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## **STRAWBERRY CULTIVATION**

### **INTRODUCTION**

Strawberry is a member of the Rose family (Rosaceae, genus *Fragaria*). It is a native of temperate regions, but varieties are available which can be cultivated in sub-tropical climate. In India, it is cultivated in areas like Mahabaleshwar, Ooty, Wyanad, Idukki, Punjab, Haryana, Himachal Pradesh and N-E states of India. This crop is generally cultivated in the open but, to tap the off-season market that fetches premium price, the crop can be cultivated in the greenhouse. The plant is a herbaceous perennial, but cultivated as an annual.

The Strawberry plant has a short, thickened stem (called a “crown”) which has a growing point at the upper end and which forms roots at its base. Botanically, Strawberry is an “aggregate” fruit, rich in vitamin ‘C’, Iron, Potassium and fiber.

Strawberry has also been credited as having cancer-fighting compounds. For hundreds of years, homeopathy practitioners have incorporated Strawberry plants and fruits in the treatment of anaemia, diabetes, kidney and liver complaints. Strawberry preserves and jellies are widely used worldwide.

### **SOIL REQUIREMENT**

Strawberry is adaptable to a wide range of soil types. They perform best on well-drained sandy loams (at least 12 inches deep). Most loam soils provide good results if drainage is adequate. Heavy soils encourage the development of roots in the top 12 inches of soil. Soil with pH between 5.5 - 7 and EC of < 0.7mS/cm is ideal for growth. Planting site with slopes of 2% provide drainage without greatly increasing soil erosion.

Many strawberry varieties are susceptible to *Verticillium* wilt. This fungal disease can persist in the soil for many years. *Verticillium* is common on Potatoes, Tomatoes, Eggplants, Raspberries, Blackberries, Gooseberries, Cherries and other stone fruits. Hence, avoid planting Strawberries where these crops have been grown in the past five years.

### **GENERAL STERILIZATION OF SOIL**

Before plantation of Strawberry, sterilization of soil is absolutely necessary. In particular, the fungus *Phytophthora* is a menace to Strawberry. The various methods of sterilization are:

- 1. Sun:** Cover the soil with plastic for 6-8 weeks. Sun-rays will heat up the soil, which will kill most fungi.
- 2. Chemical:** Hydrogen Peroxide (H<sub>2</sub>O<sub>2</sub>) with Silver.

### **STEPS IN STERILIZATION PROCEDURE**

1. Two days prior to soil sterilization, the beds should be made adequately wet. This wetness ensures that the soil micro-organisms, nematodes, etc, will get activated, thus effectively get controlled when the sterilant is added into the soil.

- On the day of sterilization, ensure that the beds are in 'wapsa' condition. This is a mandatory pre-sterilization step, to ensure that the chemical percolates effectively upon application, in addition to helping in judicious use of the chemical.
- Mix the chemical with water @ 7 ml / lit, in case of a 50 % solution. The dilution factor depends on the concentration of solution. Normally, 105 lit of the sterilant are dissolved in 15,000 lit. water which is sufficient to effectively sterilize 1 acre greenhouse.
- Out of this 15,105 liters of dissolved sterilant, take half the quantity of the solution (approx 7500 lit) and administer it through drip and the remaining half should be administered using a shower. This will ensure uniform distribution of the sterilant into the beds, upto the depth. Approximately 3 - 5 lit / m<sup>2</sup> of this solution is required, to reach the depth of the bed.
- A waiting period of 6 - 7 hours needs to be given for the chemical to act upon, after which planting can be carried out.

#### Advantages of Hydrogen Peroxide with Silver:

- Very easy and safe to use without any hazardous effect on human health.
- Economical.
- Eco-friendly and does not have any phyto-toxic effects on plants.
- Plantation can be carried out after 4 to 6 hours after sterilization.
- Destroys almost any fungal, bacterial and viral presence as well as larva and eggs of the insects in soil.
- Stable in wide range of temperature and pH.

