

# CHAPTER 42

## SWEET LIME

(*Citrus limettioides*)

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### 1. INTRODUCTION

Sweet lime is very different from the fruit that we traditionally think of as a lime. When fully ripe, the fruit's size is comparable to a large lemon, and the skin is light green or, more commonly, yellow. The taste lacks acidity that causes tartness. The resulting flavour is mild and refreshing; commonly enjoyed as a juice, or fresh from the tree. This unique citrus is believed to be a hybrid between a Mexican lime and a sweet lemon, and its dense, evergreen foliage is often distinctively cupped or rolled.

#### 1.1. Nutritive value

Sweet lime, like all citrus, contains potent vitamins and nutrients. Its high vitamin C and folic acid content ensure strong immunity, glowing skin health, and support to bones and joints. As explained in the book, "Health-Promoting Properties of Fruits and Vegetables (Simonne *et al.*, 2011). Citrus also contains other extremely beneficial compounds including chlorophyll, carotenoids, phenolics, flavonoids, and limonoids. According to the "Nutritive Value of Indian Foods" published by the National Institute of Nutrition, 100g of sweet lime has the following values:

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Sweet limes are used for many purposes for example it is suitable for eating and contains amount of oil includes peel oil as well as juice oil and they are volatile in nature. It contains high amount of ascorbic acid (Sandhu & Minhas, 2006) and its juice is used as a sweet drink in summer. Limonene (60.17%) was the most abundant terpene, followed by gamma-terpinene (11.80%), terpinolene (2.96%), beta-pinene (2.08%), linalool (1.85%), p-cymene (1.38%), geranial (1.33%) and alpha-terpineol (1.28%). The remaining terpenes amounted to <1% found in the peel oil of the sweet lime (Abdul *et al.*, 1992).

**Table 1: Nutritional Composition of Sweet lime Fruit (per 100g of edible portion)**

Parameters	value
Moisture	88.4
Protein	0.8g
Fat	0.3g
Minerals	0.7g
Fibers	0.5g
Carbohy drates	9.3g
Calcium	40 mg
Phosphorus	30 mg
Potassium	490 mg
Iron	0.7mg
Vitamin C	50 mg

## 1.2. Medicinal Uses

In India the sweet lime is therapeutically valued for its cooling effect in cases of fever and jaundice.

## 2. ORIGIN AND DISTRIBUTION

Though the Citrus genus has many points of origins ranging from Indonesia to China, a 2004 report published in the “Agriculture Review” points to the hills of Meghalaya and Nagaland as the home of sweet limes (*Citrus tanaka*). On the other hand, the book, “Fruits of Warm Climates” cites a broader range by including India’s central and northern regions. The fruit itself is a hybrid of a Mexican lime and sweet citron or sweet lemon. Now a days, sweet limes are grow in Egypt, Syria, Palestine, tropical Americas, parts of Southeast Asia, and the Mediterranean. It’s also a hobby fruit in parts of Florida and California (Shivankar, 2010).

## 3. AREA OR REGION OF CULTIVATION OR AVAILABILITY

Sweet limes, also known as “tanaka,” are cultivated in the Northeast regions of India, Punjab and Tamil Nadu specifically in the hills at high elevations between 1,000m to 2,700m. It’s difficult to determine sweet lime’s production figures, as they’re generally lumped into “sweet orange” statistics. Nonetheless, The FAO lists India’s 2011 citrus production at a staggering 54 million metric tonnes, of which the “National Bank and Agriculture and Rural Development Centre” lists sweet oranges accounting for approximately 25 percent of all citrus cultivation in the country.

Sweet limes come into season mostly during the rainy months from July to August, far before other orange varieties hit the shelves between October through November, and again from November through March. While citrus fruits can be found year-round, sweet limes are quite distinctly a summer monsoon fruit (Shivankar, 2010).

