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## **UNIT 3 CITRUS (*Citrus sp.*)**

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### **Structure**

- 3.0 Objectives
- 3.1 Introduction
- 3.2 Area and Production
- 3.3 Soil
- 3.4 Climate
- 3.5 Species and their Commercial Varieties
  - 3.5.1 Species
  - 3.5.2 Commercial Varieties
    - 3.5.2.1 Mandarins
    - 3.5.2.2 Sweet Oranges
    - 3.5.2.3 Lemon
    - 3.5.2.4 Sour Lime
    - 3.5.2.5 Sweet Lime
    - 3.5.2.6 Grapefruit
    - 3.5.2.7 Pummelo
- 3.6 Planting
- 3.7 Propagation
  - 3.7.1 Raising Stock Seedlings
  - 3.7.2 Budding
  - 3.7.3 Rootstock
    - 3.7.3.1 Sour Orange
    - 3.7.3.2 Lemon and related Species
    - 3.7.3.3 Limes and related Species
    - 3.7.3.4 Trifoliolate Orange and Hybrids
    - 3.7.3.5 Mandarin
    - 3.7.3.6 Sweet Orange
- 3.8 Nutritional Requirements
- 3.9 Cultural Practices
  - 3.9.1 Care of Young Plants
  - 3.9.2 Irrigation
  - 3.9.3 Weed Management
  - 3.9.4 Inter-cropping
  - 3.9.5 Mulching
  - 3.9.6 Training and Pruning
  - 3.9.7 Thinning of Fruits
- 3.10 Insect-pests and Diseases
  - 3.10.1 Insect-pests
    - 3.10.1.1 Citrus Psylla

## Sub Tropical Fruits

- 3.10.1.2 Citrus Leaf Miner
- 3.10.1.3 Citrus White Flies
- 3.10.1.4 Mites
- 3.10.1.5 Bark Eating Caterpillar
- 3.10.2 Diseases
  - 3.10.2.1 Citrus Canker
  - 3.10.2.2 Scab
  - 3.10.2.3 Gummosis
  - 3.10.2.4 Virus Like Diseases
  - 3.10.2.5 Citrus Nematode
- 3.11 Physiological Disorder
  - 3.11.1 Citrus Decline
  - 3.11.2 Granulation
  - 3.11.3 Fruit Drop
- 3.12 Harvesting
- 3.13 Storage
- 3.14 Packaging
- 3.15 Transportation
- 3.16 Processing
- 3.17 Let Us Sum Up
- 3.18 Key Words
- 3.19 Further References
- 3.20 Answers to Check Your Progress Exercises

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## 3.0 OBJECTIVES

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After going through this unit, you will be in a position to:

- know the history and uses of citrus,
- discuss status of area and production of citrus species in the country,
- describe the soil, climatic and nutritional requirements,
- identify the species and their commercial varieties,
- describe the planting, propagation and training methods,
- describe various pests-diseases and physiological disorders, and
- identify maturity indices, harvesting, storage, packaging and transportation of fruits.

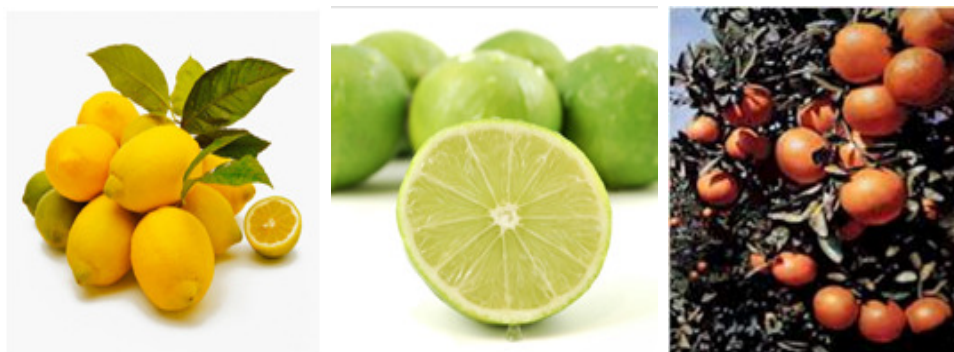
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## 3.1 INTRODUCTION

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Citrus (*Citrus sp.*) is one of the worlds leading tree fruit crop. It is a crop adaptable to wide range of soils, planting and cultural arrangements, and grows in more than 100 nations. Citrus has a number of species and varieties

of fruits, known for their characteristic flavour and attractive range of colours. The attractive evergreen foliage and flowers as well as the extraordinary fragrance are the added aesthetic value of citrus trees.



**Different Types of Citrus Species**

Most of the cultivated species of citrus are believed to be native of tropical and subtropical region of South-East Asia stretching from India and China in the northeast to Australia and New Caledonia in the South-east. The north-eastern region of India is also considered as one of the natural homes of citrus, since quite a few non-edible species like *Citrus indica*, *C. ichangensis*, etc. are found to grow in this region.

Citrus fruit are not only delicious and refreshing but also they provide vitamins, minerals and many other substances. The principle edible portion of a citrus fruit is the juice present in juice vesicles. The citrus fruits contains considerable amount of vitamin C. The juice of ripe orange and mandarin contains 8 to 12 per cent sugars and other soluble solids, 0.5 to 1.5 per cent citric acid, 25-80 mg ascorbic acid per 100 g. In lemon and lime, the acid content may go up to 6 and 8 per cent, respectively. The fruit of species with sweet juice (eg. sweet orange, mandarin and grapefruit) are eaten as fresh.

### **3.2 AREA AND PRODUCTION**

The major citrus producing countries of the world are USA, Brazil, Japan, Spain, Italy, Mexico, India, China, Egypt, Australia etc. In India, citrus fruits are grown in 412.33 thousand ha. with a total production of 5303.85 thousand mt. annually. Productivity of citrus varies from 5.0 to 15.0 tonnes per hectare depending upon the agro climatic regions. Among the citrus fruits, the mandarins (santras) occupy the largest area and production, followed by sweet oranges, limes and lemons. The major mandarin growing areas in India are Coorg of Karnataka state, Nagpur belt of Maharashtra, Darjeeling district of West Bengal, East and West districts of Sikkim, Kamrup, Dibrugarh and Lakhimpur districts of Assam, certain parts of Meghalaya, Tripura, Manipur, Nagaland, Mizoram and foothills of Himachal Pradesh. Sweet oranges are grown in Andhra Pradesh, Maharashtra, parts of Tamil Nadu and parts of North Western region. Acid lime is common in Andhra Pradesh, Maharashtra, Tamil Nadu, Bihar, Karnataka and West Bengal. Kinnow, has become quite popular in Punjab, few districts of Rajasthan, Haryana, Himachal Pradesh and Jammu district of Jammu and Kashmir.

