# Fruit Size Management Guide

## Part 1

An Australian Citrus Growers Publication

# Introduction

The information in this guide has been based on the Australian Citrus Industry funded project "Optimisation of Citrus Production and Fruit Size: An Interactive Management Model". The project was led by Dr. Ken Bevington (NSW Agriculture) and the research, which focussed on navel and Valencia oranges, was conducted between 1999-2002. The final report from the project was published in July 2003 and is available from Horticulture Australia.

Fruit size is a critical management issue for citrus growers and the single most important factor in determining market returns. Most domestic and export markets have a preference for large fruit (>72mm) and smaller fruit (<65mm) are often hard to sell.

Achieving good sized fruit is a complex process and can be affected by a wide range of variables, such as variety, budline, rootstock, tree health, nutrition, irrigation, orchard management and environmental factors.

One of the most important factors affecting fruit size is crop load. When there is a heavy crop load then fruit size is usually small. Throughout the growing season there are several management options available to growers that can be used to help modify crop load.

## The Fruit Size Management Guide Part 1 includes:

- Citrus Growth Stages, the Citrus Phenological Cycle and Key Management Actions (1-4);
- Crop Manipulation Strategies for Improving Fruit Size;
- Key Elements of Nutrition (Summary) and Tree Nutrition for Improving Fruit Size.

## The Fruit Size Management Guide Part 2 will cover:

- Estimating Crop Load;
- Measuring Fruit Size;
- Using the Predictive Fruit Size Model.

There is no simple recipe for achieving good sized fruit. Improving fruit size requires a complete package of orchard management strategies that need to be trialled and perfected over a number of years for both your individual orchard location and variety mix. This Fruit Size Management Guide provides you with the key information on what options are available and at what stage they need to be carried out.

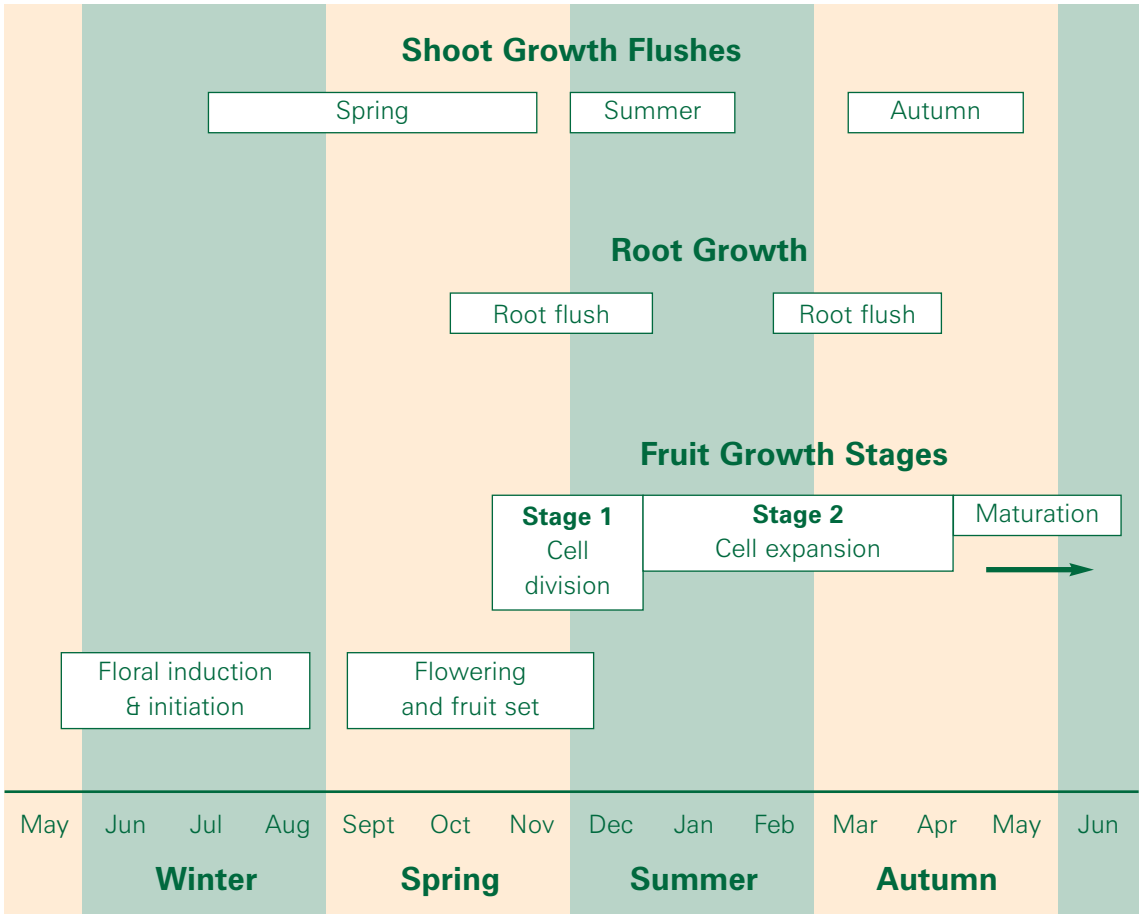
***The Fruit Size Management Guide Part 1 was compiled by Ken Bevington, Sandra Hardy & Peter Melville (NSW Agriculture); Kym Thiel (Citrus Growers of SA); Garry Fullelove (QLD Department of Primary Industries) and Peter Morrish (Murray Valley Citrus Board).***