#### 4. DIFFERENT SPECIES AND CYTOGENETIC

The sweet lime, according to W.T. Swingle classification (Nicolosi, 2007), belongs to *Citrus* genus, *limetta* species, Risso variety, Aurantiaceae subfamily and Rutaceae family. This family *Rutaceae* that includes 162 species (Tanaka, 1977) and is grown in tropical and subtropical areas of the world. Virtually all cultivated forms of *Citrus*, *Fortunella* and *Poncirus* are diploid and the diploid number of chromosomes in these genera is 18 (Krang, 1943).

*Citrus limettioides* (Sweet lime): It is concentrated in Maharashtra, Uttaranchal, H.P. and NEH region)

*Citrus limetta* (Sharbati lime): It is concentrated in Baghmara area in Garo Hills, Meghalaya.

#### 5. BOTANICAL DESCRIPTION AND GROWTH HABIT

The sweet lime is a large and spreading tree with medium-size leaves characteristically, somewhat rolled and cupped, pale green in colour with prominent oil glands and naked to margined petioles. The flowers are large, pure white and fragrant are solitary or in short cymes, borne axillary on current flush of growth (“leafy bloom”), and also without leaves from the previous flush (“bouquet bloom”). The flowers are perfect, with 5 petals and sepals; petals linear, sometimes curved lengthwise, waxy, and thick; sepals fused at base to form a small cup. Ovary is compound with 10-14 locules in most commercial cultivars; position superior, and subtended by raised nectary disc. Most varieties are self-pollinated.

The fruit is globose or ovoid, generally with low and flat papilla. The rind is tight, smooth, thin and light green but, lemon yellow on full maturity. The sections in the fruit are closely set. The colour of flesh is yellowish white. The content of juice is abundant, taste is sweet insipid, devoid of acidity. The number of seeds per fruit varies from none to five. The fruit shape, foliage characters, light coloured inner seed coat a chalazal spot are distinctive characters. Polyembryonic character of sweet lime suggests that it is probably hybrid that is nearly sterile. Fruits are so important that they have received a special name – a hesperidium. A hesperidium is basically a leathery rinded berry. The endocarp is the edible portion, divided into 10-14 segments separated by thin septa, each containing up to 5 seeds, but usually only one.

The tree, its foliage, and the form and size of the fruit resemble the Tahiti lime; the leaves are serrated and the petioles nearly wingless. The fruit is not at all similar to the

Mexican lime. The flowers are borne singly in the leaf axils or in terminal clusters of 2 to 10; the fruits may be solitary or in bunches of 2 to 5.

The Indian sweet lime has less sugar than a sweet orange but it has almost no citric acid and therefore tastes sweeter. To some people the taste feels insipid. The tree has big shiny leaves that are often cupped or rolled. The fruit is large for a lime and usually has a pronounced nipple. The colour turns orange-yellow when fully mature.

### 5.1. Flowering and fruiting

The flowers are borne singly or in clusters; in the latter case leaves may be present or absent from the main axis. A comparison of the productivity of leafy and leafless inflorescences showed the former type to produce a higher percentage of hermaphrodite flowers and mature fruit (Singh and Dhuria, 1960). The sweet lime trees bear two type of flowers viz. Staminate and hermaphrodite on the same tree, but the formation of staminate flower is more. The shy-bearing tendency of sweet lime trees has been observed due to low percentage of perfect flowers and not due to self-incompatibility as reported by some workers. To induce a higher percentage of perfect flowers have shown that average fruit-set could be increased to 1.39 per cent by bending and ringing the branches and to 2.80 per cent by spraying with IBA 100 ppm, as against 1.09 per cent fruit-set in the control (Motial, 1964). Seven-year-old trees of sweet lime were sprayed on 21 February with Planofix [NAA] or Ethrel [ethephon], both at 250-1000 p.p.m. active ingredient. At the highest rate, the two compounds increased the proportion of hermaphrodite flowers from 18.2% in the control to 34.1 and 32%, respectively (Kushal *et al.*, 1984). The sweet lime starts bearing small and uneconomic crop from the fourth year, but normal and economic crop is obtained from the seventh year. The fruits mature after about six months of their blossoming. Fruit setting can be increased with the application of PCPA at 75 and 100 ppm when applied via the foliage have been reported to cause the highest fruit set (68.5-70%) and the highest fruit yield (336-345 fruit/tree) (Gangwar and Singh, 1965).