**Table 1:** Statewise area, production and productivity in total of Citrus during 2016-17.

| Sl. No. | State          | Area (000 ha.) | Production (000 mt.) | Productivity ha/mt |
|---------|----------------|----------------|----------------------|--------------------|
| 1       | Madhya Pradesh | 96.58          | 1380.78              | 14.30              |
| 2       | Maharashtra    | 108.00         | 795.96               | 7.37               |
| 3       | Punjab         | 35.39          | 777.63               | 21.97              |
| 4       | Andhra Pradesh | 25.81          | 438.77               | 17.00              |
| 5       | Gujarat        | 31.18          | 421.77               | 13.53              |
| 6       | Bihar          | 35.28          | 318.37               | 9.02               |
| 7       | Karnataka      | 11.12          | 273.34               | 24.58              |
| 8       | Haryana        | 12.03          | 244.86               | 20.35              |
| 9       | Assam          | 18.37          | 227.69               | 12.39              |
| 10      | Odisha         | 19.43          | 191.25               | 9.84               |
| 11      | Rajashtan      | 8.23           | 169.62               | 20.61              |
| 12      | Telangana      | 10.91          | 63.81                | 5.85               |
|         | <b>Total</b>   | <b>412.33</b>  | <b>5305.85</b>       | <b>176.81</b>      |

### 3.3 SOIL

Citrus trees show great adaptability to a wide range of soils from coarse sand to heavy clays. In general, light to medium, well aerated, deep, loose, fertile soils which are free from stagnant water and injurious salts are considered ideal for citrus. Good drainage which ensures proper aeration is essential for good growth and sustained high yield in citrus. The best pH for citrus soil ranges from 5.5 to 6.6. Mandarins are grown in acidic, sandy to clay loam soils in north eastern hills as well as in non-acidic, heavy black soils in Nagpur region. Citrus trees are particularly sensitive to high salt concentrations and may be injured if the total concentrations in the soil exceed 1000 ppm.

### 3.4 CLIMATE

Citrus trees grow well in tropical and subtropical climates. It can tolerate light frost for a short period. Flowers and young fruits are very sensitive to frost and may drop even at temperature slightly below 0°C for a very short period. Near the equator citrus can be grown from sea level to an altitude of 1000 m amsl. The optimum temperature for the growth of citrus is between 25°C and 30°C. High night temperature is harmful because pigmentation of fruit doesn't take place at night. Hot winds and excessive heat during flowering and fruit setting considered to be harmful for good bearing and causes fruit drop and sun burn. A dry period before flowering generally helps in better and quicker initiation of flower buds. Citrus needs 875 to 1400 mm well distributed rains if grown without irrigation. High humidity or rain after a dry spell during fruit maturation may cause splitting of fruits. Fruits grown in relatively moist climate tend to have thinner peel and more juice than those grown in drier climates. Windbreaks should be raised in areas where stormy wind is expected to avoid the young fruits to be blown.

## 3.5 SPECIES AND THEIR COMMERCIAL VARIETIES

### 3.5.1 Species

Citrus fruits can be classified on the two modern systems i.e. the first one is Swingle's system that involves a total of three genera, 21 species of which 16 are in citrus and 9 botanical varieties and the second is Tanaka's system that involves a total of three genera and 151 species of which 144 species are in citrus.

Among all the citrus species 8 species generally cultivated for edible purpose are: *Citrus sinensis*, *C. reticulata*, *C. aurantium*, *C. limon*, *C. aurantifolia*, *C. grandis*, *C. paradisi* and *Citrus medica*. Important commercial cultivars of these species are as under:

### 3.5.2 Commercial Varieties

#### 3.5.2.1 Mandarins (*Citrus reticulata* Blanco)

i) **Nagpur Santra** : This is perhaps the most important cultivar of mandarin in India. Fruits sub globose, colour not very uniform, generally orange-yellow, smooth surface, rind thin, adheres loosely to the segments (10-12), pulp vesicles uniformly golden yellow, texture fine and tender, juice abundant, well blended, flavour excellent.



Nagpur Santra

ii) **Kinnow** : A hybrid between "King" x "Willow Leaf". It was brought to Fruit Research Station, Abohar from California in 1958-59. Fruit medium to globose to oblate. Skin golden yellow when fully ripe. Acidity moderate with fine sugar/acid blend, flavour very rich. Seeds 12-25. Ripen in January-February. Less prone to fruit drop.



Kinnow

iii) **Khasi Orange** : An important commercial cultivar, usually grown in northeastern part of India. Fruits globose to oblate. Surface smooth, orange-yellow or bright orange in colour. Rind thin with little adherence to the segments (8-13), loose, pulp vesicles uniformly orange, texture somewhat coarse, melting, juice abundant, well blended with moderate flavour, seeds vary from 10-15.

iv) **Coorg Orange** : Most important commercial cultivar of South India, especially in Coorg and other parts of Karnataka. Fruits oblate, colour



## Sub Tropical Fruits

bright yellow and uniform, segments 9-11, easily separable, pulp yellow, texture fine and tender, juice abundant, seeds 15-28 with light green tinge inside.

- v) **Darjeeling Orange** : Also known as Sikkim orange and is cultivated widely in and around Darjeeling hills. The trees are vigorous and prolific bearer. Fruit are relatively small in size, somewhat flat in shape, colour yellowish to orange when fully ripe, juice plenty and sweet with good flavour, seeds a few.
- vi) **Local** : Fruit small to medium, oblate to subglobose. Skin cadmium coloured. Base short necked and furrowed. Flavour fair, juice abundant, slightly acidic. Seeds 3 to 7 ripens in December-January.

Other cultivars are Satsuma, Emperor, Butwal etc.

