The Co-operative Citrus Growers' Association of Trinidad and Tobago Ltd.

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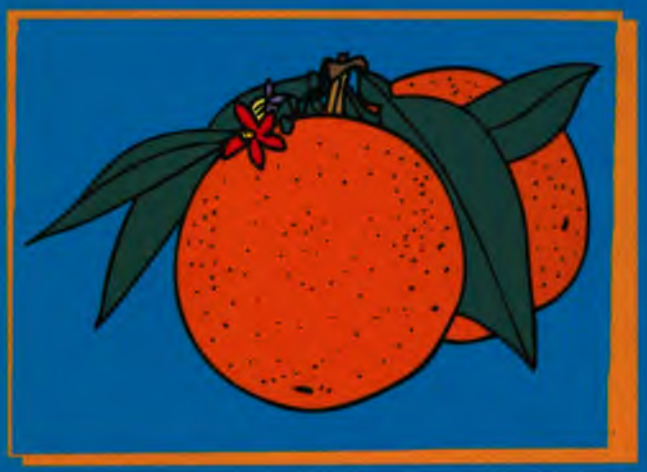

A Farmer's Guide to Citrus Production

IICA OFFICE IN TRINIDAD & TOBAGO

The Co-operative Citrus Growers' Association of Trinidad and Tobago Ltd.

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Production: Morton Publishing

Print: Caribbean Paper & Printed Products (1993) Ltd.

ACKNOWLEDGEMENT

First and foremost, I would like to thank IICA (The Inter-American Institute for Cooperation on Agriculture) for not only setting the path, but making this guide possible.

My sincere thanks to Judith Francis (former Regional Specialist, Technology and Innovation, IICA) for understanding and truly appreciating what is involved in the production of this guide.

I cannot fully express my gratitude to those who provided their services each working in their own way to make this guide a reality and who have improved this manuscript considerably.

I would like to ask those who use this guide to do so with creativity since it provides practical information which can be adjusted to meet their specific requirements.

Karl Burgess BSc, MSc.

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FOREWORD

CITRUS PRODUCTION GUIDE

The Citrus Industry in Trinidad and Tobago has historically been an important sector of the country's agricultural economy.

Citrus fruits including oranges, grapefruit, tangelos, tangerine, limes and other minor fruits have been produced in limited quantities, mostly for the fresh fruit market, with the Cooperative Citrus Growers Association processing the remaining available quantities of oranges obtained from local growers.

In recent years the industry has experienced a steady decline resulting from a combination of factors including the incidence of diseases such as citrus tristeza virus. At the same time, there has been a growing local demand for fresh citrus fruits as well as processed citrus products such as concentrate, citrus fruit drinks, freshly squeezed juices, jams and marmalades. This is consistent with the worldwide trend in demand for more healthy nutritious foods and the growing recognition of the importance of fruits in the diet.

The above factors have created the need to rehabilitate and expand the existing industry to meet this growing demand and hence creating new investment opportunities for citrus farmers.

The Inter-American Institute for Cooperation on Agriculture has over the years promoted the expansion of tropical fruit crops in response to the need for an agricultural diversification programme in the region and has supported the implementation of a Caribbean Regional Tropical Fruit Crops Project since the 1980s. This project has resulted in numerous workshops and publications in all aspects of fruit crop production and marketing.

In 2004, the Trinidad and Tobago office continues to promote the fruit sector and is represented on the Trinidad and Tobago Citrus Task Force. The office is therefore pleased to collaborate with the Cooperative Citrus Growers Association in the production of this guide to citrus production, which is intended to serve as a guide for the successful production of citrus in Trinidad and Tobago and the wider Caribbean.

It is our hope that the Citrus Farmers' Extension Officer, Researchers and other Stakeholders will find the materials therein useful.

Aaron Parke
Representative in Trinidad & Tobago
and Coordinator, Caribbean Regional Agenda

INTRODUCTION

Citrus is believed to have originated somewhere in the vast region of Southern Asia, with the centre of origin as possibly India, Burma or China. With exploration and trade many types of citrus moved westward into Europe and Africa. It eventually arrived into the Caribbean during the second voyage of Christopher Columbus. It was introduced into Haiti in 1493 and into Barbados by Captain Shaddock in the 17th Century. Grapefruit is believed to have originated in Barbados either as a mutation or hybrid of the shaddock. It was introduced into Florida probably from Jamaica in or about 1809.

In Trinidad and Tobago, citrus, especially oranges, limes and grapefruit are favourite fruit trees for both the backyard and commercial growers. Today the range of citrus has been extended to include easy-peel varieties such as Dancy, Fremont and Hansen. With the spread of new pests and diseases, the apparent changes in local weather patterns and the increasing demands for citrus for health benefits, the need arises for a revised and revived approach to citrus production.

The intent of this guide is to provide the farmer with information on the important practices involved in the growing of citrus. Each citrus type has its own peculiarities as it relates to cultivar, soil type, scion/stock relationship and environmental considerations. This guide is neither a literature review nor does it seek to achieve the status of a technical paper. Instead, it attempts to be as current as possible with the understanding that changes are currently occurring especially in the fields of environment-friendly pesticides, wider ranges of inorganic fertilizer, and varying management styles and strategies as they all relate to citrus production. Indeed, not all aspects are addressed. The challenge lies for the farmer and interested parties to use this guide with the technology available to advance in awareness and knowledge of citrus.

CULTIVARS

Commercial citrus belong to the Citrus genus of the Rutaceae family and are classified into several groups including sweet oranges (Citrus sinensis [L.] Osb.), grapefruits (Citrus paradisi Macf.), limes (Citrus aurantifolia Christm. Swing), lemons (Citrus limon [L.] Burm.), shaddocks (Citrus grandis [L.] Osb.), mandarins (Citrus reticulata Blanco) plus various hybrids for example, ortanique (orange x tangerine).

Between groups and within each group one can find differences in the size, colour, shape, taste, texture and quantity of fruits and size and shape of leaves and trees. There are even differences in the time of bearing which have been traditionally recognised as:

- Early - October to December.
- Mid Season - January to February.
- Late Season - March to April.

It is important to realise that these times are not constant and will vary from year to year, depending on the location, soil type, cultural practices and weather pattern.

1. ORANGES

Oranges can be divided into two (2) main groups. These are *'the sweet'* and *'the sour or bitter'* oranges. Within the *sweet orange group* there are four (4) subgroups:

- Common or Round oranges e.g. Valencia, Pineapple, Parson Brown, Hamlin, Cocoa.
- Navel oranges e.g. Washington, Australian Navel.
- Pigmented or Blood oranges e.g. St. Michael's Blood whose reddish colour is not developed locally possibly due to generally high night time temperatures.
- Sugar or Acidless oranges (these do not occur in Trinidad & Tobago).

Sour or Bitter Oranges:

- Seville Sour (bitter sweet orange).

These generally have a sour or bitter flavour and bumpy skin.

Table 1. CHARACTERISTICS OF SOME ORANGES

Variety	Season	Fruit Size	Seed Content*	Juice Content	Flavour	Yield
Valencia	Late	Medium	Few/Seedless	High	Good	High
Pineapple	Mid	Medium	Seedy	Good	Sweet	High
Parson Brown	Early	Medium/Small	Seedy	Good	Sweet	High
Hamlin	Early	Medium/Small	Seedless	Good	Sweet	High
Cocoa	Early	Medium	Seedy	Good	Sweet	High
Washington Navel	Early	Medium/Large	Seedless	Fair	Sweet	Erratic
St. Michael's Blood	Early	Medium	Moderate	High	Sweet	High

** seedless 0-8, moderate 9-15 and seedy > 15.*

Plate 1: Valencia Oranges

Plate 2: Pineapple Oranges

Plate 3: Parson Brown Oranges

Plate 4: Hamlin Oranges

2. GRAPEFRUITS

These generally are medium to large fruits with a smooth rind, solid or semi-hollow pith and have a distinctive flavour. Grapefruits are of two main types namely:

- Non-pigmented flesh e.g. White Marsh, Duncan.
- Pigmented e.g. Pink Marsh, Foster, Ruby.