## 6. CLIMATE

Sweet lime is evergreen, grown in truly subtropical climates of the world although in tropical regions of the world they tend to produce cyclic growth flushes and hence regulating cropping in tropical areas for forcing them into concentrated bloom needs judicious management of water deficit stress according to soil type and growing season. It grows best between a temperature range of 13°C to 37°C. Temperatures below – 4°C are harmful for the young plants. Soil temperature around 25°C seems to be optimum for root growth. Dry and arid conditions coupled with well-defined summer having low rainfall (ranging from 75cm to 250 cm) are most favourable for the growth of the crop. High humidity favours spread of many diseases and frost is highly injurious. Hot wind during summer results in desiccation and drop of flowers and developing fruits. Barring these

limitations it is grown in all subtropical and tropical areas of the world. The sub-tropical climate is best suited for sweet lime growth and development. It also grows successfully at higher altitude in Assam.

## 7. SOIL

Sweet lime can grow well in wide range of soils. Soil properties like soil reaction, soil fertility, drainage, free lime and salt concentrations, etc. are some important factors that determine the success of sweet lime plantation. It flourishes well on light soils with a good drainage. Deep soils with pH range of 5.5 to 7.5 are considered good. However, they can grow in pH range of 4 to 9. Presence of calcium carbonate concentration within feeding zone may adversely affect the growth. Light loam or heavier but well drained sub-soils appears to be ideal for its cultivation.

## 8. PROPAGATION

Sweet lime is commercially propagated by hardwood stem cuttings. However, it can also be propagated by budding, air-layering, and occasionally by nucellar seedlings. Sweet lime is highly polyembryony, the average number of embryos per seed has been reported as 5.8. In India, the sweet lime is grown from cuttings. The hardwood cuttings are prepared from selected shoots of consistently high yielding trees. The cuttings are best rooted during the monsoon under open conditions (Jauhari, and Rahman, 1959). 25-cm long sweet lime cuttings taken in July were treated with IBA or NAA, each at 1500-6000 p.p.m., and planted in pots filled with sand. Rooting and subsequent sprouting and growth of plants were best with IBA at 1500 p.p.m. followed closely by NAA at 1500 p.p.m. (Singh *et al.*, 1986). The root formation in cuttings can be enhanced by the application of IBA at 3000 ppm by quick dip method. Under favourable conditions rooting completes in 4 to 6 weeks. However, the plants raised from stem cuttings generally shallow rooted and are surface feeders, which is a demerit (Sumaya, 2005). Propagation by shield budding is successful provided that the operation is performed in March-April and only the current season's bud wood is used. The suitable rootstock is *jatti khatti* (rough lemon) in the Punjab, *Karna Khatta* in Uttar Pradesh and *Jambheri* in other parts of the country (Arora, *et al.*, 2012).

### 8.1 Micropropagation

The morphogenetic response of *Citrus limon* (Assam Lemon) and *C. limettioides* (sweet lime) microshoots to paclobutrazol at 0, 0.5, 1, 2.5 and 5 mg/litre in an MS 3 medium. Observations recorded after 5 weeks of culture showed that paclobutrazol was effective in reducing the growth of the plants. Both species showed increased root weight and diameter with paclobutrazol at 5 mg/litre, but this rate suppressed root length, number of leaves and shoot weight. Root length reduction was more in Assam lemon than sweet lime. Increase in root diameter was prominent in sweet lime (Singh *et al.*, 2001).

## 9. VARIETY

There are said to be several strains in India differing in fruit shape and tree productivity. Sweet lime trees grow bushy and the light skinned roundish yellow fruits have very smooth surfaces. The fruits are of great commercial value in local markets and are consumed fresh.