### 3.5.2.2 Sweet Oranges

- i) **Mosambi** : This cultivar is widely grown in Maharashtra and Andhra Pradesh. Fruit light yellowish orange in colour, fruit small to medium, subglobose, surface rough with longitudinal furrows and bears a circular ring around the apical end. The rind is thin and tight. Flesh colour is pale yellow or whitish. Juice has low acidity. Seeds 20-25 per fruit. Ripens in November.



Mosambi

- ii) **Malta (Blood Red)** : This is popular in Punjab. Fruit medium to large, roundish to slightly oblong in shape. Rind is thin, deep orange and tight. Flesh fully red when ripe, rich flavour with sweetness and acidity well blended. Fruit quality excellent. Seeds 8 to 10. Ripens in December.
- iii) **Sathgudi** : This is a famous variety of Andhra Pradesh and Tamil Nadu. Fruit is medium, subglobose, areole absent. Rind is medium thick, smooth and finely pitted. The pulp is straw coloured, juicy with good flavour. Seeds 12 to 20. Ripens from October to February.
- iv) **Pineapple** : It has originated as a seedling in Florida. In India, it is cultivated in Punjab, Haryana and Uttar Pradesh. Fruit is medium to large, subglobose, and orange in colour. Rind is thin, bright and glossy in appearance. Flesh is primrose yellow, juicy, sweet and having flavour like pineapple. Seeds 12 to 25. Mid season variety, ripens in December.
- v) **Washington Navel** : It is originated in Brazil and was introduced to Washington in 1870 and thus got the name. Trees less vigorous and poorly adapted to humid tropics or intense desert heat. Fruit large round with prominent navel, rind thick, membrane thin, pulp extremely tender and melting, peeling and separation of segments easy, juice abundant, flavour excellent, fruits seedless.

Other varieties are Jaffa, Shamouti, Valencia Late, Hamlin, Batavian etc.

### 3.5.2.3 Lemon

- i) **Eureka** : Introduced from America and Europe and best suited in Punjab and Western parts of Uttar Pradesh. Tree medium to large, spreading open sparingly spinous.



Lemon - Eureka

Fruit medium, oblong, apex nipped. Rind is medium thin, colour lemon yellow, surface slightly rough. Juice abundant, clear, strongly acidic with excellent flavour. Seeds rarely present. Ripens in August - September.

- ii) **Baramasi** : The tree of baramasi is vigorous, spreading and thornless. New growth and flowers are purple. The trees flower and fruit throughout the year. The fruit is lemon yellow, round, tapering towards the base, apex is rounded. The skin is smooth and thin. Fruit is very juicy and seedless, contains 7 per cent acidity. This variety is more suitable than Eureka for growing in the irrigated arid region of Punjab.

- iii) **Pant Lemon** : An indigenous variety of Assam and grown extensively in Maharashtra, Andhra Pradesh and other parts of South India. Tree small, open, thorny, fruit medium-sized, ovoid to oblong, rind medium, thick, surface smooth, segments range from 9 to 12, pulp moderately firm, greenish white, vesicles slender, juicy, highly acidic, quality very good, average number of seeds may range from 0 to 14.

Other varieties are Lisbon, Meyer Lemon, Kagzi Kalan, Villafranca, Pant Lemon.

### 3.5.2.4 Sour Lime

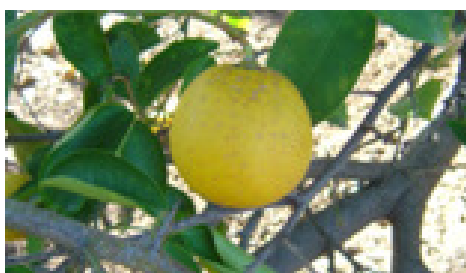
A highly polyembryonic species, tree small, bushy, thorny. Important cultivar of this species in India is Kagzi Lime. Fruit small, round to oval, greenish yellow, thin skinned. Core solid, pulp greenish, juice abundant, highly acidic. Seeds small and smooth. This cultivar is highly susceptible to Tristeza virus and bacterial canker.



Sour Lime

### 3.5.2.5 Sweet Lime

A highly polyembryonic species, tree medium in size, irregular growth habit, thorny. No specific cultivar is their, only local cultivar is known. Fruits medium sized, subglobose to oblong, nipple flat, rind thin, smooth with prominent oil glands, greenish to



Sweet Lime

orange yellow in colour on maturity. Segments around 10, pulp colour straw yellow, very juicy, lacking in acidity and insipid. Seeds 5 to 6. Ripens in September.

### 3.5.2.6 Grapefruit

i) **Marsh Seedless** : Fruit medium to large, oblate roundish in shape. Skin lightly yellow, smooth. Acidity and sweetness medium. Seeds range between 0 to 6. Ripens in December - January.



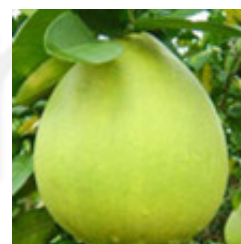
Marsh Seedless

ii) **Duncan** : Fruit large, oblate in shape. Skin pale light yellow, flesh pink. Acidity and sweetness less blended, bitterness well marked. Seeds 40 to 50. Ripens in November - December.

iii) **Foster** : Fruit medium to long, oblate in shape. Skin pale yellow, flesh pink. Acidity and sweetness well blended, bitterness well marked. Seeds 40 to 50. Ripens in November - December.

### 3.5.2.7 Pummelo

A monoembryonic species, fruits large, subglobose to pyriform in shape with thick spongy rind and less juice, borne singly. Seeds very large and coarsely veined. It is grown in certain parts of Punjab, Uttar Pradesh.



Pummelo

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## 3.6 PLANTING

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In citrus, square and rectangular system of planting are generally practiced. The planting density usually varies from 200 to 400 plants/hectare but high density planting is also followed using modified agro-techniques. In square system, spacing of 3 m x 3 m (1111 plants/ha.) or 4 m x 4 m (625 plants/ha.) for limes and lemons, 5 m x 5 m (400 plants/ha.) for mandarins, 6 m x 6 m (278 plants/ha.) for oranges, 7 m x 7 m (204 plants/ha.) for pummelo and grapefruit are generally used. However, in rectangular system the spacing for different citrus species can be modified using 3 x 5 m (667 plants/ha.), 4 m x 6 m (417 plants/ha.), 5 m x 7 m (286 plants/ha.) and 6 m x 8 m (208 plants/ha.) which leave more space between rows providing scope for mechanized orchard management. A spacing of 4.5 to 5 m is found to be optimum for Kinnow mandarin budded on Jatti Khatti. Coorg Mandarins are planted at a spacing of 4.5 m while Nagpur mandarins are spaced at 5.5 to 6 m. High density planting of Satsuma mandarin accommodate 1666 and 3333 plants/ha. considerably increased fruit production.