October 2003

# Citrus Growth Stages

| Time (Approximate) | Growth Stage | Development Phase |
|---|---|---|
| Mid-May to July | Floral Induction and Initiation | Transition of resting buds to floral buds |
| August to mid-September | Pre-bloom | Bud break and inflorescence development |
| Mid-September to October | Flowering | Flowering and initial fruit set |
| November to December | Stage I Fruit Growth | Fruit cell division and physiological fruit drop |
| January to April | Stage II Fruit Growth | Fruit cell expansion |
| May onwards | Maturation | Fruit maturity and harvest |

# Citrus Phenological Cycle



# Key Management Actions 1

## **Floral Induction and Initiation** Mid-May – July

Low temperatures during winter induce citrus buds to flower. An induction period of about a month is generally sufficient to ensure adequate flowering. The number of flowers produced and proportion of different types of inflorescences is strongly influenced by crop load in the previous season. Most flowers are produced on shoots that grew during the previous year.

The long-term management goal is to achieve consistent levels of flowering with a high proportion of leafy inflorescences carried on strong bearing shoots.

### Positive impacts:

✔ Well-pruned canopy with a good distribution of strong bearing shoots close to main scaffold branches (promotes leafy inflorescences)

✔ Moderate crop load in the previous season

✔ Early harvest

### Negative impacts:

✘ Light crop load in the previous season resulting in excessive flowering (for oranges < 3.5-4.0 fruit / 0.5m quadrat)

✘ Drought or water stress (increases flowering)

✘ Poor vegetative growth in the previous season (restricts potential flowering sites)

### Take action if:

- Heavy flowering is expected

### Crop manipulation strategies to improve fruit size:

✔ **For mandarins only.** Apply a winter GA spray to reduce flowering and increase proportion of leafy inflorescences. Use Ralex® at 200mls/100L in June-July. Follow label directions.

**N.B.** There is no registration for oranges in Australia at present. Trials are underway.

### Other management actions:

- Consider foliar applications of urea to promote flowering in an expected light flowering year

# Key Management Actions 2

## **Pre-bloom to Flowering** August – October

Critical period for spring flush and inflorescence development. High demand period for nutrients. The number of flowers and proportion of different types of inflorescences will provide an early indication of potential crop load and fruit size problems.

Key management goal is to ensure trees are well supplied with all required nutrients leading into flowering and fruit set.

### Positive impacts:

✔ High proportion of leafy inflorescences on strong bearing branches with large leaves

✔ Optimum nutrient levels (as shown by February leaf analysis)

✔ Good soil moisture

✔ High heat unit accumulation during late September – October (promotes early fruit development)

✔ Maximum temperature in the range 25-30°C

### Negative impacts:

✘ Excessive flower numbers and high proportion of leafless inflorescences

✘ Nutrient deficiencies

✘ Water stress

✘ High incidence of frosts during August-September (reduces potential fruit set)

✘ Low soil temperatures during September (reduces nutrient uptake)