### 9.1. Mitha chikna

The plant is medium tall, spreading, densely and thorny. It is a prolific bearer. The fruit is almost spherical or globose, light yellow, surface very smooth and glossy. Rind is very thin, leathery, adherence medium to strong. The number of segments is 10-11. Juice is abundant, taste sweet or insipid sweet, flavour agreeable.

### 9.2. Mithotra

Tree is spreading with light green foliage. Stout thorns present on twigs, fruit is large, lemon yellow, apex slightly depressed, the rind is rough and thick and oil glands are prominent. The flesh colour is yellowish white. Juice is abundant, nice taste and flavour agreeable. Seed 5-6 per fruit. Fruits ripen in September.

### 9.3. Indian (Palestine)

The fruit is oblong, ovoid or nearly round, with rounded base and small nipple at apex, occasionally slightly ribbed; peel aromatic, greenish to orange-yellow when ripe, smooth, with conspicuous oil glands, thin; pulp pale-yellow, usually in 10 segments, tender, very juicy, non-acid, bland, faintly bitter. The tree may be large or shrubby; is spreading, irregular, thorny, with leaves resembling those of the orange but paler and with more prominent oil glands, their petioles faintly winged. Buds and flowers are white. The tree is hardier than that of the acid lime; bears late in the rainy season in India when other citrus fruits are out-of-season.

### 9.4. Columbia

It is a clonal selection mentioned by *Swingle and Reece* (1967).

### 9.5. Soh Synteng

It is strongly acid variation in Assam with new shoots and flower buds briefly pinkish.

### 9.6. Soh Jew

A seedless strain is found to grow in Jaintia Hills of Meghalaya.

### 9.7. NRCC Sweet lime - 1

Round fruit attractive, yellow colour, oval shape and very juicy fruits with thin peel thickness (2.72mm). It is selected as a seedling. Fruits are medium size av. fruit weight 198g, sweet having 10.5 % TSS with very low acidity (0.18%).

## 10. CROP IMPROVEMENT

The sweet lime is self-compatible. In studies aimed at improving yield, Indian scientists found that self-pollination results in maximum fruit set, while cross-pollination with sweet orange or grapefruit results in greater fruit retention, at the same time increasing fruit size and seed count. Therefore, the practice of interplanting with sweet orange and grapefruit has been adopted in commercial orchards.

The general objectives of sweet lime crop improvement mainly fall under 3 classes as follows:

- i. **Fruit characters:** The prime objective of the sweet lime breeder is to obtain an excellent desert quality fruit. In addition to this the fruit should have few or no seeds suitable shape and size meeting the commercial requirements good shipping and keeping qualities attractive rind colour firm texture to meet the canning industry requirements e.g. grapefruit citron and oranges high juice colour for juice and mixed drink purposes and standard vitamin C content (Khan, 2007).
- ii. **Tree characters:** Compactness vigour productiveness disease and pest resistance, cold hardiness, adaptability to various agro-climatic conditions, congeniality with rootstocks and better coverage with early mid and late varieties.
- iii. **Rootstocks characters:** To obtain rootstock adaptable to different and adverse soil conditions resistant to trunk and root diseases, high compatibility with the scion and high proportion of nucellar embryony. At the same time to obtain rootstocks which do not impart vigorous growth on the part of scion so as to make the scion to bear fruits of coarse texture and insipid taste (Sumaya, 2005).

## 11. CULTIVATION

### 11.1. Planting

The best season of planting is June to August. Pits of the size of 60 cm x 60 cm x 60 cm may be dug for planting seedlings. 10 kg of FYM and 500 g of superphosphate may be applied per pit while planting. Planting may be done in other months with good irrigation system. The normal spacing is 5 m x 5 m and plant population is 400 /ha.

### 11.2. Training and Pruning

In order to allow the growth of a strong trunk, initially shoots upto 40-50 cm from the ground level should be removed. The centre of the plant should remain open. Branches

should be well distributed to all sides. Cross twigs and water suckers are to be removed early. The bearing trees require little or no pruning. All diseased, injured and drooping branches and dead wood are to be removed periodically.