Under North India, citrus is planted twice a year. The spring planting season starts after 15 February and monsoon season starts from July to September.



Pits of 50 x 50 x 50 cm are prepared and may be dug deep enough only to accommodate the ball of the plant. If the soil is of heavy texture, pits of 1 m x 1 m x 1 m may be dug to facilitate better root penetration. Before planting the seedlings, the pits should be properly filled with 25 kg farmyard manure or compost and BHC @ 200 g per pits. At the time of planting the soil is taken out from the centre of the pit to accommodate the ball of the earth around the roots. Care should be taken so that the bud union is left at least 15 cm above the ground level. The soil is then replaced and firmly pressed around the plant without damaging the roots. The plants are watered immediately after planting.

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## 3.7 PROPAGATION

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Seeds of most of the citrus species are polyembryonic, the nucellar seedlings obtained through seed propagation come remarkably true to types. Mandarin and acid lime plantations in India are mostly raised from seeds. Lemons, citrons and sweet limes are easily propagated by cuttings. Air layering can also be done in pummelo and mandarins. However, most of the citrus cultivars are propagated commercially by budding.

### 3.7.1 Raising Stock Seedlings

Seeds should be obtained from good, fully matured fruits growing on vigorous, productive healthy trees. Seeds are best sown fresh as they lose viability on drying. The optimum temperature for seeds germination is 32°C. Germination in seed bed takes about a month. Five to six months later, uniform, upright, vigorous seedlings are transplanted on a nursery bed at spacing of 30 x 100 cm or into plastic bags. These seedlings will be ready for budding after six months. The stock seedlings are considered buddable when the stem thickness reaches 8 mm in diameter or pencil size.

### 3.7.2 Budding

Bud wood is taken from certified virus free mother plant. Buds should be round and brown but not angular and green, and should be unsprouted. The most common method of budding citrus is shield or T-budding. Budding should preferably be done at 20 to 30 cm height of the stock. To prevent water penetration, the inserted bud wood is wrapped with transparent polythene strip leaving the eye free. On successful union, the strip is unwrapped after 2 to 3 weeks and the bud is allowed to grow. Lopping of the rootstock just above the inserted bud is done 4 to 8 weeks after budding depending on season of budding. An alternative practice is to first cut the budded seedling completely well above the bud, immediately after budding. The budded plants become ready for planting in 1 to 2 years depending on growth rate.

### 3.7.3 Rootstock

The rootstock is a vital component of a budded citrus tree. Since every aspect of a citrus tree, such as growth, longevity, performance, disease resistance, fruit quality etc. are influenced to a great extent by rootstocks. There is a

## Sub Tropical Fruits

wide variability among rootstocks and no single rootstock is considered satisfactory in all respects. Finding the best rootstock for each citrus species or cultivars of a species in every locality is almost impossible. However, the commonly used rootstocks are:

### 3.7.3.1 Sour Orange (*Citrus aurantium*)

It is used as rootstock for oranges, grapefruit and mandarin. Sour orange is susceptible to burrowing nematode.



Rootstock-Sour Orange fruits

### 3.7.3.2 Lemon and Related Species (*C. limon*)

Rough lemon (*C. jambhiri*) is probably of hybrid origin and is highly polyembryonic. It can be used for oranges, grapefruit, lemons and mandarins. It is tristeza tolerant but susceptible to foot rot and nematodes. Rough lemon is a commonly used rootstock in India.

### 3.7.3.3 Lime and Related Species (*C. aurantifolia*)

The most widely used acid lime rootstock is rangpur lime. It is resistant to tristeza but susceptible to foot rot. Sweet limes are very similar to rough lemon.

### 3.7.3.4 Trifoliate Orange and Hybrids (*Poncirus trifoliata*)

Dwarf trees are produced when trifoliate orange is used as rootstock. It is resistant to phytophthora foot rot, tristeza and the citrus nematode. Citrange (Sweet orange x trifoliate orange) is a widely used rootstock. Troyer and Carrizo are quite common rootstock.



Trifoliate orange-rootstock tree

### 3.7.3.5 Mandarin (*C. reticulata*)

Mandarin rootstock is widely used in China. The most common rootstock is Cleopatra which is identical with Billi kichilli of India where it appears to be native.

### 3.7.3.6 Sweet Orange (*C. sinensis*)

Sweet orange is widely used as a rootstock in California. It is susceptible to phytophthora foot rot. It can be used for all citrus cultivars.

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## Check Your Progress Exercise 1

**Note :** a) Space is given below for the answer.

b) Compare your answer with that given at the end of the unit.

1. What are the main species of mandarin group ?

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- .....
- .....
2. Write down the nutritive value of citrus fruits.

- .....
- .....
- .....
3. Which species of citrus is cultivated for edible purpose ?

### 3.8 NUTRITIONAL REQUIREMENT

Citrus being an evergreen plant requires generous supply of all essential elements in order to have good plant growth and to bear good amount of best quality fruits. For non bearing trees, fertilizer application may be done in an area more than drip circle, leaving 15 to 30 cm radius around the tree trunk. It is advisable to apply the fertilizers in split doses and application should be made when there is sufficient moisture in the soil. In old bearing orchards, since the entire area becomes covered with citrus roots, fertilizers may be applied by broadcasting from trunk to trunk leaving 30 cm around the tree trunk.

Citrus thrives well under a wide range of nutrient levels and it is almost impossible to outline a single fertilizer programme that is best for all conditions. A wide variety of fertilizers schedules are now used, which result in higher yields of good quality fruits. A few of the fertilizer schedule was followed for different citrus fruits.