Table 2. CHARACTERISTICS OF SOME GRAPEFRUITS

Variety	Season	Fruit Size	Seed Content	Juice Content	Flavour	Yield
White Marsh	Mid	Medium	Seedless	High	Good	High
Duncan	Early	Large	Seedy	High	Good	High
Pink Marsh	Early	Medium	Seedless	High	Good	High
Foster	Early	Medium/Large	Seedy	High	Good	Medium
Ruby	Early	Medium/Large	Seedless	High	Good	High

Plate 5: White Marsh grapefruit

Plate 6: Duncan grapefruit

Plate 7: Pink Marsh grapefruit

Plate 8: Foster grapefruit

Plate 9: Ruby grapefruit

3. MANDARINS / TANGERINES

This group is comprised of a range of cultivars having the following characteristics:

- The fruit has a flattened shape.
- The fruit peel easily.
- The pith or centre is open or hollow.
- The seeds contain green cotyledons.
- The flavour and aroma are quite distinct.
- Trees are prone to irregular bearing.

Examples of these include the Portugal, Dancy and Cleopatra.

Table 3. CHARACTERISTICS OF MANDARINS/TANGERINES

Variety	Season	Fruit Size	Seed Content	Juice Content	Flavour	Yield
Portugal	Early	Small/Medium	Many	High	Sweet/Acidic	Irregular
Dancy	Mid	Small/Medium	Few/Moderate	Moderate	Sweet/Acidic	Irregular
Cleopatra*	Late	Small	Moderate	High	Sweet/Acidic	High

** used usually as a rootstock*

Plate 10: Portugal

Plate 11: Dancy

Plate 12: Cleopatra

4. LIMES / LEMONS

This group has the following characteristics:

- The juice is highly acidic.
- Trees are generally shrub-like and may or may not have thorns.
- Can bear year round.
- Vigorous growth.

Some examples of these include the West Indian lime, Tahiti, Rough Lemon and Lisbon Lemon.

Table 4. CHARACTERISTICS OF SOME LIMES

Variety	Season	Fruit Size	Seed Content	Juice Content	Flavour	Yield
West Indian lime	Early	Small	Moderate	High	Acidic	High
Tahiti lime	Early	Medium	Seedless	High	Acidic	Moderate/High

Plate 13: West Indian lime

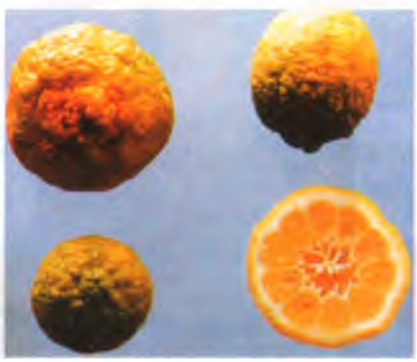


Plate 14: Rough Lemon

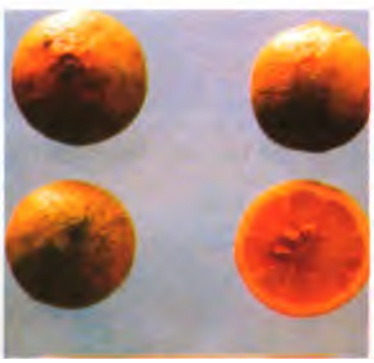


Plate 15: Lisbon Lemon

Table 5. CHARACTERISTICS OF SOME LEMONS

Variety	Season	Fruit Size	Seed Content	Juice Content	Flavour	Yield
Rough	Mid	Medium	Moderate	Medium	Moderate	Moderate/High
Lisbon	Late	Medium	Few/None	High	Acidic	Moderate/High

5. CITRONS

This group is characterized by:

- Medium to very large inedible fruits.
- Peel that is very thick and often bumpy.
- Small, firm flesh which contains little juice.
- Trees with thick stems, light grey bark and soft wood.
- Large flowers, sometimes with a purple tinge.

Some examples of these include the Barrackpore and the St. Augustine.

Table 6. CHARACTERISTICS OF SOME CITRONS

Variety	Season	Fruit Size	Seed Content	Juice Content	Flavour	Yield
St. Augustine citron	Early	Medium/Large	Few	Very Low	Acidic	Moderate
Etrog citron	Early	Small/Medium	?	Very Low	Acidic	Moderate
Barrackpore citron	Early	Large	?	Very Low	Acidic	Moderate

Plate 16: St Augustine citron

6. PUMMELOS / SHADDOCKS

In this group the tree looks similar to grapefruit however the leaves and flowers are generally the largest of the citrus family and fruit have the following characteristics:

- They are the largest of the citrus fruits.
- Variable size and shape (generally round to pear shaped).
- The rind is thick to very thick.
- The flesh is firm, somewhat crispy to crunchy with little to moderate juice.
- The segments are easily separated with juice sacs having distinctive flavour.
- Young leaves and stems are pubescent (hairy).

Some locally identified examples of these include the Large Red, Large Pink, Large White and Small White.

Table 7. CHARACTERISTICS OF PUMMELOS/SHADDOCK

Variety	Season	Fruit Size	Seed Content	Juice Content	Flavour	Yield
Shaddock	Early	Variable	Few	Moderate	Sweet	Moderate

Plate 17: Pummelo (large white)

Plate 18: Pummelo (small white)

Plate 19: Pummelo (large pink)

Plate 20: Pummelo (large red)

7. CITRUS HYBRIDS

These are mainly mandarin hybrids, i.e. crosses within the citrus family and include:

1. Ortanique – a cross between the orange and the tangerine/mandarin
2. King - a cross between the orange and the tangerine/mandarin
3. Tangelo – a cross between grapefruit and tangerine.

The main commercial hybrid in Trinidad and Tobago is Ortanique which is characterized by:

- Manadarin shape fruit.
- Bright yellow to orange peel which is smooth and glossy.
- Bright orange coloured flesh at maturing.
- Rich distinctive flavour juice

Table 8. CHARACTERISTICS OF SOME CITRUS HYBRIDS

Variety	Season	Fruit Size	Seed Content	Juice Content	Flavour	Yield
Ortanique	Late	Medium	Moderate	High	Sweet	Erratic
Temple	Mid	Medium	Seedy	Moderate	Sweet	High
King	Late	Large	Variable	Moderate	Sweet	Variable
Tangelo	Mid	Small/Medium	Seedy	Moderate	Acid/subacid	Moderate

Plate 21: Ortanique

Plate 22: Temple

Plate 23: King

PLANTING MATERIAL

When choosing a plant, it is important to look for the following features:

- Each plant must have a healthy appearance with no signs of pests and diseases.
- Each plant must be labelled to ensure you have the desired selection. This is very important when establishing commercial groves since different varieties have different requirements.
- Each plant must have an upright/straight appearance.
- The bud/graft union must be properly healed and at the recommended height of 30 - 40 centimetres (12-16 inches).
- No growth from the rootstock must exist.
- There must be a good friable soil mix to stimulate root growth and better plant performance.
- The containers, bags or pots must be of reasonable height/depth, which encourages natural taproot and lateral root growth and development thereby ensuring a more desirable plant.

Purchase plants from recognized/certified nurseries.

Poor Plants - Lower Yields - Less Profit

Quality Plants - Higher Yields - Greater Profit

Choose A Quality Plant. Choose Carefully. Choose Wisely!