### **11.3. Irrigation**

Sweet lime requires life-saving watering in the first year during winter and summer. Irrigation improves the plant growth, flowering and fruiting in sweet lime. It also reduces the fruit crops and increases the fruit size. Under unirrigated condition chances of damage to spring blossom is high and the next crop maturing in October-November may be heavier. Diseases like root rot and collar rot may occur under over irrigated condition and if the collar region is wetted. Light irrigation with high frequency is beneficial. Irrigation water containing more than 1000 ppm salts is injurious. Quantity of water and frequency of irrigation depends on the soil texture and growth stage. Partial drying out of the soil in spring season may be acceptable. Increases in the yield of sweet lime were achieved for microsprinkler plus drip (80%), microsprinkler (57%) and surface plus drip irrigation (74%). During the first year of planting, the highest net income was achieved for microsprinkler plus drip irrigation for sweet lime with inter-cropping of cowpea and potato crops (Manjunatha *et al.*, 2000). The maximum value of crop coefficient (Kc) for sweet lime under drip irrigation (1.17) was greater than that for other citrus trees under irrigation systems other than drip irrigation (0.75). The maximum value of evapotranspiration to pan evaporation ratio (ETp:Epan) for sweet lime under drip irrigation (0.71) was comparable with that of Valencia orange under drip irrigation in Arizona, USA (Sepaskhah and Kashefipou, 1995).

### **11.4. Manures and fertilizers**

Sweet lime plants should be manured in three equal doses three times in a year in February, June and September. Depending on the soil, age and growth of plants, the dose varies. The dose should increase every year proportionately to reach full quantity on the eighth year (Table 2 and 3). Irrigation should be applied if there is moisture stress after application of fertilizers. One or two sprays of micro nutrient mixtures may be given. Abdolhossein (2013) recommended that application of 250 g of ammonium sulfate for every tree in soil and spraying 10 mgL<sup>-1</sup> iron sulfate during June to improve the quantity and quality characteristics as well as increased yield of sweet lime in calcareous soil.

### **11.5. Interculture**

Ploughing, spading of basins, weed control, etc., are important inter-culture operations for soil aeration and health. Chemical control of weeds with weedicides like grammaxone, simazine, diurone, terbsal, etc. may also be adopted. Nag *et al.*, (2008) noticed that use of jute non-woven geo-textiles as mulch for cultivation of sweet lime with turmeric as an intercrop in the dry lateritic soil of Midnapore (West) district of West Bengal. They were



observed that yields of sweet lime and turmeric were substantially higher fetching higher economic returns to the growers. Ghosh (1985) obtained large sized and juicy fruits with grass mulching in sweet lime.

**Table 2: Year wise requirement of farm yard manure (FYM) (Kg/plant/year)**

FYM	Age of the plant						
	I	II	III	IV	V	VI	VII onwards
Kg/plant	20	10	15	20	25	30	40

**Table 3 : Year wise requirement of various nutrients (g/plant/year)**

Nutrients	Age of the plant					
	I	II	III	IV	V	VI onwards
Nitrogen	100	200	300	400	450	500
Phosphorus	50	100	150	200	200	250
Potash	25	50	75	200	200	250
ZNSO <sub>4</sub>	25	25	50	50	100	150
FeSO <sub>4</sub>	25	25	50	50	100	150
MnSO <sub>4</sub>	25	25	50	50	100	150

## 11.6. Intercrops

Leguminous vegetables like cow peas, french bean, peas, etc. may be grown in sweet lime orchards. Intercropping is advisable only during the initial three years.

## 11.7. Improvement of fruit setting and fruit retention by plant growth regulators

Fruit set (17.74%) and yields (245.6 fruits/tree) were highest in sweet lime with Aron (an acrylic polymer at 1 ml/litre) + NPK (0.5:0.5:0.5 kg/tree), and next highest with Aron alone (15.3% and 202.6 fruits/tree). The control fruit set and yields were 4.92% and 93.6 fruits/tree, respectively (Awan *et al.*, 1985). Sweet limes were sprayed at full bloom with GA at 250-1000 p.p.m., PCPA at 25-100 p.p.m., 2,4,5-T at 5-20 p.p.m. or 2,4-D at 5-20 p.p.m. All treatments increased fruit set (except the highest rate of 2,4,5-T) and reduced preharvest fruit drop, GA being most successful. They also increased fruit size, TSS and ascorbic acid contents, and slightly delayed fruit maturity (Kumar, *et al* 1975).