**Table 2 :** For Malta Orange the following fertilizer schedule has been recommended.

| Age of the plant | Farmyard manure (kg/plant) | Nitrogen (g/plant) |
|------------------|----------------------------|--------------------|
| 1 – 3            | 5 – 20                     | 50 – 150           |
| 4 – 6            | 25 – 50                    | 200 – 250          |
| 7 – 9            | 60 – 90                    | 300 – 400          |
| 10 & above       | 100                        | 400 – 800          |

**Table 3 :** For Khasi Orange the following fertilizer schedule has been recommended.

| Age of the plant | Sulphate of ammonia (kg/plant) | Super phosphate (kg/plant) | Sulphate of potash (kg/plant) |
|------------------|--------------------------------|----------------------------|-------------------------------|
| 5                | 1.125                          | 0.787                      | 0.450                         |
| 10               | 2.250                          | 2.025                      | 1.462                         |
| 15 & above       | 3.600                          | 3.150                      | 2.250                         |

**Table 4 :** For Darjeeling Orange the following fertilizer schedule has been recommended for each plant.

| Nutrients                         | 2 <sup>nd</sup> year | 3 <sup>rd</sup> year | 4 <sup>th</sup> year | 5 <sup>th</sup> year | 6 <sup>th</sup> year |
|-----------------------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
| N (g)                             | 100                  | 150                  | 200                  | 250                  | 300                  |
| P <sub>2</sub> O <sub>5</sub> (g) | 100                  | 150                  | 200                  | 250                  | 300                  |
| K <sub>2</sub> O (g)              | 100                  | 150                  | 200                  | 250                  | 300                  |
| Manure/Compost (kg)               | 10                   | 10 – 15              | 10 – 15              | 10 – 15              | 10 – 15              |

The whole quantity of farmyard manure should be applied in December. Nitrogen dose is given in two split doses the first part is given in February and the second in April-May after the fruit set. For optimum productivity of citrus cultivars the following fertilizers doses are recommended in some states of India.

**Table 5 :** Fertilizer doses for some state of India.

| State          | Nitrogen<br>(g/plant) | Phosphorous<br>(g/plant) | Potassium<br>(g/plant) |
|----------------|-----------------------|--------------------------|------------------------|
| Punjab         | 400                   | 200                      | 200                    |
| Assam          | 300                   | 250                      | 300                    |
| Maharashtra    | 600                   | 200                      | 100                    |
| Karnataka      | 400                   | 200                      | 200                    |
| Andhra Pradesh | 400                   | 200                      | 200                    |
| Tamil Nadu     | 600                   | 200                      | 300                    |

Micronutrients are usually supplied through foliar sprays. Better absorption and effects of foliar sprays are observed when the new spring flush leaves are half expanded. Zinc sulphate @ 0.5 per cent was applied for maintaining satisfactory level of zinc.

## 3.9 CULTURAL PRACTICES

### 3.9.1 Care of Young Plants

The young plants must be protected against high or low temperature and strong winds. The trunk of the young trees should be white washed to protect them against the hot sun. **Windbreaks should be planted on south-west side to reduce sun burn and wind damage.** The young citrus plants are susceptible to frost and must be protected by providing a cover over the young plants with farm waste material during first two years. The young plants must be watered regularly in the arid regions. The sprouts which develop on the trunks of the trees below the scaffold branches should be removed.

### 3.9.2 Irrigation

Water is one of the critical inputs for successful production of citrus fruits. Citrus trees are more exacting in their demand for water. The water requirement of citrus depends on rainfall evapo-transpiration and soil type. As a rule, citrus soil should be kept moist, but not wet to a depth of at least one meter. The water requirement in citrus varies according to species. The water requirement of grapefruit is higher than other citrus and it varies from 900 to 1200 mm per year. Acid lime requires 875 mm water per year under tropical conditions of South India. The application of irrigation at right time and in right quantity is more important. Under North India weekly irrigation during March to June and fortnightly irrigation during November to February, are followed. Citrus trees are highly sensitive to excess moisture and water logging conditions. The excessive irrigation may results in poor soil aeration leading to reduced growth and yield, and leads to root rot and other diseases. Citrus trees are sensitive to salinity and the total soluble salts in the irrigation water should not exceed 1000 ppm.

### 3.9.3 Weed Management

The citrus orchards are infested with weeds which compete with main crop for water, nutrients and space. Mechanical means of weed control like regular tillage operations, keeps the growth of most of the weeds under check in citrus orchards. As frequent cultivation of citrus soil is restricted to a greater extent, use of chemical means of weed control has a wider acceptability in citrus. Chemicals like simazine, atrazine, bromacil, paraquat and glyphosates at 6 kg/ha a.i. was found effective in controlling weeds in citrus orchards.

### 3.9.4 Inter-cropping

The interspace in a young orchard can be economically utilized by growing short duration crops till the citrus plants come into bearing. A careful selection of intercrop is essential, to maintain soil conditions, as well as to improve the soil fertility, during the pre bearing stage of citrus orchards. The intercrops should be of short duration, shallow rooted, non exhaustive and preferably of leguminous type. The choice of intercrop has great bearing in growth, development and productivity of citrus. Pea, Cowpea are used as intercrop in citrus orchards.

### 3.9.5 Mulching

Use of mulches of organic and synthetic origins conserve soil moisture, check weed growth, regulate soil temperature and also prevent soil erosion. Mulching materials of organic origin are also known to be beneficial through their contribution to the supply of most of the plant nutrients and organic matter in the soil. Various materials of plant origin like straw, leaves and crop residues are being successfully employed as organic mulches, in citrus orchards. In recent years, mulching with black polythene sheet is also under practise.

### 3.9.6 Training and Pruning

Citrus requires the least amount of pruning except that a very strong framework



be developed at the beginning. For that purpose training and pruning are started in the nursery and continued in the field during the early years. The rootstock as well as 30 to 45 cm of the scion should be kept unbranched, and 4 to 5 well spaced branches are retained, so that a thick bushy crown is formed. Annual pruning is undesirable in citrus as results of experiments show that in general, pruning results in reduction in yield in citrus, but improves fruit quality. Inward growing branches, crossed branches, dead or diseased woods, should be removed.

### 3.9.7 Thinning of Fruits

When the citrus trees are 3 to 4 years old even than they produce heavy crop, this is more common in light soils. At this stage the crop needs to be regulated through judicious thinning especially during first few years of bearing. If heavy crop are taken from the trees during the initial years, not only the tree health gets impaired but also the fruit size is reduced. Thinning of the fruit and floral buds, should be done to keep a balance of the tree foliage and number of fruits, per tree and for proper flushing every year.