PLANT QUARANTINE REGULATIONS

Every person must apply for an import permit before importing any plant material into the country. This is in accordance with the Plant Protection Act No. 13 of 1975 para. 3. (1) which states '*subject to this Act no person shall import into Trinidad and Tobago any fruit, planting material, plant pest, pathogen, plant product, soil, vegetables, or any other prescribed article* **unless he first obtains a permit in accordance with the provision of this Act** *or the regulation.*'

Do not bring non-certified citrus material into the country as you might bring new pest/diseases which will put whole citrus industry in the country at risk.

PROPAGATION METHODS

Citrus plants can be propagated by several techniques namely, by seed or by vegetative methods including budding, grafting, layering or cuttings.

A. Propagation From Seeds

The seeds obtained from most citrus varieties will germinate and grow into mature plants. However,

- They usually take a very long time to flower.
- They may not true to type. i.e. they may not resemble their parents especially when it comes to bearing fruit.
- They tend to be very vigorous having upright growth with sharp, strong pointed thorns and very bushy.
- They tend to be susceptible to a wide range of soil borne diseases and nematodes
- They produce inferior quality fruits in the first few years of bearing.

*Therefore it is wise **NOT** to use seeds to propagate your citrus plants.* However plants produced from seed have the major advantage of starting off virus-free.

If you want to start your own nursery, it is advisable to:

- Seek assistance from the Ministry of Agriculture, Land and Marine Resources.
- Locate a reputable seed company or seed nursery to purchase seeds, and,
- Ensure that seeds be certified/recommended virus free for specific viruses by Ministry of Agriculture, Land and Marine Resources/Plant Quarantine Division.
- Ensure that budwood used is certified virus-free.

Trinidad and Tobago is currently embarking on a mandatory certification programme that will allow sale of plants from certified nurseries only. The following information on propagation is mainly for the guidance of current and potential nurserymen.

B. Vegetative Propagation

Plants propagated vegetatively (by budding, grafting, layering etc.) will be true to type i.e. resemble their parents; begin to provide fruits much earlier- within 2 years, and if certified scion/stock is used, then they will be relatively disease-free guaranteeing higher yields and greater profits.

B1. The Rootstock

A suitable rootstock is needed for a successful orchard since the root system of your future tree is responsible for the uptake of water and nutrients to the plant, ensures support to the budded plant and provides tolerance to some diseases (Table 9). In addition, with the appropriate rootstock one can ensure the following advantages:

- Resistance or tolerance to soil nematodes.
- Resistance or tolerance to certain citrus viruses/diseases.
- Adaptability to several soil types and conditions e.g. Sour orange and Troyer Citrange stock are suited to clay, while Rough Lemon is suited to a sandy soil.
- Influences size, yield, texture and internal quality of fruit.
- Have dwarfing ability, e.g. Trifoliate orange enables the tree to remain relatively short.

Disadvantages of Rootstock:

- Fruit quality is negatively affected by very vigorous stock growth
- No one rootstock is resistant to all diseases.

Table 9. CHARACTERISTICS OF SOME ROOTSTOCKS

Rootstock	Tree vigour	Tolerance To				Effect on fruit yield
		Soil fungi	Tristeza	Exocortis	Citrus nematode	
Cleopatra mandarin	H	T	T	T	S	LI
Sour orange	I	T	S	T	S	I
Carrizo citrange	H	T	T	S	T	H
Swingle citrumelo	H	T	T	S	T	H
Troyer citrange	I	R	T	S	R	I
Volkamer lemon	H	S	T	T	S	H
Rough lemon	H	S	T	T	S	H

Source: Davies F., Abrigo L., 1994 Citrus p. 84-85

Key to Symbol: G - Good; H - High; I - Intermediate; L - Low
R - Resistant; S - Susceptible; T - Tolerant

Choosing A Rootstock / Scion

It is important to select a rootstock/scion combination for your particular environment. This decision will affect the life of the orchard, your yield, your profits. It is a long term decision.

In choosing a rootstock it is necessary to do the following:

- Know your soil type.
- Know the status of your soil. i.e. its "pH", which nutrients are available in what quantities, and its water holding capacity.
- Obtain information on the history of the site i.e. one which had citrus or other crops, previously planted on that site.
- Decide on the market you wish to target i.e. fresh fruits for the table market as opposed to fruits for the processing plant.
- Choose scion(s) wisely since one cannot easily switch to another scion later in the life of the tree.

SITE SELECTION

It is impossible to have the ideal site (soil, water, temperature, wind etc.) to grow your citrus. Every site will have some limitations, however one can use the appropriate practices (e.g. irrigation, fertilization) to overcome some aspects of your site problems like drought and poor soil.

When choosing a site, several factors must be taken into consideration:

Soil

Citrus can grow on a wide range of soil types, but will grow better on a deep sandy to sandy loam soil, or any well drained soil.

Find out which type of soil you have; the characteristics of the soil, its pH, which nutrients are available and in what quantities. This can be achieved by requesting personnel from the Soils Section of the Ministry of Agriculture, Land and Marine Resources (Research Division) to take samples of your soil for analysis. They will advise you what you need to do to improve your soil structure and also which nutrients you will need to improve the growth and performance of your crop.

Of importance is the pH of the soil which should range between 5.5 and 6.0. If the pH is not correct or the area is waterlogged the nutrients will remain in the soil and not be taken up by the tree.

A *soil test* will help determine the suitability of the site for citrus.

Water

Proper water management is necessary throughout the life of your citrus. Water is especially important when plants are newly established and in the vegetative stages of growth. If water is available all year (a wet year or you irrigate all year) then flowering and fruiting tend to be poor with resultant low yields since the plants remain in the vegetative stage.

Citrus need a dry period in order for the plant to shift from vegetative to reproductive (flowering to fruiting) stage. The suggested dry period for flowering is 6-10 weeks for grapefruits, 4-6 weeks for oranges and 3-5 weeks for limes. If there is a prolonged dry season, then the plants will require some form of irrigation to ensure plant survival, continued tree growth, and satisfactory yields.

Other methods to overcome drought include:

- Use of a mulch, e.g., dry grass on the soil surface to conserve water for newly planted trees up to three years.
- Use generous amounts of organic matter, like manure, at planting in order to improve the water holding capacity of the soil and promote faster plant growth.

Water Is Necessary For Maximum Growth And Best Yields.

Excessive Water/Flooding

Excessive water affects plants in the following ways::

- If the water becomes stagnant, the plant will not 'breathe'. i.e receive oxygen and will eventually die.
- Very young plants will die faster.

If your soil is a heavy clay, then you may expect the following:

- Severe drying out of the soil during the dry periods of the year.
- Heavy waterlogged soil in the wet season.
- Difficulties in planting in the wet season.

If the area is prone to flooding then the following measures are required for successful cultivation:

- Properly grading the land to improve drainage.
- Establishing a drainage system.
- Planting on raised beds or mounds.
- Using a rootstock which is tolerant to excessive water e.g. Troyer citrange.

Temperature

Citrus can tolerate the range of temperatures which exist in the Caribbean. The main issue with respect to temperature is the development of peel colour. The development of attractive yellow and orange colour is influenced by a combination of low soil temperature and low air temperature at night. These conditions are more common at high elevations and in some valleys.

Wind

Constant strong, intense/sustained winds may:

- Create faster loss of water from the plant resulting in wilting of leaves and a general unhealthy appearance.
- Cause the plant to have a 'wind swept' appearance.
- Predispose the plant to high populations of sucking insects.
- Cause premature fruit drop thereby lowering yields.

Wind Avoidance - The best approach to alleviate the wind situation would be:

- Know the general direction of the wind.
- Maintain open canopies in order to reduce wind resistance by regular pruning.
- Plant in areas where wind is not heavy.
- Establish windbreaks.

Topography

For commercial production, it is best to choose flat or gently undulating land where mechanical operations can be undertaken safely.

Location

In selecting a site it is important to:

- Have easy access to the site for conduct of field operations.
- Be able to minimise problems associated with praedial larceny.
- Select as good as possible a soil type for citrus production .