## 11.8. Insect pests and their management

### 11.8.1. Citrus Leaf Miner (*Phyllocnistis citrella*)

It is a serious pest of young growing plants and the nursery. It remains active throughout the year. The damage is caused by pale yellow larvae which make shining silvery zigzag

mines in new emerging leaves on each flush. The attacked leaves curl up, may dry and fall. The photosynthetic activity of the foliage is greatly reduced, which adversely affect the vigour of the plants. Leaf miner attack also encourages the development of citrus canker.

To control the pest spraying of confidor (Imidacloprid) 17.80% SL @ 0.5 ml per litre of water or Curacuron (Profenofos) 50 EC @ 2 ml/L or Nuvacron 36 SL (monocrotophos) @ 2 ml/L or Hostathion 40 EC @ 1.0 ml/L or Chlorpyriphos @ 3.00 ml/L at each flush.

### 11.8.2. Citrus Psylla (*Diaphorina Citri*)

It remains active throughout the year with peak period of infestation from March to November. Both nymphs and adults suck the cell sap from leaves, buds and young shoots. As a result the terminal shoots may wilt and dry, plant growth is affected. It also acts as a vector of greening disease, which is responsible for citrus decline. The adult psyllid is a wood coloured and can fly actively. It rests on the leaves with closed wings and hind end raised upward.

Spraying of rogor 30 EC (Dimethoate) @ 1.5 ml/L or Nuvacron 36 SL (Monocrotophos) @ 1.5 ml/L of water or Imidacloprid @ 0.5 ml/L is advised.

### 11.8.3. Aphid (*Toxoptera gossypii*)

Aphids attack citrus during December to March months. It sucks the cell sap from tender shoots and leaves. The growth is adversely affected.

Spraying of Nuvacron 36 SL (Monocrotophos) @ 1.5 ml/L or rogor 30 EC (Dimathoate) @ 1.5 ml/L Metasystox @ 2 ml/L of water is suggested for controlling the pest.

### 11.8.4. Lemon Butterfly (*Papilio detnoleus*)

It is highly destructive pest of all citrus species. The beautifully coloured larvae are seen on young leaves on terminal shots. It eats up the leaf lamina from margins towards mid-rib. Later on it may feed on mature leaves and defoliate the whole shoot. The naked shoots on the tree are easily identified by Hooking at the faeces on the ground.

The best method is to kill the larvae manually as it is easy to pick up the caterpillars from the young plantations and nursery plants. In case of severe infestation, spraying of dursban 20 EC chloropyriphos @ 3 ml per litre or Ekalux 25 EC (quinalphos) @ 2 ml/L or thiodan 35 EC (Endosulphan) 2 ml/L of water or Sevin 50 WP (carbaryl) @ 2.5 g/litre of water are recommended.

#### 11.8.5. Citrus White Fly (*Dialeurodes citri*) and Citrus Black Fly (*Aleurocanthus woglumi*)

Both nymphs and adults cause the damage by sucking cell sap from the tender foliage. The attacked leaves curl back ward and drop. Sooty mould develops on the honeydew excreted by the nymphs. The black coating interferes with the photosynthetic activity of the plants. Even fruits show black coating of sooty mould.

Spraying of thiodan 35 EC (endosulphan) @ 2 ml/L or hostathion (triazophos) 40 EC @ 2.5 ml/L or, nuvacron 36 SL (monocrotophos) @ 2 ml/L of water in April and September will be helpful to minimize the damage.