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## 3.10 INSECT-PESTS AND DISEASES

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Different citrus crops are attacked by several insect-pest and disease. These have been described one by one below:

### 3.10.1 Insect-pests

A great number of insects and mites have been reported to attack different species and cultivars of citrus.

#### 3.10.1.1 Citrus Psylla (*Diaphornia citri*)

Citrus psylla attacks all species and varieties of citrus. Both the adults and nymphs of this pest suck the sap from the tender parts of the buds, leaves and branches. In case of severe attack, the leaves become distorted, sickly, curled up and wither away, causing heavy leaf fall. The nymphs secrete whitish crystalline honey dew which helps in the growth of fungal infection. The pest can be controlled by spraying the plants with Phosphomidon (0.025 %), Malathion (0.05 %) and Monocrotophos (0.025 %).

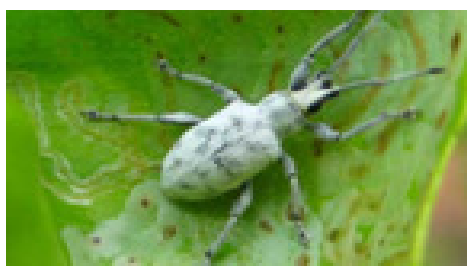


Citrus Psylla-Insect

#### 3.10.1.2 Citrus Leaf Miner (*Phyllocnistis citrella*)

Citrus leaf miner is a serious pest of almost all citrus species, but this pest mostly attacks species and varieties with succulent leaves and thin cuticle. The larvae feed on the epidermis of tender leaves. The affected leaves turn yellow, get distorted and crumpled which gradually dry and die away.

To control the pest population, pruning of all affected parts during winter should be done. Weekly spray with systemic insecticides like Phosphomidon (0.03 %) or Monocrotophos (0.035 %) during emergence of new leaves has been found to be highly beneficial.



**Citrus Leaf Miner**

### 3.10.1.3 Citrus White Flies (*Dialeurodes citric*)

About one dozen species of white flies have been reported to attack citrus sp. in India. Of these the most destructive ones are citrus black fly and citrus white fly. Citrus black fly, has caused great damage to citrus orchards in few districts of Maharashtra. The adult and nymphs suck the sap from tender foliage and devitalize the tree. Sometimes, infestation is so severe that the whole orchard looks sickly and black. Fruit turn black in colour and become insipid in taste.

It can be effectively checked by spraying 570 ml of Thiodan 35 EC (endosulphan) in 500 litre of water.

### 3.10.1.4 Mites

Several species of mites may attack tropical citrus orchards during dry periods. It multiplies very fast when favourable weather condition (high temperature and high humidity, but no or little rain) prevails. The mites destroy epidermal cells of leaves and fruits, and thus cause 'russetting' (dark or silver grey spots). Lesions formed on young fruit expand and render the fruit unfit for sale. Control measures include spraying with 0.02 per cent Malathion or 0.05 per cent Monocrotophos.

### 3.10.1.5 Bark Eating Caterpillar

It is commonly found insect causing damage to old and neglected plantations. The caterpillars are bark feeders causing damage to transportation tissues.

Removal of webbing followed by spraying with carbaryl dust (50 % WP) on the infested portion of the bark controls the pest.

## 3.10.2 Diseases

Citrus is attacked by a number of diseases caused by fungi, bacteria and viruses. The important one's are discussed below:

### 3.10.2.1 Citrus Canker (*Xanthomonas citri* pv. *citri* (Hasse))

It is one of the most serious disease of kagzi lime, especially during the rainy season. The disease is highly infectious spread from tree to tree through the water splash. It affects the leaves, twigs, fruits and even thorns. The lesions appear as small, yellowish spots which enlarge to a diameter of 3 to 4 mm and become raised and rough or spongy and turn brown. In case of severe infection, the fruit becomes totally unmarketable.

## Sub Tropical Fruits

The spread of infection can be checked by pruning and burning of diseased twigs, especially before monsoon. The cut ends of stem and branches may be disinfected with Bordeaux paints containing 1 kg monohydrated copper sulphate, 2 kg hydrated lime and 3 kg linseed oil. Three sprays of Streptocycline at 100 ppm or combination of Streptomycin and Copper or Neem cake suspension during February, October and December would keep the disease under control.



**Citrus Canker**

### 3.10.2.2 Scab (*Elsinoe fawetti*)

Sour orange orchards are affected by this form of scab, which is widely distributed. The typical symptoms of scab are development of corky lesions on leaves, fruits and on young twigs, distortion of leaves, hardening of fruits leading to premature drop in severe infection.

It can be effectively controlled by spraying Bavistin (0.05 %), Topsin-M (0.05 %) with pasting Bordeaux mixture (1 %) after pruning the infected parts.

### 3.10.2.3 Gummosis (*Phytophthora palmovira*)

The disease usually starts with dark water soaked spots on the bark at the base of the tree, later the bark shrinks and loosens in vertical strips, while the gum is exuded. Sweet oranges, mandarins, grapefruits and lemons are highly susceptible, while the rootstocks like Sour orange, Trifoliate orange and Rangpur lime are usually considered as tolerant to gummosis.



**Gummosis disease of Citrus**

Control measures include use of resistant rootstocks, grafting as high as possible from the ground level, keeping the soil round the stem base dry and use of copper fungicides. The nursery should be kept free from

stagnant water. If the infection has not spread much on the tree, the affected portion may be scrapped and disinfected with Mercuric chloride (0.1 %) followed by an application of Bordeaux paste (1:2:20 water) on the affected as well as healthy portion on the stem.

### 3.10.2.4 Virus Like Diseases

i) **Greening** : It is caused due to mycoplasma like organism. Leaves of infected trees show chlorotic pattern similar to zinc



**Greening virus of Citrus**

deficiency. The leaves may be completely yellow or yellow with green veins. Die back of branches and greening of fruit takes place. The disease is spread through the vector *Diaphornia citri*. Use disease free bud wood and spray against the vector citrus psylla to control this disease.

