There are several reliable external and internal indices of tomato fruit maturity. The external fruit maturity index is based on skin color, while



the internal indices are based on seed development and locular gel formation. However, the most widely used index of tomato maturity is the skin colour. Fresh, well formed, firm with smooth/shiny surface, oval shape and 45 to 75mm diameter is also a sign of maturity.

STAGES OF HARVESTING

Harvesting of tomatoes is done depending on the purpose to which the fruits are to be used. The different stages of harvesting are as follows-

Mature dark green colour

Harvest the fruit at mature dark green stage for distant market. Spray the fruits with ethylene 48 hours prior to shipping. Skin is not readily scraped off with fingernail. Cross section of the fruit will show formation of locules with jelly like substance, the seeds are not cut and slip away from knife. Fruits for long distance shipment are picked at this stage and ripened after reaching the market.

Breaker Stage

Break in colour from green to yellow with pink or red skin covering observed on $\frac{1}{4}$ part of the fruit. Fruits are harvested at this stage to ensure the best quality. Such fruit are less prone to damage during shipment and fetch a higher price.

Turning Stage

10 to 30 per cent of the surface in the aggregate shows a definite change in colour from green to tarnish yellow, pink, red or a combination thereof.

Pink Stage

Pink colour observed on $\frac{3}{4}$ part of the fruit

Reddish Pink

Fruits are stiff and nearly whole fruit turns reddish pink. Fruits for local sale are harvested at this stage. About 60-90% of the surface in aggregate shows pinkish red or red colour.

Fully Ripe

Fruits are fully ripened and soft having dark red colour. Harvest the fruits at this stage for processing.

As a safety precaution tomato harvest should not be done during rains and the storage area must be kept dry to avoid insect infestation.



GRADING

- The main fruit characteristics used to grade tomatoes are size, color, shape, appearance, and firmness.
- Tomatoes should be separated into small, medium, and large sizes.
- The fruit should have a smooth, shiny external appearance, with small blossom- end and stem-end scars.
- Finally, the fruit should be firm enough to withstand transport and distribution to market.

WASHING

Washing in clean water is essential to remove dirt and foreign materials. The water may be chlorinated, and the chlorine level (100 ppm) should be checked frequently. Washed fruits are rinsed in clean water and air dried to remove the adhering excess surface water.

PACKAGING

- The type of container used for packing tomatoes depends on the market destination.
- Tomatoes sold in the domestic market are packed in a diversity of container types. However, they should be well-ventilated, strong, and capable of being stacked without damaging the fruit. They should not be over-stuffed.
- For local markets fruits are packed in padded bamboo baskets or plastic food grade crates while wooden containers are used for long distance transport. Sufficient care should be taken to ensure that bruises and other damages are not caused to the fruits during packaging. Plastic crates can be stacked conveniently with minimum damage to the fruits. The fruits may be packed in 7 ply rating ventilated CFB boxes of 10 Kg. capacity, with the dimension of 300 x 250 and 300mm.
- Layer wise packing by use of paper is done to induce heat for ripening of tomato during transportation for long distance. It also protects from damage and bruises which may rupture the fruit. Any damage of tomato simply induces fungal infection and rotting which starts damaging other tomatoes in the box. Green and breaker stage tomatoes are put in bottom of crate and with color maturity more colored tomato are placed in top layers.

- Improper packaging can be a major source of post harvest loss. Sized and graded mature-green tomatoes destined for export are typically packed loose in strong well-ventilated fibreboard cartons containing a net weight of 11 kg. Precautions during packing.
- Containers should not be filled either too loosely or too tightly because loose products may vibrate against each other and cause bruising.
- Over-packing results in compression bruising.
- Soft and over-ripe fruits should not be packed for market, as they will bruise easily and not tolerate transport and handling without suffering high amounts of postharvest losses.

CUSHIONING MATERIALS

- Cushioning materials like dry grass, paddy straw, leaves, saw dust, paper shreds etc are used for packaging.
- It should dissipate the heat of respiration of the produce
- It should be free from infection and should be physiologically inactive
- Moulded pulp tray, honeycomb portion, cell pack are used replacing the cushioning material

STORAGE

Tomato fruits harvested at breaker stage can be stored for 10 to 12 days at room temperature. The storage life can be extended to 4 to 5 weeks by storing at 12 to 13°C depending upon the maturity stage at which the fruits are harvested. In cold chain method where the temperature is maintained at 12-13°C from harvest to consumption the storage life can be extended up to 6 weeks. The storage temperature has to be raised to 20°C one week before marketing as this temperature is optimum for the development of colour (lycopene) development and ripening. The fruits intended for low temperature storage can be pre-cooled to 12°C using forced air precooler maintained at 12°C and 90-95% RH. Maintaining precooler temperature at 5°C and 90-95% RH reduces the precooling time without causing chilling injury.

Tomatoes are stored in baskets in which the fruits are piled with alternate layers of charcoal and left undisturbed for six months. Plants with unripe tomatoes are hung in a shady place upside down and they will keep fresh thus for up to three months. Ethylene supposed to move more slowly when tomatoes are inverted. Some farmers preserve tomatoes by keeping them in a cool sand bed. They can thus delay selling the tomatoes by 30-45 days and get a better price for them.

Recommended storage temperature for different maturity stages of tomato

Maturity stage	Storage temperature (°C), R.H. (90-95 %)	Storage life (days)
Mature green	12-14 °C	30-35
Breaker-turning	12-13°C	28-30
Pink-light red	10-12°C	10-14
Firm ripe	7-10°C	4-5

Freshness facts

Optimum Carrying Temperature

12°C to 15°C
(mature green)

0°C to 12°C (turning)

8°C to 10°C (ripe)



Optimum Humidity (in %)

90



Storage Life

1 to 2 Weeks
(mature green/turning)

1 Week (ripe)

3 Days @ Ambient Temperature



Highest freezing point	-0,5°C
Acceptable product temp. at loading into containers	Max. 2°C above carrying temperature
Ventilation setting for containers	25 m³/hr
Climacteric / non-climacteric	Climacteric
Ethylene production	Very low
Ethylene sensitivity	High
Modified / controlled atmosphere	3%-5% O₂; 2%-3% CO₂ (see text)
Potential benefits	Reduced O ₂ ; reduced ripening, respiration, and ethylene production. Increased CO ₂ ; delayed ripening