#### 11.8.6. Mites (*Eutetranychus orientalis*)

Mites become serious pest after rainy season. Leaves, flowers and fruits are damaged. The leaves have minute specks left by the feeding of mites. Leaves generally give dusty looks. In case of severe infestation, the leaves show mottling and finally drop. Skin of fruits show unpleasant patches. Marketability of fruits is greatly reduced. Spraying of miticide or rogor 30 EC (dimethoate) @ 1.5 ml/L as soon as attack is seen in May-June.

#### 11.8.7. Leaf Folder (*Psorosticha zizyphi*)

Both young and mature plantations are attacked from May to October. The larvae feed inside the leaves by webbing them together and start feeding from top to downwards. The plants remain stunted. Spraying of nuvacron 36 SL (monocrotophos) @ 1.5-2.0 ml/L of water or dursban 20 EC (chloropyriphos) @ 2.5 ml/L or Ekalux 25 EC (Quinalphos) @ 2 ml/L is suggested.

#### 11.8.8. Bark Eating Caterpillar (*Indarbela quadrinotata*)

This is a pest of neglected orchards. The caterpillars eat by making holes in the wood particularly near scaffold crotches. It feeds on the bark under the cover which consists of fine pieces of wood and pellets of excreta. Keeping the orchard clean and regular removing the webbing from the holes with strong wire and injecting chloropyriphos 50:50 solution or kerosene oil followed by plugging the holes with cotton will be helpful to keep the pest population minimum.

#### 11.8.9. Citrus Nematode (*Tylenchulus semipenetrans*)

The female adult is oval and remains attached to the roots and suck cell sap as a result terminal growth is infected. The general plant vigour is adversely affected. Nursery should be raised on nematode free soil.

## 11.9. Diseases and their management

### 11.9.1. Citrus Canker (*Xanthomonas citri*)

It is a very serious disease of citrus particularly limes. Disease appears on leaves, twigs and fruits. On leaves it appears as yellowish spots. Which gradually enlarge, turn rough and brownish and become raised on both sides of the leaf. These spots are surrounded by a yellow halo. On peel of the fruit, the lesions become rough and corky. To control the disease, spraying of 100 ppm streptomycin + 2g copper sulphate /L of water in February, October and December is suggested.

### 11.9.2. Scab (*Elsinoe fawcetti*)

Small dark, brown, rough, irregular raised lesions mostly on the underside of the leaves appear. Twigs and fruits also get infected. Spraying of Bordeaux mixture 2:2:250 or 50% copper oxychloride @ 4g/L of water or Ziram 27 SC or Dithane M-45 @ 2.5 gm/L thrice from June to August at 20 days interval is recommended.

### 11.9.3. Gummosis (*Phytophthora palmivora*)

This disease is known by different names, viz. foot rot, root rot, collar rot or crown rot etc. Normally orchards with poor soil drainage, or flood irrigated are prone to the disease. Fungus causes rotting of rootlets, dropping of the blighted leaves. The infected plants flower heavily. Profuse gumming from the stem and branches is the main symptom of this disease. To control the disease following steps to be taken; i. Collect and bury deep in soil the diseased leaves or fruits. ii. Use Cleopatra as a rootstock. iii. Avoid flood irrigation. iv. Paint the trunk portions with Bordeaux paint up to 20 cm of height. v. Spray Bordeaux mixture 2:2:250 thrice, i.e. in February before flowering, June and end July or give two applications of Ridomil MZ as paint (2g/100 ml of Linseed oil) to the infected portion of the trunk and drench (25g/10 litre of water/tree) the soil at the base of the tree in February-March and July-August or two, spray of Aliette 80 WP (2.5 g/L of water) in April and September.

### 11.9.4. Wither Tip

It is also called die back (anthracnose). It is caused by a fungus *Colletotrichum gloeosporioides* or may be due to physiological causes. Symptoms of anthracnose appear on leaves, young shoots, and fruits. On leaves the necrotic spots appear as acervuli arranged in concentric rings. Dead parts of twigs give silvery grey appearance. Leaves shedding and twig die back are characteristic symptoms of wither tip. In severe cases the stem and infection of immature fruits results in fruit drop and show tree die back.