- ii) **Tristeza** : Tristeza ‘a quick decline’ is a widespread virus through out the citrus growing regions. The symptoms of tristeza virus consist of two components: the stem pitting and seedling yellows. Stem pitting is indicated by honey combing, development of pitting of the inner face of the bark of trunk. Presence of seedling yellows is indicated by foliar chlorosis. The infected trees



Tristesza virus of Citrus

shows absence of new growth, defoliation, root decay, stunted growth, twig die back, leading to death of plant. It is transmitted by *Toxoptera citricidus*. Use of tolerant rootstock such as sweet orange, Rangpur lime, rough lemon, citranges. Use only disease free bud wood. Use of insecticides against aphid vector to check the spread of the disease.

- iii) **Exocortis** : It is caused due to viroids. Cracking and scaling of bark of trifoliolate, citranges and Rangpur lime rootstocks is noted. Epinasty and curling of leaves, yellow blotches and cracks appears on shoots of some citrus species. Trees show stunted growth.

The disease spreads through contaminated budding knives and also through infected bud wood.

### 3.10.2.5 Citrus Nematode (*Tylenchulus semipenetrans* Cobb)

Nematodes are the key factors of declining of many citrus orchards. The nematodes may affect the growth of citrus trees by injuring root bark, removing plants nutrients during feeding, impairing normal growth and functioning of roots and possibly injecting toxic material into the trees.

It can effectively be controlled by using chemicals. Soil application of Carbofuran, Chlorpyrifos or Monocrotophos at 1000 ppm control citrus nematodes. It can also be reduced by application of Neem, Mustard or Mahua cakes as soil amendments.

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## 3.11 PHYSIOLOGICAL DISORDER

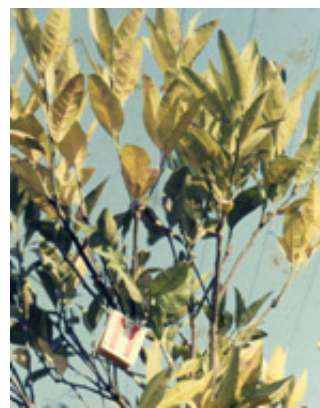
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### 3.11.1 Citrus Decline

The decline in citrus is characterized by death of twig and small branches, yellowing of the leaves, reduction in leaf size and poor yield. Affected trees become unproductive. Citrus decline is a complex phenomenon brought about by diverse factors, such as improper soil orchard management practices (graft incompatibility, excessive intercropping, lack of fertilization, improper



irrigation), soil conditions (soil salinity, poor drainage and poor physical conditions of the soil), micro nutrients imbalance (deficiency of Zn, Cu, Mn and Fe), pests (Citrus leaf miner, aphid, psylla, fruit sucking moth, lemon butterfly and mites), diseases (gummosis, canker and pink disease), viruses (tristeza, xyloporosis, greening and porosis) and nematodes (*Tylenchulus semipenetrans*).

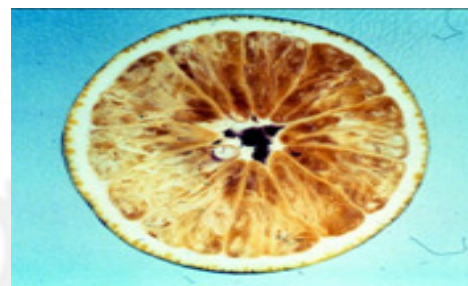


Citrus decline physiological solution

Antibiotic treatments of the affected trees have shown promise but use of disease free planting material is strongly advocated as the only definite means of keeping the disease under check. The use of resistant rootstock like Rangpur lime, trifoliate orange and citranges is recommended for tristeza control.

### 3.11.2 Granulation

In granulation, the juice sacs become tough, enlarged nearly colourless and tasteless. In granulated fruits, cell walls of juice vesicles become thicker than normal, pectic substances increase and form gels, alcohol insoluble fraction of juice vesicle increases, sugar, organic acid and carotenoids decrease, whereas mineral constituents increase. Number of viable seeds per fruit is considerably reduced in granulated fruits. Although moisture content of the granulated vesicles is higher than normal. The water gets bound in gels and therefore is not available as juice. Granulated vesicles are rather tasteless because of low sugars and acid content. The exact cause of the granulation is still remaining unknown. In India, sweet orange, like Hemlin orange, mosambi, are prone to granulation and among mandarins, Dancy is highly susceptible while kinnow show least susceptibility.



Following measures are effective for reducing the incidence of granulation reducing. Spraying of 16 ppm 2,4-D on developing fruits, spraying a mixture containing zinc, copper and potassium each at 0.25 per cent at monthly interval are effective in controlling the incidence.

### 3.11.3 Fruit Drop

Fruit drop is a serious problem in citrus. Generally the trees bear large number of flower and fruits, all of which they are unable to carry to maturity. It is a common observation that not more than 7 to 8 per cent of the flowers develop into mature fruits. First from the unfertilized flower drop it continues up to pre harvest drop. The fruit drop is primarily due to the formation of an abscission layer at the point of attachment of the fruit with the twig.

Excessive pre harvest drop can be checked by spraying the trees with 10 ppm of 2,4-D in September about 2 months before harvesting. When the fruit



drop happens due to pathological cause, it can be checked by spraying the trees with 20 ppm Auerofungin (35 g in 500 litre of water) or Bordeaux mixture @ 2:2:250 in April, July, August and September.

### 3.12 HARVESTING

The citrus fruits should be harvested when they are fully ripe as they are non-climacteric in nature. Citrus fruits develop their characteristics flavour and aroma at fully ripe stage. A citrus fruit generally takes from six to twelve months to mature. Harvesting times depends on the species and cultivars and also on the agro climatic conditions. Limes and lemons are harvested when fully developed but the skin remains green, however, these are considered to be mature when the fruits contain a minimum of 25 per cent juice. TSS/acid ratio is also considered to be a fairly a good index of maturity in most of the citrus fruits.

Harvesting should be done by clipping from the tree. A sharp clipper or slightly curved blunt shear is best suited for picking the fruits. The best means of reaching high fruits is with a ladder. Fruit should be collected in a picking bags carried over the pickers shoulders. Before storage or packing the fruits should be properly cleaned and suitably graded.