#### CLIMATE

Strawberry is classified according to response of variety to photo-period. There are two primary types of Strawberry now grown commercially; day-neutral and short-day plants. Long-day ('ever-bearing') plants are also available, but they are rarely grown outside of home garden. Short-day types are actually facultative short-day plants and initiate flower bud either under short-day conditions (less than 14 hrs of day length) or when temperature is less than 15°C. The critical photo-period for floral induction is 8-12 hrs depending on the varieties. Long-day plants typically initiate their flower buds when day-length is greater than 12 hrs and temperatures are moderate. Photo-period has a profound effect on Strawberry flowering while light intensity exerts a lesser effect. Day-Neutral (DN) plants are relatively insensitive to day-length.

Strawberry thrives best in temperate climate. It is a short-day plant which requires exposure to about 10 days of less than 8 hours sunshine for initiation of flowering. The temperature requirement for most of Strawberry genotypes ranges from 15 to 25°C. The ideal temperature for flower bud initiation ranges from 14 - 18°C. In general temperatures above 28°C initiate flower bud in all commercial Strawberry varieties.

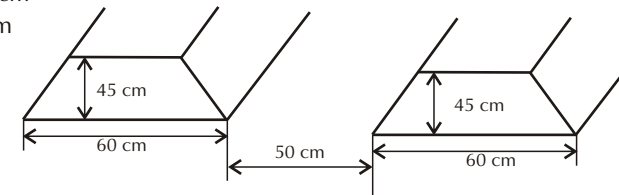
Soil temperature of less than 25°C increases reproductive development and reduces vegetative growth.

#### BED PREPARATION

Plants are grown on raised beds.

##### Two-row system:

Bed width: 60 cm  
Pathway: 50 cm  
Height: 45 cm



#### BASAL DOSE

F.Y.M. → 10 tones/acre

18:46:0 (Di-Ammonium Phosphate - D.A.P.) → 50 kg/acre

#### MULCHING

It is ideal if mulching is carried out before plantation. However, in some cases, mulching is carried out 30 days after, or immediately after planting. Black and silver, double-colored polyethylene mulching film is used. The outer surface of the film is silver colored. The primary use of plastic mulch is to regulate soil temperature, in addition to protecting the roots from cold injury. Other advantages of mulching include: reduced fruit decay, clean fruits, soil moisture conservation, saving irrigation water, preventing weed growth and lowering soil temperature during hot weather and protecting flower from frost.

#### IRRIGATION

Strawberry generally requires irrigation for optimum growth and yield. Drip irrigation is the dominant mode of water application used commercially.

In drip system, 1 - 2 lateral lines of 16 mm, with dripper at every 30 cm and having discharge of 2 or 4 lph. Strawberry, being a relatively shallow-rooted plant, is highly susceptible to drought. Hence always maintain optimum soil moisture level (field capacity).

#### PLANTING

There are different seasons in different areas of plantation:

**North India:** September to January.

**North East:** November to January.

**South India:** November to January and July to August.

**Maharashtra:** August to November.

#### PLANT SPACING

Planting is carried out in 2 rows with spacing of 30 cm x 30 cm

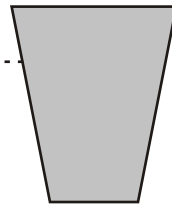
#### PLANT POPULATION/ACRE

24,000 plants

## PLANTING AND AFTER-CARE

Plants are transplanted manually. The rooted plant plugs are planted into the holes made in the bed. While planting, care should be taken that the crown portion of the plant should not come in contact with the soil. 1/3rd portion of plant should be above the soil. After planting, irrigate the bed using rose can or sprinkler. Bed should be moist, hence showering at regular intervals is required. Post-planting should be followed by a 21 day schedule which essentially include rooting and plant protection chemicals.

25 per cent above the soil level  
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75 per cent under the soil level



## PLANT LIFECYCLE

The total life of the crop is for 8 - 9 months. After planting, if the conditions are appropriate for the desired growth of the plant, the plant will start flowering approximately 35 - 40 after planting.