CULTURAL PRACTICES

Land Preparation

Where practicable, sites for growing citrus should be cleared completely and levelled before any planting operation begins. Any debris and unwanted materials should be removed from the site so as not to affect future field operations.

Land preparation should be guided by topography, drainage requirements, possible soil erosion and anticipated field layout. The site should be ploughed to a depth of at least 60 cm. (24 inches), and the beds cambered to at least 6-7 m. (20-25 feet) wide. The top of the camber should be at least 1 m. (3 ft.) above the furrow, allowing sufficient depth of soil for taproot and lateral root growth, thereby ensuring proper anchorage for the plant.

Rotavating the land at this stage will help in reducing the size of the clods in the soil, forming a finer tilth whilst at the same time grading the beds. At this stage, organic matter in the form of manure as well as limestone, (if recommended), can be applied.

Establishing Windbreaks

Constant intense winds affect the growth and performance of citrus plants. If the site is prone to these constant winds, then establish windbreaks. Windbreaks can be spaced about 60-120 m. (200-400 feet) apart. The number of windbreaks required depends on the acreage of the site and the wind intensity/constancy.

You the grower must decide whether a windbreak is necessary.

NOTE: A windbreak protects 10 times its height on its leeward side. Before establishing the windbreak, determine the expected height of the windbreak at maturity. Tree species suitable for windbreaks include Pomerac (*Eugenia* sp.), Jamoon (*Syzygium cumini*) or Mango (*Mangifera* sp.) trees. These species may provide additional revenue to the farmer.

Inter-planting with short-term crops provides revenue during the early years of establishment. Options include Bananas/Plantains (*Musa* sp.), Pigeon peas (*Cajanus* sp.), Pumpkins (*Cucurbita* sp.), Hot Peppers (*Capsicum* sp.) and Pawpaw (*Carica* sp.).

Tree Spacing

The tree spacing and field layout adopted should allow for the maximum interception of sunlight to obtain the highest yield per hectare while maintaining adequate space for mechanical operations. Recommended spacing for citrus can approximate:

Oranges	6.5m by 6.5m (20 feet by 20 feet)
Grapefruits	8m by 8m (25 feet by 25 feet)
Limes	4.5m by 4.5m (15 feet by15 feet)

Several planting patterns are in use, the most important being the square, the rectangular and the triangular patterns (Figure 1). The number of plants per/ha will vary with the layout desired. The rectangular and square layouts (Table 10) are neat systems easy to lay out and allow for easier mechanization. The triangular layout makes more efficient use of space by allowing a narrower interrow and about fifteen percent more trees can be planted.

Where the land is undulating the trees may be planted in lines following the contour of the land. The trees will not be equidistant and the number of plants will be generally less than the other layouts. However, there is the advantage of preventing excessive soil erosion which outweighs the reduction in tree population.

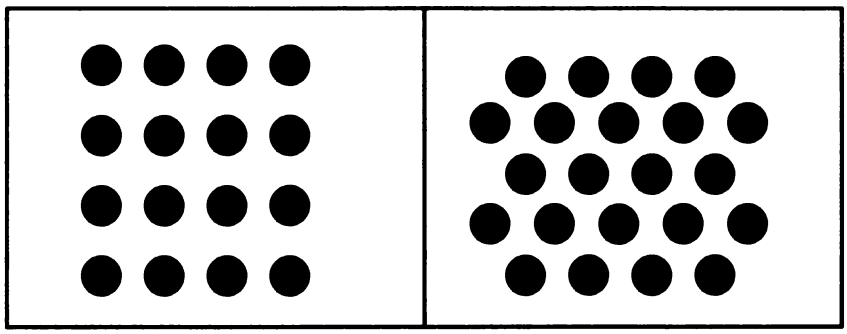


Figure 1. Comparison of Square (left) and Triangular (right) Methods of Planting

Table 10. Tree Spacings for Square and Triangular Layout of Citrus

Citrus Type	Layout	In Rows	Between Rows	No. of trees/ha
Oranges	Square	6m (18 ft)	6m (18 ft)	278
	Triangular	6m (18 ft)	5m (16.7 ft)	333
Grapefruit	Square	7m (22ft)	7m (22ft)	204
	Triangular	7m (22ft)	5.5m (18.3ft)	260
Limes	Square	4.5m (15ft) 4.5m	4.5m (15ft)	494
	Triangular	(15ft)	4m (13.3ft)	556

When lining out fields:

- Allow space for roads, drains and operation of machines.
- Take into account soil type, the rootstock and the expected growth rate.
- Ensure that rows are regular and the spacing of the plants is uniform.

High Density Planting

To optimize land use farmers may adopt high density planting. The trend worldwide is to plant trees closer together so when the trees mature they form a hedge. In making the choice between traditional spacing or high density planting farmers should weigh the increased costs with higher yields.

Advantages

- Higher yields for at least the first seven years, and earlier recovery of cost of establishment.
- Under conditions of poor soil fertility, trees never achieve full size and high density planting will always give higher yields.

Disadvantages:

- Cost of establishment and maintenance per unit area is higher.
- Pruning will be required when canopies touch. If competition for light occurs, trees become taller, fruiting is limited to the upper canopy and there is a general decline in yield.

PLANTING

The best time to plant trees is early in the wet season during the months of June - July. Trees planted at this time can become well established before the dry period begins. If however the rainfall is uncertain or irrigation is not available at planting then the plants should be properly watered and mulched with dry vegetation to conserve water. Keep mulch at least 30cm (12") from the stem of the plant to prevent stem rot/ foot rot and possible death of the plant. Do not plant more trees than can be cared for in one season.

Planting holes can be dug with the appropriate hand tools, or if there are many trees to be planted, then a tractor-mounted auger can be used. If using an auger, the sides of the holes should be rasped, as the smooth edge may restrict proper root growth and development.

The size of the hole should be at least twice the size of the container in which the plant is grown. The soil from the hole can be mixed with well-rotted pen manure or leaf litter. About 4g of high phosphorous (P) fertilizer, e.g. (15: 30: 15 or 9:33:9), should be added to increase availability and support plant growth.

The citrus plant must be removed from its polythene bag. Trees should be planted at the same depth in the field as it was in the polythene bag. Ideally, the bud union should be at least 30 cm (12") above soil level (Figure 2). *Do not establish the plant too deeply since the scion can come into contact with the soil and foot rot can occur even at this early stage. Too shallow planting depth will expose the roots and cause poor growth.*

After placing the plant in the ground, repack the soil around the root base and press firmly to remove air pockets. Some growers add water and press down the soil while others prefer to add water after the soil is firmly set around the plant. A slight mound around the root base will prevent water settling against the plant. This settling of water can cause root death leading to reduced growth or tree death. Plant as quickly as possible after removal from the container to prevent the root ball from drying out.

The plant may be staked to prevent wind from bending the plant. Staking identifies and supports the plant, encourages upright growth and thus prevents accidental destruction of the plant.