The full grown sweet orange tree yields 500 to 1000 fruits. A healthy mandarin tree is reported to yield 350 to 500 fruits, while a kagzi lime may produce 600 to 1500 fruits per year.

### 3.13 STORAGE

Citrus fruits can be stored well for a few days at room temperature, but cold storage helps in extending the storage life to several months, without any appreciable reduction in marketable quality. Cooling oranges immediately after harvest (0 to 1.6°C for 16 hours) improves storage life.

The recommended storage condition of some citrus fruits is given below:

**Table 6 :** Storage conditions for some citrus fruit.

| Name of crop   | Temperature<br>(°C) | Relative humidity<br>(%) | Period        |
|----------------|---------------------|--------------------------|---------------|
| Orange         | -1 to 7             | 85 to 90                 | 1 to 6 months |
| Mandarin       | 4 to 7              | 85 to 90                 | 3 to 12 weeks |
| Grapefruit     | 10 to 15            | 85 to 90                 | 3 to 13 weeks |
| Lemon (Green)  | 11 to 14            | 85 to 90                 | 1 to 4 months |
| Lemon (Yellow) | 0 to 10             | 85 to 90                 | 3 to 6 weeks  |
| Lime           | 8 to 10             | 85 to 90                 | 3 to 8 weeks  |

### 3.14 PACKAGING

Now-a-days, most citrus fruits are packed in card board boxes holding 18 to 20 kg fruits. Fibre board cartons are also suitable packages for long distance

transport through railways. In most parts of the country, citrus fruits are packed in bamboo basket and wooden boxes.

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### 3.15 TRANSPORTATION

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For long distance the fruits are transport through railways and trucks, while even for export purpose air services are taken. Railway wagons for transplanting fruits should be well ventilated so as to neutralize the heat generated by the fruits or absorbed due to radiation. In India, fruits packed in bamboo baskets and wooden boxes are transported through road and rail.

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### 3.16 PROCESSING

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Citrus fruits can be utilized in a number of ways as salads, juices, squashes, cocktails, syrup, concentrate, marmalades and pickles. The peel of thick rinded citrus fruits can also be made into delicious candy. Orange, lemon, lime and grapefruit juices are bottled and canned in large scale. The rind of citrus fruits is rich in pectin and certain essential oils, which is used in flavouring and in perfumery.

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#### Check Your Progress Exercise 2

**Note :** a) Space is given below for the answer.

b) Compare your answer with that given at the end of the unit.

1. What are the main causes of citrus decline ?

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2. What are the control measures of citrus leaf miner and gummosis ?

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3. What are the processed products of citrus ?

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### 3.17 LET US SUM UP

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In the present unit, you have studied about the different species of citrus and their commercial cultivars along with their area of cultivation and production. You got knowledge about the planting and propagation methods, their

nutritional requirements, cultural practices which performed in the citrus orchards, symptoms and control measures of different insect-pests, diseases and physiological disorders. Get the information about the harvesting, storing, packaging, transporting and processing of fruits. This units also have provided knowledge about orchard management operations like care of young plants, weeding, training and pruning, manuring and fertilization, irrigation, pest and disease management for higher fruit production and better quality fruits.

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### 3.18 KEY WORDS

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- Granulation** : A disorder in citrus wherein the juice vesicles becomes hardened greenish which causes decrease in soluble solids, acids and accumulation of polysaccharides and increase in sodium, calcium and magnesium content.
- Tristeza** : Sad appearance of the tree caused by virus.
- Fruit drop** : Dropping of fruits at different stages of development due to competition among the growing fruitlets, lack of pollination and fertilization, unfavourable environmental conditions, hormonal imbalance etc.

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### 3.19 FURTHER REFERENCES

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3. Singh, S., Krishnamurthy, S. and Katyal, S.L. (1967). **Fruit Culture in India**, ICAR, New Delhi.

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### 3.20 ANSWERS TO CHECK YOUR PROGRESS EXERCISES

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#### Check Your Progress Exercise 1

1. The main species of the mandarin group are *Citrus reticulata* (Blanco), *C. unshiu* (Macrovitich), *C. deliciosa* (Tanore), *C. tangerina hort* (Tanaka), *C. reshni* (Tanaka) and *C. nobilis* (Lourerio).
2. Citrus fruit are rich in vitamin C, minerals and many other substances. The juice of ripe orange and mandarin contains 8 to 12 per cent sugars and other soluble solids, 0.5 to 1.5 per cent citric acid, 25-80 mg ascorbic acid per 100 g. Grapefruit and sour orange contains relatively less sugar and more citric acid (1.5 to 3.0 %). In lemon and lime, the acid content may go up to 6 and 8 per cent, respectively. The rind of citrus fruits is rich in pectin and certain essential oils, which is used in flavouring and in perfumery.

3. For edible purpose the following species are cultivated: *Citrus sinensis*, *C. reticulata*, *C. aurantium*, *C. limon*, *C. aurantifolia*, *C. grandis*, *C. paradisi* and *Citrus medica*.
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### **Check Your Progress Exercise 2**

1. Citrus decline is caused due to many reasons such as improper soil orchard management practices (graft incompatibility, excessive intercropping, lack of fertilization, improper irrigation), soil conditions (soil salinity, poor drainage and poor physical conditions of the soil), micro nutrients imbalance (deficiency of Zn, Cu, Mn and Fe), pests (Citrus leaf miner, aphid, psylla, fruit sucking moth, lemon butterfly and mites), diseases (gummosis, canker and pink disease), viruses (tristeza, xyloporosis, greening and porosis) and nematodes (*Tylenchulus semipenetrans*).
2. Citrus leaf miner can be controlled by pruning of all affected parts during winter. Weekly spray with systemic insecticides like Phosphomidon (0.03 %) or Monocrotophos (0.035 %) during emergence of new leaves has been found to be highly beneficial whereas gummosis is controlled by using resistant rootstocks, grafting as high as possible from the ground level, keeping the soil round the stem base dry, use of copper fungicides. The nursery should be kept free from stagnant water. If the infection has not spread much on the tree, the affected portion may be scrapped and disinfected with Mercuric chloride (0.1 %) followed by an application of Bordeaux paste (1:2:20 water) on the affected as well as healthy portion on the stem.
3. Marmalade, juice, candy, pickle, squash and nectars are major processed products of citrus.