To control the disease follow the recommended practices for pest control and cultural operations. Prune the diseased wood, leaves and fruits and destroy. Spray the affected trees with Bavistin 1.0 gm/litre of water in February and Bordeaux mixture 2:2:250 in March and repeat the same in July-August.

#### 11.9.5. Melanose or Stem and Fruit Rot

It is caused by fungus *Phomopsis citri*. It manifests as dark circular depressions and yellowish margins on leaves, branches and fruits. Later the spots become raised rough and light brown and yellow margins disappear. Sand paper texture develops on the surface of leaves and fruits. Spraying of 2:2:250 Bordeaux mixture during July-August and September is to be done to control the rot.

### 11.10. Virus like Diseases and their management

#### 11.10.1. Greening

It is caused by bacterium and manifests as stiff upright multiple twigs and buds. The leaves become small and mottled. Premature defoliation and branches show die back. Use of disease free bud wood and control of citrus psylla (*Diaphorina citri*), as it is a vector for greening disease, is suggested.

#### 11.10.2. Tristeza

It is caused by a virus. It causes vein clearing in young leaves. The infected trees appear as their roots have been damaged. This is due to sieve tube necrosis at the bud union and crease formation, which check carbohydrate translocation from top to roots resulting in starvation of roots. Due to heavy bearing, trees usually exhaust. Controlling the insect vector (aphid), by regular spraying of insecticides is only the way to check the further spread of the disease.

#### 11.10.3. Exocortis (Viroid)

The bark below the bud union shreds. The wood becomes naked at the soil level. Roots get damaged. Trees show stunting. As it spreads through cutting tools, sterilizing the tools before use in the orchard is advised.

#### 11.10.4. Ring Spot

It appears as yellow rings on mature leaves. Rings may be few to many per leaf. Rings may coalesce to form bigger patches. The severely infected plants show die-back and decline. The virus spreads through infected bud-wood. Use of virus free bud wood for raising of nursery is advised.

## **12. HARVESTING, YIELD, POST-HARVEST MANAGEMENT AND STORAGE**

### **12.1. Maturity**

All citrus are non-climacteric fruit, meaning that they ripen gradually over weeks or months and are slow to abscise from the tree. External colour changes during ripening are a function of climate more than ripeness, and a poor indicator of maturity. The best indices of maturity for citrus are internal viz. °brix (sugar), acid content, and the °Brix/acid ratio.

### **12.2. Harvesting**

The fruits are ready for harvesting from August to October in the north parts of India and September to November in Assam. In the south, August-September is the main season for harvesting.

### **12.3. Yield**

The yield is about 100-150 quintals per hectare depending upon age of the plantation, soil type, climate and management practices followed.

### **12.4. Post-harvest management and storage**

To impart uniform yellow-orange colour to the fruits application of ethephon @ 250 ppm along with 1 per cent calcium acetate as foliar spray at maturity stage is recommended. Sweet limes have a long shelf life at room temperature, as they keep fresh for up to two weeks. In the refrigerator, sweet limes last for four to eight weeks. It's possible to freeze slices of the fruit, though the limonin content in sweet limes may cause the pulp to taste bitter over time. A way to avoid this is by freezing the fruit in a "wet pack," achieved by submerging the slices in sweet syrup within an airtight glass jar. The sweet lime juice can be frozen. The frozen juice will keep for up to six months, though it's best to check the fruit periodically to ensure it doesn't become sour.

## **13. ECONOMIC LIFE OF PLANTATION**

Orange and sweet Lime - 25 to 30 years.

## **14. FUTURE RESEARCH THRUST**

Sweet lime cultivation in India is witnessing manifold challenges due to vagaries of climate, depleting land and water resources, unavailability of quality planting material, lack of post-harvest and marketing infrastructure. With growing economy, awareness towards quality, nutritional safeguard and consequently higher demand for fruits and beverages, the

challenges of enhanced quality production and productivity are being increasingly felt. These emerging challenges call for paradigm shift in production with up-to-date state of the art technological interventions.

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