## FERTIGATION IN STRAWBERRY: For 1000 m<sup>2</sup>

### 20-50 days after plantation.

- 12:61:00 – 1 kg (Monday, Wednesday & Friday)
- 13:00:45 – 1 kg (Tuesday, Thursday & Saturday)

### 50-60 days after plantation.

- 19:19:19 – 1 kg (Monday, Wednesday & Friday)
- CaNO<sub>3</sub> – 0.5 Kg (Tuesday, Thursday & Saturday)

### 60-100 days after plantation.

- 16:08:24 – 375 gms (Monday, Wednesday & Friday)
- 0:0:50 – 375 gms (Tuesday, Thursday & Saturday)
- Fertilon Combi – 25 gm/1000 lit of water. (once a week)

## SPRAY AND DRENCH SCHEDULE

- Silixol spray @ 1 ml/lit. (once in 15 days). This is a silicon source.
- Stim rich spray @ 1 ml / lit. (once in 15 days). Stim rich is a plant growth promoter.
- Spintor @ 0.4 ml / lit (once in 10 days). This is a preventive spray against thrips.
- 13: 40:13 drench @ 1 gm / lit. or 12:61:0 drench @ 1 gm / lit. This drench is carried out if the temperature is too low and phosphorus deficiency is observed.
- Topsin-M drench @ 1.5 gm/lit. (once in 10 days)

## HARVESTING AND YIELD

Strawberries are generally harvested when 1/2 to 3/4th of fruit portion attains natural crimson colour. Depending on the weather conditions, picking is usually done on every second or third day usually during the morning hours. Strawberries are harvested in small trays or baskets. They should be kept in a shady place to avoid damage due to excessive heat in the open field.

The average yield obtained if the plant management and climatic conditions are conducive is approximately 500 - 600 gm/plant/season.

## POST-HARVEST MANAGEMENT

Fruits are graded on the basis of their weight, size and color.

Grade	Weight (gm)
Jumbo	> 35
First	25 to 35
Second	15 to 25
Third	< 15

## STORAGE

For distant marketing, Strawberries should be pre-cooled at 1°C within 2 hours, of harvesting and kept at the same temperature. After pre-cooling, they are shipped in refrigerated vans.

## PACKING

Packing is done according to the grades for long distance markets. Fruits of good quality are packed in perforated cardboard cartons with paper cuttings as cushioning material. Fruits of lower grades are packed in baskets. Food grade plastic punnet is popular for packing. Capacity of each punnet is 250 gms and shape of punnet is usually square or oval. Such 8 punnets are packed in corrugated tray having capacity of 2 kg. For longer distance, such 7 trays are put into corrugated box known as 'Outer' which weighs around 14 kg.

## TRANSPORTATION

Road transport by trucks/lorries is the most convenient mode of transport due to accessibility to the market. Refrigerated vans can also be used for better shelf life of fruit. Air transport also is being used for quicker delivery.

## MARKETING

Majority of the growers sell their produce either through trade agents at village level or commission agents at the market in metro cities.

## MARKET OPPORTUNITY IN THE OFF SEASON

To tap the market opportunity during off seasons, Strawberry can be cultivated in greenhouses. The temperature and humidity conditions required can be created by timely operation of foggers, top shade nets, etc. In Strawberry greenhouse, the sides of the greenhouse should be fully opened. No side nets

are installed in the greenhouse. The rest of the greenhouse specifications remain unchanged.

## INSECT PEST

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### 1. Flower Thrips: *Frankliniella occidentalis*:

Symptoms:

- Necrotic flecking or bronzing of the seeds and fruits, especially beneath the calyx.
- The entire fruit may become bronzed and cracked.
- Seeds are prominent.

### 2. Spider Mites: *Tetranychus urticae*

Symptoms:

- Adults deposit eggs on the underside of the leaves and feeding damage appears as yellow patches on the leaf.
- Presence of webbing on flowers and fruits.

### 3. Cyclamen Mite: *Phytonemus pallidus*

Symptoms:

- Leaves heavily infested with cyclamen mites become severely stunted and crinkled.
- Feeding on flowers can cause them to wither and die.
- Fruit on infested plants is dwarfed, and the seeds stand out on the flesh of the berry.