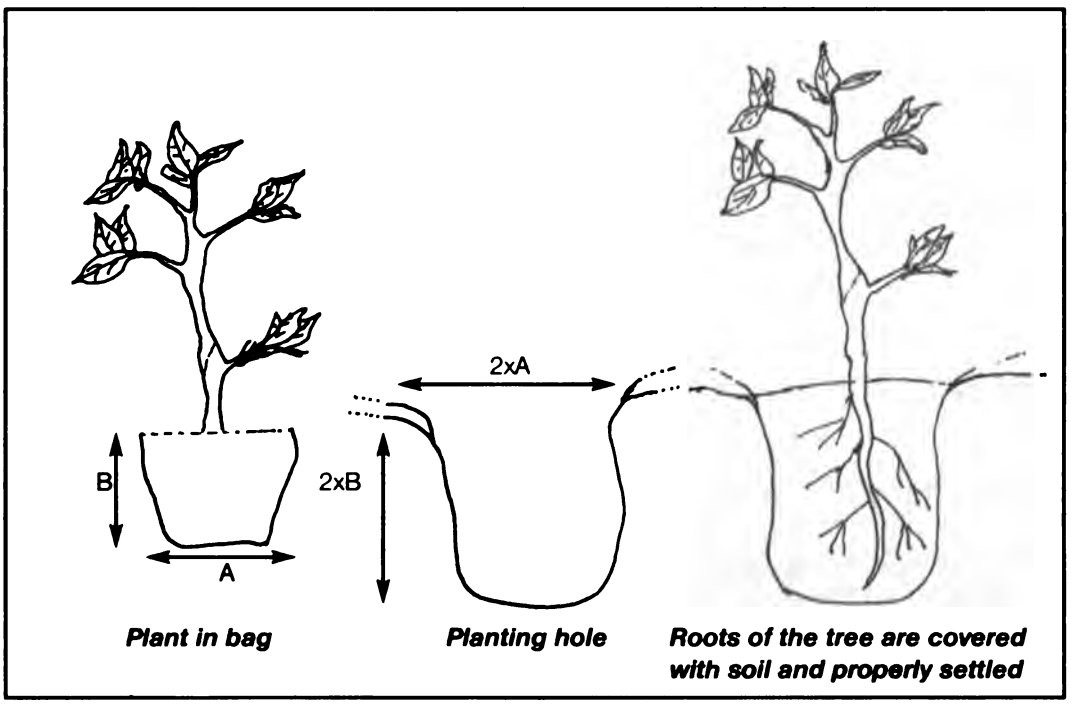


Fig. 2 Transplanting Young Trees

FERTILIZING

To maintain vigorous growth, citrus need a variety of elements, which are supplied in the form of fertilizers. The fertilizer needs of your plant can be determined by:

1. Observation

The general appearance of the tree and the pale or yellow colouring of the leaves may suggest that the plant is lacking some nutrient.

2. Stage of Growth

- At planting use a fertilizer with a high Phosphorous (P) relative to Nitrogen (N) and Potassium (K)
- At new flushes shift to a high N and low P and low K
- At flowering shift to high K and low N and low P

3. Yield Level

A rough guide for fertilizer requirements is provided in Table 11 Leaf analysis and soil analysis can help you to determine more precisely the nutritional status of the plant and soil and thus optimize fertilizer use. Leaf analysis should be conducted on an annual basis, so you can determine the nutritional status of the trees over a period of time and to address deficiencies. Soil tests may be less frequent.

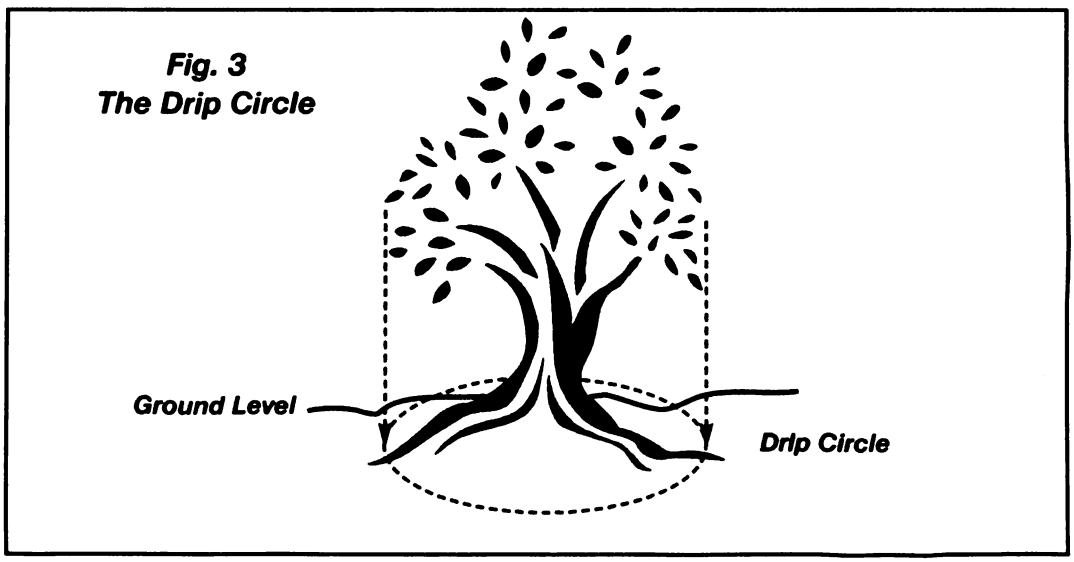
Check fertilizer ratios before purchasing

Read fertilizer packages and follow instructions

Fertilizers should never be placed against the stem of the tree

Fertilizer can be applied in the dry / granular form, by hand, i.e. broadcasting around plant at all stages of growth. This should be applied from young to mature trees in the area known as the 'drip circle', i.e. the circle around the tree's outermost branches where the feeder root system is found (Figure 3).

Where irrigation systems are used, fertilizers can be applied through the system. It is important to use high quality, very soluble materials to prevent the clogging of the irrigation systems' emitters. Again the solution is applied on the drip circle.



NUTRIENT DEFICIENCY AND TOXICITY SYMPTOMS

Experienced growers can diagnose basic nutrient problems by observing the symptoms expressed on shoots, fruit and leaves and by the location of the affected leaves on the plant (Table 12; Plates24-31).

Table 11. Rough Fertilizing Guide

Age of Tree Year	Quantity Per Plant 12 : 12 : 17 : 2	Number/Time of Application/Year		
		Onset of rains	Mid wet season	Before wet season ends
1	120 g. (4 ounces)	1	1	1
2	240 g. (8 ounces)	1	1	1
3	0.45 kg (1pound)	1	1	1
4	0.90 kg (2 pounds)	1	1	0
5	18 kg (4 pounds)	1	1	0

Table 12. Nutrient Deficiency Symptoms

Element	Appearance of Symptoms
Nitrogen - N	Even yellowing of entire leaf appearing in older leaves first, premature leaf drop, small fruit, thin peel.
Phosphorous - P	Small leaves may develop purple to red colouration, reduction in flowers, small fruits, P deficiency is rare.
Potassium - K	Yellow leaves with brown margins leaf drop at flowering. Deficiency more recognizable in fruit than in leaves, small fruit, thin peel.
Magnesium - Mg	Leaves with marked green veins especially at base of blade interveinal chlorosis at margins and tip.
Calcium - Ca	Interveinal chlorosis similar to Nitrogen. Symptoms are not commonly seen.
Sulphur - S	Deficiency symptoms similar to Nitrogen, leaves uniformly pale green.
Iron - Fe	Common problem. Interveinal chlorosis with a network of green veins. In severe cases, leaves light yellow to white in colour.
Manganese - Mn	Light green mottles between green veins on young expanding leaves.
Copper - Cu	Leaves abnormally large, limb die back, brownish gum on fruits, twigs and leaves.
Zinc - Zn	Very distinct interveinal chlorosis, small leaves and shorter internodes.
Boron - B	Dull green leaves, corky leaf vein. Fruits may have pockets of brown in the rind.
Molybdenum - Mo	Interveinal yellow spots and may have distortion of new leaves. Deficiencies are rare.

Some Deficiency Symptoms

Plate 24: Magnesium deficiency

Plate 25: Iron deficiency

Plate 26: Manganese deficiency

Plate 27: Copper deficiency

Plate 28: Zinc deficiency

Plate 29: Boron toxicity

Plate 30: Molybdenum deficiency

Plate 31: Boron deficiency (fruit)

WEED MANAGEMENT

Weed control is a major part of grove management with implications to cost, nutrition, water relations and pest and disease management. Weeds compete with the plant for nutrients and water, interfere with field operations and block drains, however some ground cover reduces soil erosion.