✘ Poor tree health

### Crop manipulation strategies to improve fruit size:

✔ Selective branch pruning or hedging to reduce the number of flowering sites

### Other management actions:

- Monitor irrigation requirements
- Apply 50% of annual nitrogen, 30% of potassium and bulk of phosphorus during pre-bloom period
- Revise fertiliser program where leaf N levels are <2.4% or >2.8%, leaf P levels are <0.12% and leaf K levels are <1.0%
- Consider foliar application of urea if soil temperatures remain low during September (<13°C)
- Apply foliar applications of magnesium, manganese and zinc if levels are low

# Key Management Actions 3

## **Stage I Fruit Growth** November – December

Critical period for determining crop load and potential maximum fruit size. Most sensitive period to adverse climatic conditions. Eighty to ninety percent of potential size at harvest determined by the end of December.

Key management goal is to maximise fruit growth.

### Positive impacts:

✔ Mild climatic conditions will favour fruit set (maximum temperatures <30°C)

✔ Above average minimum temperatures will enhance fruit growth

✔ Good rainfall

### Negative impacts:

✘ Water stress

✘ Deficiencies of key nutrients

✘ High temperatures (maximum temperatures >35°C)

✘ Maximum temperatures >38°C can cause excessive shedding of fruitlets (worse where water stress is also a problem)

✘ Competition between large numbers of developing fruitlets (reduces fruit size)

### Take action if:

- Fruit density counts for oranges are > 8-10 fruit / 0.5m quadrat in late November

### Crop manipulation strategies to improve fruit size:

✔ Chemical thinning of fruitlets using ethephon (Ethrel®) when they are 10-15mm in size. Only use when there is a heavy crop load (don't use on medium to light crop loads). Chemical thinning reduces crop load by 20-30%. Follow label directions.

### Other management actions:

- Monitor irrigation requirements (avoid water stress especially if temperatures are high)
- Apply 25% of annual nitrogen and 30-50% of annual potassium
- Supplement potassium with foliar applications of potassium nitrate to promote cell division
- Foliar applications of calcium nitrate to improve rind quality

# Key Management Actions 4

## **Stage II Fruit Growth** January – April

Key management goal is to realise maximum potential fruit size determined during Stage 1.

### Positive impacts:

✔ Moderate temperatures during January and February
(optimum temperature range for fruit growth 20-30°C)

✔ Optimum crop load

### Negative impacts:

✘ Water stress

✘ Above average maximum and minimum temperatures

✘ Excessive crop load (fruit growth declines earlier on trees carrying heavy crop loads)

### Take action if:

- Fruit density counts for oranges are > 8-10 fruit / 0.5m quadrat
- Proportion of fruit <40 mm at beginning of January exceeds 50%
(indicates early crop loads were too high or possible management or tree health problems)

### Crop manipulation strategies to improve fruit size:

✔ Hand thinning during January-February, the earlier the better. Aim for 4-5 oranges / 0.5m quadrat.
Remove wind blemished, damaged and small fruit (<40mm in early January or <50mm in early February).

### Other management actions:

- Monitor irrigation requirements (avoid water stress especially from January to mid-March)
- Apply 25% of annual nitrogen. Adjust to crop load.
- Apply 30% of annual potassium
- Supplement potassium with foliar applications of potassium nitrate
- A late hand thinning of a heavy crop in March will improve flowering for the next season and reduce alternate bearing

# Crop Manipulation Strategies for Improving Fruit Size

## Introduction

Crop load on citrus trees largely determines final fruit size, accounting for up to 60% of the annual variation. A light crop load will tend to produce a small number of large fruit, while a heavy crop load will tend to produce a large number of small fruit. A heavy crop load will exhaust the energy reserves of the tree and reduce vegetative growth, resulting in less flowering and fruiting sites and carbohydrate stores for the following season. This pattern of biennial high and low crop loads occurs in most citrus varieties.

The main aim as a manager should be to manipulate the trees to optimise the crop load while maintaining good fruit size. By manipulating the crop load trees will tend to fruit more evenly each year. Those blocks that are healthy and well managed will consistently deliver the best economic returns due to the balance between crop load and fruit size and quality. The optimum crop load will vary for each block due to differences in variety, budline, rootstock, tree age, vigour, tree spacings etc.

**Crop manipulation should be considered as early as possible in the fruiting cycle to have the most effect on crop load.** By manipulating crop load as early as possible, energy reserves will be used more effectively to produce a lighter crop of larger sized fruit.