### 4. Strawberry Leaf Roller: *Ancylis comptana*

Symptoms:

- Early hatching larvae; may burrow into the buds and damage the developing flowers resulting in deformed fruits.

### 5. Cut Worms: *Agrotis ipsilon*

Symptoms:

- Cut irregular holes on the foliage.
- Destroy emerging leaves at the crown portion.
- Make holes in the berries.

## DISEASES

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### 1. Botrytis: Gray mold (*Botrytis cinerea*)

Symptoms & Pre-disposing factors:

- Infection on petals, stalk, fruit caps and the fruit.
- Fruit infection appears as soft with light brown patches on the fruit.
- The infected berries dry up and remain on the plant.
- Damp and rainy weather are the pre-disposing factors.
- Improve air flow in the canopy, by maintaining correct spacing and removing lower old and dried-up leaves.

### 2. Anthracnose: (*Colletotrichum acutatum*)

Symptoms & Pre-disposing factors:

- Lesions first appear as small, dark spots on stolons and petioles.
- Lesions enlarge to become dark, elongated, dry; sunken lesions which often girdle the stem.
- Warm and high humid conditions are pre-disposing factors.

### 3. Crown Rot/Leather Rot: (*Phytophthora cactorum*)

Symptoms & Pre-disposing factors:

- Initial symptoms include stunting of plants and wilting of foliage.
- In advanced stages, the plants collapse and the crown turns into deep dark red color.
- Disease is favoured by ill-drained soils.

### 4. Leaf Spot: (*Mycosphaerella fragariae*)

Symptoms & Pre-disposing factors:

- Small round spots, with dark brown to purple margins, and grey center.
- Numerous spots coalesce and cause death of the leaf.
- High temperature and long periods of leaf wetness pre-disposes the plant to infection.

### 5. Angular Leaf Spot: (*Xanthomonas fragariae*)

Symptoms & Pre-disposing factors:

- Water soaked irregular lesions seen on lower surface of the leaf.
- Pathogen is spread by rain and overhead sprinklers.
- Dry, infected leaves should be discarded and burned.
- Warm days and cool nights favour infection.

### 6. Leaf Scorch: (*Diplocarpon earlianum*)

Symptoms & Pre-disposing factors:

- Purplish to brownish blotches, which are round to angular in shape.
- Long periods of leaf wetness due to frequent rains, ill-drained soils and poor air circulation within the canopy increases the spread and incidence of the disease.

### 7. Powdery Mildew: (*Sphaerotheca macularis*)

Symptoms & Pre-disposing factors:

- Infected leaves roll upwards, causes purple blotches on leaves, white fungal mycelium on fruits.
- Avoid overhead irrigation, high humidity and excess use of nitrogenous fertilizers.
- Apply fungicide at the first sign of infection.

### 8. Leaf Blight: (*Phomopsis obscurans*)

Symptoms & Pre-disposing factors:

- Symptoms on leaves begin with solid reddish-purple spots that develop a tan center as they grow.
- As the disease progresses, leaf spots enlarge to V-shaped lesions with dry brown centers with reddish purple borders.

### 9. Verticillium Wilt: (*Verticillium albo-atrum*)

Symptoms & Pre-disposing factors:

- Wilting of the plant with drooping of older leaves.
- Leaves turn reddish yellow or dark brown.

### CROP PROTECTION:

Insect Pests				
Pest	Trade Name / Active Ingredient	Dosage & Rate of application	Pre-harvest Interval	Restrictions & precautions
Spider Mite	Vertimec / Abamectin (1.8%)	0.4 ml / lit	3 days	Maximum upto 5 applications. Intervals between applications are 7 days.
Aphid, Spider Mite	Vertimec + Actara (Abamectin + Thiamethoxam)	0.4 ml / lit + 0.5 gm / lit	3 days	For aphids, foliar application at 7 days interval. For spider mites, foliar application at interval of 14 days.
Spider Mite	Concord (Bifenthrin)	1 ml / lit	1 day	Max. 5 application / year. Interval between application: 7 - 14 days.
Thrips	Spintor (Spinosad 11.6%)	0.4 ml / lit	1 day	Maximum 5 applications / season, not more than 2 consecutive applications.
Thrips	Actara (Thiamethoxam 25%)	0.5 gm / lit	3 days	2 applications at an interval of 7 days.
Cyclamen Mite	Sulfur	1.5 gm / lit	12 hours	From beginning of attack, at 14 days interval.
Cyclamen Mite	Vertimec (Abamectin 1.8%)	0.4 ml / lit	3 days	Maximum upto 5 applications. Intervals between applications is 7 days.
White Fly	Azadirachtin 4.5%	2 ml / lit	12 hours	Used as preventive spray. Do not mix with captan, Sulphur.