Weeds can be controlled by:

Manual or Mechanical Methods - using a hand/brushing cutlass, tractor powered brush cutter or blade or nylon string trimmer. The advantage of this method is that the cut material returns organic matter back to the soil thereby helping to improve the soil structure.

Chemical Methods – Chemical methods provide a cost effective and long lasting option for weed management. Their efficacy depends upon several factors such as:

- Rain or irrigation reduces the effectiveness by washing away the chemical.
- Herbicide drift, due to application under windy conditions can cause damage. This may be seen as small yellow spots on leaves and may cause leaf loss (Plate 32).
- Age of the weeds - younger weeds are more actively growing and are more susceptible to herbicides.
- Some herbicides remain in the soil for a long period of time and can have long-term detrimental effects on the plant. If possible, avoid use of these e.g. Karmex on heavy clay soils.
- The quality and pH of the water used to mix the chemicals can have a direct effect on the effectiveness of the chemical used.

To reduce cost of herbicide, it is best to identify the weed and use an appropriate chemical.

Herbicides should be applied carefully. Read the label properly and apply according to the label recommendations and with equipment that is in good working condition.

Remember to wear all protective gear when applying chemicals.

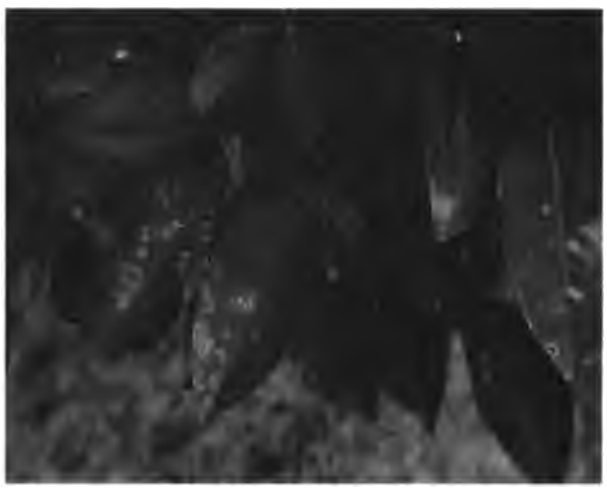


Plate 32: Gramoxone Injury

EPIPHYTES AND VINES

Epiphytes are plants that live on the branches of citrus and include orchids, ferns, pines (Bromeliads), aroids, mosses and lichens. Vines originate on the ground and climb on branches. Major problem vines of citrus include Grapevine *Cissus* sp., Kudzu *Puereria* sp., Loofah *Luffa* sp. and *Philodendron* sp. Vines and epiphytes may cover the entire tree, reducing the amounts of light intercepted by the plant, thereby limiting flower production and yields.

They generally:

- Give the trees an unsightly and unhealthy appearance.
- Tend to be more prevalent where the humidity and rainfall are high.
- Make harvesting difficult.
- Upon removal, fruits of all stages of development are destroyed.
- Increase maintenance costs.
- Reduce the effectiveness of spraying operations.

Vines, pines and orchids can be manually removed. Chemical control of vines is dealt with under the weed control programme. Copper fungicides used for disease control also assist in reducing epiphytes.

BIRDVINE

Birdvine, *Phthirusa stelis* is a parasite found growing on citrus (Plate 33). It competes with the tree causing reduced plant growth and development, dieback to twigs and branches and if left unchecked can result in the death of the tree. It is host to brown Citrus Aphid (*Toxoptera citricida*) a vector of Citrus Tristeza Virus (CTV). Control methods include:

- Hand removal.
- Pruning of heavily infested branches.
- Rehabilitation of heavily infested orchards may be effected by spraying trees with a 15-20% solution of urea.

Plate 33: Birdvine

MULCHING

Mulch is usually an organic material such as grass cuttings, wood chips or manure spread on top of the soil to:

- Reduce loss of soil water via evaporation.
- Provide humus which will help to aerate and keep soil loose.
- Prevent weed establishment.
- Facilitate growth of useful soil bacteria.

Keep mulch away from the plant stems (about 60 cm or 12 inches) since the moisture in the mulch could create conditions leading to stem rot. Excess mulch in dry season may increase the risk of fire.

PRUNING

This is the selective removal of stems and branches of the tree. It is aimed at:

- Removal of dead, dying, diseased or damaged parts or even branches affected with Birdvine.
- Removal of shoots from rootstock. This is most important in young citrus plants. Rootstock shoots can be identified by their vigorous and upright growth and their origin below the bud union.
- Controlling the height and the shape of the tree. It is also recommended to prune young trees very lightly to develop scaffold branches.
- Opening the canopy of mature trees to allow more light and air to enter the tree canopy to reduce the incidence of pests and diseases.

The best time to prune is at the end of the harvest season or at the beginning of the rainy season before flushing.

After pruning, a fertilizer with a high nitrogen (N) and lower Phosphorous (P) and Potassium (K) (2:1:1 ratio) could be used to encourage faster growth. When pruning, use sharp tools to make a clean cut and to reduce the incidence of pests and diseases, which live and multiply within jagged cuts. For thick branches, the cut should be as follows (Figure 4):

1. Make a small cut on the underside of the branch to be pruned.
2. Make a second cut on the upper side of the branch further away from the main stem and remove the branch.
3. Make a clean cut nearer to the main branch.
4. Sometimes it is necessary to apply a sealing paste at the end of thick branches.

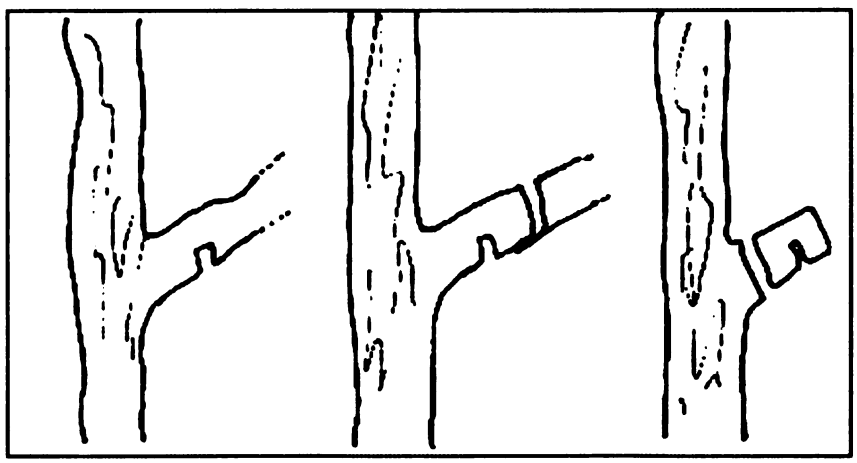


Figure 4: Pruning Thick Branches

It is important to develop a regular pruning programme to reduce cost of heavy pruning, which results in tree taking longer to begin re-fruiting.

PEST MANAGEMENT

Citrus is plagued by a wide range of insects and mites which can cause unhealthy plant appearances and poor growth and yields. Fortunately however, there is an equally wide range of species which feed on these pests and naturally keep their populations at acceptable levels. Some pest problems will still occur and must be managed, but in doing

so, the natural enemies must be conserved. A variety of pest control measures can be adopted, based on an understanding of the lifestyle and seasonality of the pest, damage caused, which pesticides are appropriate and how it should be applied. This approach is termed Integrated Pest Management (IPM) and may involve a combination of selected chemicals, natural enemies and cultural practices. IPM relies heavily on farmers' knowledge and requires farmers to:

- Observe when pests occur and when their numbers increase.
- Understand the life cycle of the pest.
- Understand the insecticide and its effectiveness. It is better to use environmentally friendly chemicals, e.g. Citrus oils since many insecticides though effective do cause harm to beneficial insects, e.g. bees which are necessary for the pollination of citrus.
- Time spraying operations and release of biological agents (natural enemies) to coincide with the most vulnerable stage of the insects' life cycle.