A number of management options exist to regulate crop load in anticipated heavy crop years. These include:

| Growth Phase | Management Option | Timing |
|---|---|---|
| Floral Induction & Initiation | Flower Suppression | Jun-Jul |
| Pre Bloom to Flowering | Pruning | Aug-Oct |
| Stage I Fruit Growth (cell division) | Chemical Thinning | Nov-Dec |
| Stage II Fruit Growth (cell expansion) | Hand Thinning | Jan-Apr |
| Fruit Maturation | Harvest timing | May |

## Flower Suppression at Floral Initiation

Floral initiation of citrus in southern Australia usually occurs between June and July. However it is difficult to identify any differences between vegetative and floral shoots until early spring.

Many factors have an influence on the flowering of citrus, but it is closely linked with the past physiological and developmental history of the tree branches. External factors like, temperature and water stress will also change the intensity of flowering.

Gibberellic acid (GA) has been shown to inhibit flower initiation in citrus, and has been used in other citrus growing countries for a number of years. Presently the only registered gibberellic acid compound for flower suppression in citrus is Ralex®, and its use is restricted to mandarins in Australia. There are currently no products registered in Australia for use on oranges.

Research has shown that suppressing flowers with GA during flower initiation will reduce the number of leafless inflorescences (white blossom), and proportionally increase the more desirable leafy inflorescences. Leafy inflorescences tend to set more fruit and have a higher initial growth rate, resulting in larger fruit at harvest. It is thought that the leaves act as a competitive sink for nutrients and supply some of these elements directly to the flowers.

Presently trials are continuing to evaluate the best timing for winter GA sprays in oranges in Australia. Two response periods have been noticed; the first is in the winter rest period around

June; and the second at budburst. Overseas, trees are most commonly sprayed at budburst, before the emerging shoots are around 1mm in length. The timing of this budburst spray is critical with only a narrow window for application to achieve good results. If the spray is applied too late after bud burst, there will be no effect because the flowers have already started to form within the developing shoot. The objective of flower suppression is to manipulate the forming bud into a vegetative state before any determination of floral parts has occurred.

Applications of GA should be made as directed on the label and be trialled on small areas to fine-tune the technique on your own property.

## Pruning at Flowering

Pruning citrus to reduce crop load is a valuable management tool that gives the operator complete control over how much of the tree is removed. In a predicted heavy crop load year, pruning of unwanted branches will have multiple benefits on healthy trees, including:

- improved light and spray penetration (reduce pests & disease);
- increase in fruit size (as a consequence of reduced crop load);
- more fruit of even colour throughout the canopy;
- reduced incidence of windrub on fruit from dead wood;
- maintain tree height, spread, and structure for easier management and harvest.

Pruning should be performed before or during flowering with an emphasis placed on removing weak or dead branches, crossover limbs, water shoots, or undesirable limbs. It is important to assess each block before pruning and consider what outcomes are desired. For example, young trees do not need to be heavily pruned, but require a light pruning to establish canopy shape, and removal of watershoots, twisted branches etc. By pruning too heavily at a young age the tree will respond with vegetative growth, hence a delay in bearing.

On established orchards a number of factors need to be considered before pruning:

- pruning should be progressive, and may take 3 years to obtain the desired outcome;
- always aim for a balance between vegetative growth and fruiting wood;
- monitor pests/pathogens on regrowth, particularly inside the canopy;
- prioritise high value blocks and prune these first;
- healthy trees suffering from crowding or shading will respond the best;
- dead wood should be removed – this can carry disease and increase blemish;
- skirt trees for improved irrigation and pest and disease control;
- supervise pruners until you are satisfied they are performing the task to your standard;
- remain diligent with sterilisation of pruning equipment to reduce the spread of disease.

Light distribution into the canopy is possibly the greatest benefit of pruning. Fruit set inside the canopy is better protected from temperature extremes, sunburn, and frost. Correct pruning encourages a consistent crop of good quality fruit that is able to grow from strong bearing wood.

Hedging during flowering is an effective way of removing excess flowers. It is a non-selective type of pruning, so care should be taken as to how much of the canopy is removed.