Diseases				
Disease	Trade Name / Active Ingredient	Dosage & Rate of application	Pre-harvest Interval	Restrictions & precautions
Strawberry Mildew	Amistar (Azoxystrobin 50%)	0.5 ml / lit	1 day	Maximum 6 applications / cycle. Application interval 14 - 21 days.
Strawberry Mildew, Spider Mmite	Sulphur	1.5 gm / lit	12 hours	Apply at 14 days interval.
Grey Mold	Captaf (Captan)	2 gm / lit	1 day	Apply at beginning of flowering and before fruit formation. Repeat weekly.
Leaf Spot, Grey Mould	Kocide (Copper hydroxide)	2 gm / lit	12 hours	Preventive applications when conditions are conducive. Minimum of 2 weekly applications.
Strawberry Mildew	Rally 40 W (Myclobutanil)	0.5 gm / lit	1 day	Maximum 4 applications / cycle. Application interval is 7 days.
Grey Mold, Leaf Spot, Early Blight	Blitox (Copper oxychloride)	1.5 gm / lit	12 hours	Read label before application.
Grey Mold, Strawberry Mmildew	Topsin - M (Thiophanate Methyl 70%)	2 gm / lit	1 day	Apply at the beginning to the middle and end of flowering.
Fruit Rot	Aliette (Fosetyl Aluminium)	1 gm / lit	1 day	Not more than 4 applications per season.

### Nutrient Deficiency

Deficiency	Symptoms
Nitrogen	Plants remain small and may turn from green to light green or yellow
Phosphorus	The first sign is a deep green appearance of plants and reduction in leaf size. In severe deficiency; upper surface of leaves develop a dark metallic shine. White underside becomes reddish purple. Fruit size reduces. Calyx around fruit becomes reddish.
Potassium	Confused with magnesium deficiency or with leaf scorch caused by salinity; mature leaves show browning and drying of upper leaf surface; symptoms appear first on older leaves.
Magnesium	Marginal leaf scorch begins as yellowing and browning of the upper leaf margin
Calcium	Tip burn symptoms may appear on immature leaves. The tip of these leaves fail to expand fully and become black. Fruit develops a dense cover of seeds either in patches or over the entire fruit. The roots become short, stubby and dark.
Manganese	Pale green to yellowing of young leaves. Fruit size can be reduced
Zinc	Green 'halo' develops along the serrated margins of young immature leaf blades. The blades become narrow at the base and eventually become elongated with severe deficiency.
Iron	Yellowing and green-veining are the first sign of iron deficiency
Boron	Younger leaves show puckering and tip burn followed by marginal yellowing and crinkling with reduced growth of the growing point.

### Non Nutrient Plant Disorders:

- **Distorted or misshapen fruit:**  
Possible cause : Insect such as thrips or bug, poor pollination, frost damage at flowering or strawberry phyllody (phytoplasma-green petal) \* like Boron Deficiency.
- **Marginal leaf Burn:**  
Possible cause soil disease such as *Verticillium* wilt or crown rot, salt damage from saline water or fertilizer burn: Similar to K, Mn and Mo deficiency.
- **Yellowing of Leaves:**  
Possible cause - Herbicide damage. Similar to Fe, Zn, or Mn.
- **Reddish leaf surface:**  
Possible cause Red spider (two spotted mite). Similar to K and P deficiency.
- **Albino fruit:**  
Possible cause - over cast weather during fruit ripening with high nitrogen content in soil and low sugar levels in fruit. Similar to K deficiency.