Pesticide use is critical to the IPM. It provides an effective tool for rapidly managing pests, however, it can have a negative effect on the natural control agents, and can be harmful to human health and the environment.

When using pesticides, then:

- Know which pest you are controlling. This will allow use of the appropriate insecticide/miticide and achieve optimal results.
- Read and follow manufacturer directions carefully.
- Always check the pesticide label to determine the pre-harvest interval.
- Only use products approved for the crop.
- Alternate the use of chemicals to prevent insects building up resistance to chemicals.
- Avoid spraying when trees are flowering since spraying can destroy pollinators, reduce crop yields and your profit.
- Best time to spray for maximum effect is either late evening or early morning when insect activity is generally high and wind speed is usually low.
- Your spray equipment must be in proper working condition – not leaking nor malfunctioning - to ensure effective coverage and no harm to the operator.

COMMON PESTS

1. **Bachacs** (Two species *Atta cephalotes* and *Acromyrmex octospinosus*). These are brown in colour and approximately 1 cm in length.

Damage:

- Cuts semi-circular sections from young leaves (Plate 34).
- Can be a year-round problem.
- Affects all citrus varieties but Portugals appear to be less favored.
- Can cause defoliation of trees and result in death of young/newly planted citrus.

Control: The nest has to be destroyed by using the appropriate bait, which should be kept dry and if possible placed close to the nest.

Plate 34: Leaves cut by Bachacs

2. **Sucking Insects:** Aphids (e.g. *Toxoptera* spp, *Aphis* spp); Whiteflies (e.g. *Dialeurodes* spp., *Aleurocanthus* sp.), Mealybugs (e.g. *Planococcus citri*) and Scales (e.g. *Coccus* spp., *Unaspis* spp.).

Several groups of sucking insects affect citrus, and are among the most serious of citrus pests if the population control exerted by their natural enemies is disrupted. Aphids and adult whiteflies are mobile and easily recognized as tiny insects but immature forms of whiteflies and scales, and to lesser extent mealybugs may not be immediately recognized as insects. They are generally small (1-2mm) and brown, green, white or black in colour. Some species are protected by a hard shield-like scale. They are immobile during much of their life history, and can be found on stems, twigs and around upper and lower surface of leaf veins.

Damage:

- These insects suck sap from the plant. Heavy infestations can result in chlorosis of leaves. i.e. leaves become pale green to yellow in colour and dieback of branches.
- Aphids are particularly important as vectors of Citrus Tristeza Virus and can cause leaf to crinkle and provide hiding places for other pests (Plate 35).
- Scales, whiteflies and mealybugs excrete copious amounts of sugary waste called honeydew, which coats the leaves of the tree. Upon this waste a fungus called Sooty Mould develops, giving the leaf a blackish appearance (Plate 36). This fungus prevents light from reaching the leaf surface, reduces photosynthesis and results in poor plant growth, lower yields, poor quality fruits and an unhealthy tree appearance. Honeydew-producing insects are often attended by ants.

Plate 35: Aphid Injury

Plate 36: Sooty Mould

Control:

- Most species are usually under natural control.
- For exotic species a national effort to release introduce control organisms may be required. This has been successfully done for the Citrus Blackfly with a parasitic wasp.
- If natural control is not enough, pursue an Integrated Pest Management Programme (IPM).
- If pesticide application is required, use an appropriate insecticide and spray plants thoroughly, i.e. both the upper and lower surface of leaves.

3. **Pegone Bee** (*Trigona* spp.) - These are small, black sting-less bees. They are an occasional problem early in the season when other forms of food (nectar) are in short supply.

Damage:

- They bore holes in ripe fruit causing fruits to decay faster.
- Cause damage to stem of tree resulting in scarring of the bark.

Control:

As damage is sporadic, chemical control can be uneconomic. The best form of control is to find the nest and destroy it with an appropriate insecticide. Locating the nests is usually difficult as the bees have a wide foraging range.

4. **Rust Mites** (*Phyllocoptruta* spp.) - These are not insects but related to spiders and ticks. Rust mites are invisible to the naked eye but can be detected by the damage caused by their feeding.

Damage:

- Primarily a dry season problem.
- Infest both upper and lower surface of leaves, fruits and young green twigs.

- Heavy mite populations cause leaves to turn bronze in colour.
- Can cause folding of leaves, stunt growth of plant and produce brown stains on the fruit surface. Fruits may be smaller and tend to deteriorate faster than normal.

Control:

- Use recommended miticide, e.g. M-Pede.
- Conserve natural enemies by restricting chemical application to spot sprays.

6. **Citrus Leaf Miner** (*Phyllocnistis citrella*) - The adult is small whitish moth about 2mm in length. The larvae feed internally on developing leaves, and in so doing create a characteristic serpentine mine.

Damage:

- Curling of young leaves, especially in nurseries.

Control:

- Insecticide application is effective in nursery plants but not in established orchards.

DISEASE MANAGEMENT

Citrus are affected by a range of diseases which may reduce yields, cause defoliation, affect juice quantity and make fruits unmarketable, or cause tree death. With observation and experience some diseases can be easily identified by their symptoms while others will require samples to be sent to a diagnostic laboratory for identification by a plant pathologist. On the other hand some symptoms may be the result of an entirely different problem, e.g., poor weed spraying practices can adversely affect the external appearance of leaves.

A range of factors influence infection and spread of disease and these include: heavy rainfall, high relative humidity, infected plant material or presence of vectors. Once infection occurs, diseases are difficult to eradicate. In order to gain control, seek advice from an Extension Officer on preventative measures e.g.

- Use of certified budwood/rootstock.
- Provision of good drainage.
- Proper sanitation procedures e.g. pruning dead wood.

Fungal Diseases

1 **Melanose** (*Diaporthe citri*)
Symptoms of Melanose are small, dark-brown, raised lesions (up to 1mm diameter), which appear on surface of leaves and fruits giving a rough sandpaper-like texture (Plate 37). It is most prevalent when there are many dead branches on the tree and where high moisture conditions exist.

Damage:

- Affects immature leaves and twigs, with leaves having distorted depressions. Leaves fall off prematurely.
- Trees over 10 years are most susceptible.

Control:

- Careful pruning and proper disposal of cut branches, dead wood, rotted fruits.
- Use a copper spray especially on young flushes and at fruit set.

2. Greasy Spot (*Mycosphaerella citri*)
   These are brown/black spots on both sides of the leaves and are most evident during alternating periods of wet and dry (Plate 38).

Damage:

- Infects leaves causing defoliation and reducing photosynthesis.
- Infects fruits resulting in poor colour and unhealthy appearance.
- Yields decrease considerably with defoliation.

Control:

Use appropriate/recommended copper fungicide at least twice per year (once with new flush and another before fruit set).

3. Foot Rot or Gummosis (*Phytophthora* spp.)
   This disease causes lesions to appear at base of the tree near the soil surface especially if this area remains wet for a long period of time.

Damage:

- Early symptom is chlorosis - leaves become yellow resembling nitrogen deficiency and the bark begins to rot.
- Gum begins to exude from the affected area.
- In severe cases yields decline and trees may die.

Control:

Reduce wet conditions around trees. Weeds and mulch should be kept away from the trunk of tree to reduce moisture effects. Spray base of tree with a recommended fungicide (e.g. Ridomil) and practice proper planting procedure like planting on mounds and using tolerant/resistant rootstock. In cases of very severe infections, remove diseased trees and replace with healthy trees. Damage to the tree trunk through weed control practices provide entry for this soil fungus into the plant.

4. **Lime Withertip - Anthracnose** (*Gloeosporium limetticolum* (Clausen))

Damage:

- Infects young tissue (leaves, buds), and tips shrivel (Plate 39).
- Trees become stunted or dwarfed.
- Fruits become distorted, shriveled with brown depressions (Plate 40).

Control:

- Cut/remove diseased part of the tree.
- Spraying with recommended copper fungicide at new growth, at blossom time and at petal fall.
- Alternate fungicides so that there is no build up of resistance to the chemical.

Plate 37: Melanose Symptoms

Plate 38: Greasy Spot Symptoms

Plate 39: Lime Anthracnose Symptoms

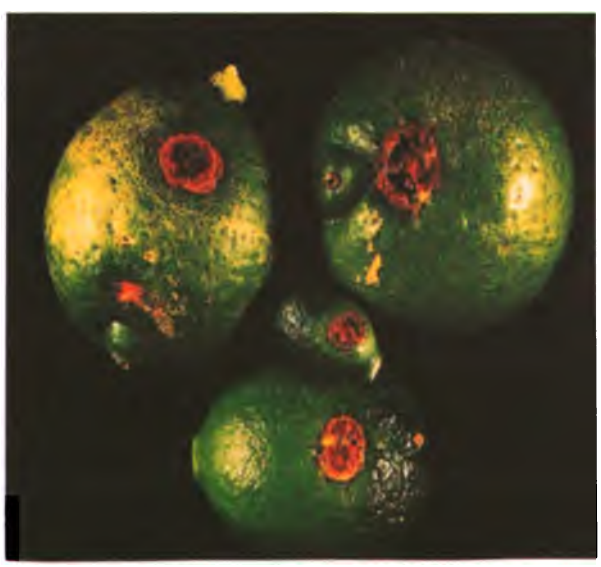


Plate 40: Lime Anthracnose Symptoms (on fruits)

Virus Diseases

1. **Tristeza/Citrus Tristeza Virus (CTV)**
   This is a virus spread by aphids which suck sap from infected trees and so transmit virus to other trees.

Damage:

- Sour Orange rootstock is highly susceptible to rapid decline.
- Fruit size is reduced.
- Overgrowth may occur at the bud union.
- Leaves slowly become yellow and there is an abundance of flowers and small fruits, which become dry and cling to the trees.
- Trees eventually die.

Control: Use high quality plants with tolerant rootstock and virus-free bud wood.

2. **Exocortis** - a disease induced by exocortis viroid and transmitted by infected bud wood, and contaminated pruning tools.

Damage on susceptible stocks:

- Trees are stunted.
- Scaling of the bark on the rootstock and bark is generally thinner than normal.
- Symptoms can be seen very early in life of the tree, 3 - 5 years.

Control: Use high quality plants with tolerant rootstock and virus-free bud wood.

3. **Psorosis** - probably a complex of diseases with parallel symptoms.

Damage:

- Distinct curling-back or flaking of bark.
- General decline in growth and yield.

Control: Use high quality plants with tolerant rootstock and virus-free bud wood.

HARVESTING AND HANDLING

All fruits must be picked, handled and packed properly to avoid damage or potential damage when storing and or transporting to the market. Picking of fruits should be done by hand, usually with a slight twist of the wrist, which leaves the 'button' or calyx on the fruit. Pulling the fruit could result in the 'button' being removed or the skin broken at the stem end

(plugging). This could result in fruit being easily attacked by insects, fungal infections and other post harvest problems all of which result in lower fruit prices. Fruits which cannot be reached by hand can be clipped with fruit pickers and picked up when they fall to the ground. This usually results in surface blemishes and/or unsightly appearances.

- Do not use a rod/stick to beat the fruits off the tree.
- Hook the fruits and pull towards the ground.
- Do not pick up spoilt fruit on the ground while harvesting good fruits.
- Never shake or knock down the fruit with sticks or stones.
- Do not transport fruits in unclean bags like fertilizer bags (even if you wash the bag).

The fruits are either placed in crates or bags that are then collected for transport to the relevant markets. The standard weights of crates are 41 kg for oranges and 36 kg for grapefruit.

Grading Citrus Fruits

Your fruit quality depends upon:

- External appearance: Fruit size, peel colour and the degree of peel blemishes.
- Internal fruit quality: Total Soluble Solids (TSS), acids, the ratio of TSS to acids, plus the degree of bitterness or aromaticity.

Many factors affect fruit quality, viz: weather patterns, cultivars, rootstock, cultural practices, water management, nutrition, pests and diseases. The price of your fruit will be determined by the grade and by the quality. Suggested grades for sweet oranges are:

Grade A: Fruits greater than 8.5cm (3.4 inches), in diameter.
Grade B: Fruits, which are between 7.0–8.5 cm (2.8–3.4 inches) in diameter.
Grade C: Fruits, which are less than 7 cm (2.8 inches) in diameter.

Quality Fruits Command Higher Prices.

YIELD

Your citrus yields will vary according to the variety. i.e. oranges will be different from limes. Within each variety, differences will also occur; Valencia will be different from Parson Brown and so on. Yields will also vary from year to year because of differences in meteorological conditions, management practices, tree health or a combination of factors.

Generally tree life is twenty to thirty years with commercial production beginning around year four to five. With older trees, there are fewer marketable fruits, trees may be taller

making harvest difficult and general maintenance costs will be higher. A well managed orchard should yield 3 crates/tree or 30 T/ha oranges or 6 crates/tree or 40 T/ha grapefruit.

ECONOMICS - ESTIMATING COST OF PRODUCTION

As a citrus grower you must take into consideration several cost aspects such as:

Capital Investment

- Building workshops, storerooms, and office facilities.
- Farm machinery - tractor, pickup or a 4 x 4 vehicle.
- Equipment - brushcutter, disc plough, trailer, agricultural tools, office equipment, motor/mist blowers.

Operation Costs

- Materials - fertilizers, insecticides, herbicides and packing crates, etc.
- Planting material.
- Fuel and lubricants.
- Office consumables.
- Financial - bank charges, loans repayments, interest rates, land and building taxes, etc.

Personnel Costs

- Salaries to farm managers, supervisors, office staff, security personnel, drivers, general labour, sprayer, etc.
- Consultant fees to pathologists, agronomists etc.

In short every aspect of citrus production involves a cost of some kind. This must be undertaken with the understanding that in the initial establishment of an orchard (Table 13) the return on your investment will not be realized until around years 5 - 10. In addition your profits will be affected by local and international market variations e.g. if the price of fuel increases practically all your costs may be higher.

Table 13. Estimated Cost of Establishment for One Ha of Oranges (Year 2003)

Activity	Unit	Amount	Cost/Unit	Total Cost
Land Preparation	ha	1	$ 3000.00	$ 3000.00
• Camber beds	ha	1	$ 3000.00	$ 3000.00
• Rotovate	ha	1	$ 6.00/m	$ 4500.00
• Drains				
Plants	each	350	$ 15.00	$ 5250.00
Planting Out	Man days	15	$ 80.00	$ 1200.00
Fertilizers				
• 12:24:12	kg	40	$ 12.00	$ 480.00
• Fertilizing	Man days	1	$ 80.00	$ 80.00
Miscellaneous				
• Stakes	Each	350	$ 2.00	$ 280.00
• Manure	Tonne	1	$ 525.00	$ 525.00
TOTAL COST				**$ 18,315.00**

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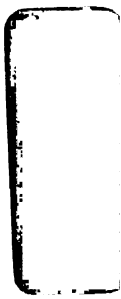
PHOTOGRAPHIC ACKNOWLEDGEMENTS

- **Plates 1 - 23**
  Courtesy Baksh, N.(1995) Citrus Varieties of Trinidad and Tobago. IICA/ Ministry of Agriculture, Land and Food Production (Trinidad and Tobago)

- **Plates 24 – 32; 37 - 40**
  Courtesy Whiteside, J. O. et al. (1988)
  Compendium of Citrus Diseases. A P S Press

- **Plates 33 - 36**
  Courtesy Karl Burgess, Agriculturist



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