*For more pruning information refer to the new Pruning for Fruit Size leaflet or contact your local horticulturist.*

## Chemical Thinning at Stage I Fruit Growth

Once the fruiting cycle progresses from flowering to fruit set, it becomes too late in the season to heavily prune trees because of the increased chance of fruit drop and sunburn.

The next opportunity to improve fruit size is near the end of the natural fruit drop stage when fruitlets are 10-15mm in size, using a chemical thinning compound. Ethephon is registered under the trade name Ethrel®, and has been shown to cost effectively thin fruit in navel and Valencia oranges and Imperial and Murcott mandarins. The amount of fruit removed by Ethrel® can vary depending on fruit load and application rate.

Growers who have trialled ethephon in the past have had mixed outcomes, usually as a result of poor timing, or excessive thinning from over application. If used carefully, under the right environmental conditions, it can be a great management tool to increase fruit size by reducing crop load. However, a few considerations must be made before spraying ethephon.

- the fruit load on the tree must be heavy to warrant thinning for fruit size (monitor using frame counts);
- trees must be in good health and not stressed;
- ensure good soil moisture; irrigate trees 2-3 days prior to spraying;
- spray around the end of the natural physiological fruit drop (monitor using fruit drop pans; November-QLD, December – NSW, Vic,SA), when the fruitlets are 10-15mm in size;
- use a water application rate of 3500L/ha;
- do not apply in cool weather (below 18°C), in the afternoon, or if rain is likely within 1-2 days after spraying;
- avoid slow drying conditions;
- spray equipment must be accurately calibrated;
- read and follow the label directions before use;
- fruit drop should occur 7-14 days after application;
- fruit dropped is indiscriminate – large and small, marked and unmarked fruit will be thinned. If there is marked fruit or a mixed second crop (poor first flowering set) then hand thinning targeted at these unwanted fruit may be the better option.

The temperature after application is also a key factor in the effectiveness of this thinning treatment and weather forecasts should be checked before considering applying Ethrel®. It is important to start off trialling a small number of trees on your property to fine-tune the application. If too much Ethrel® is applied it will not only excessively reduce the fruit number, but also has the potential to cause excessive leaf drop.

A number of other chemicals are used overseas for fruit thinning, including 3,5,6-TPA and Napthalene Acetic Acid (NAA). These compounds are not registered for use on citrus in Australia at present.

## Hand Thinning at Stage II Fruit Growth

By the time the natural fruit drop finishes in December, the number of fruitlets left on the tree will give a good indication of crop load. It is important to observe trees all over the property and randomly take quadrat measurements on trees (refer to Crop Load Measurement in part 2 of this guide) to get an indication of crop load before making any further decisions. Edge rows, end trees, and trees in poor health should not be considered as crop load indicators.

Hand thinning is the last management tool to manipulate crop load and increase fruit size before harvest. Once the fruit growth cycle passes from cell division (Oct-Dec), into cell expansion (Jan-May), the cells inside the fruit stop dividing or multiplying. Therefore the fruit has a predetermined final size as early as January providing the trees are not stressed. For the most effect on fruit size, hand thinning should be done as early as possible.

The response from hand thinning will be more effective with an extremely large crop load than with a moderate crop load. Research has suggested that at least 20% of fruit need to be removed to see any positive increase in fruit size distribution for orange varieties.

Hand thinning varieties that tend to continually produce large crop loads with fruit clusters (e.g. some mandarin varieties) will respond well, resulting in increased fruit size and more marketable fruit. By removing the fruit after the natural fruit drop period in January, the competition for nutrients between fruits, particularly those in clusters, is reduced. The result is an increase in the supply of carbohydrates to the remaining fruit.

Hand thinning gives managers the option to manipulate crop load and remove poor quality fruit from the tree in one operation. This can lead to better fruit size and quicker harvesting and grading operations. Aim for frame counts of 3-5 fruit for oranges and for mandarins 8-10 fruit (NSW, Vic, SA) and 10-15 fruit (QLD).

**Specifications for hand thinning are:**

- remove damaged fruit first (wind blemished and those blemished by pests and disease);
- remove fruit that are small;
- thin clusters to one or two fruit;
- have no fruit touching;
- remove fruit hanging close to the ground;
- leave terminal fruit on Imperials;
- because Murcott fruit can sunburn badly during summer, leave extra fruit on the tree at the first thinning to allow for the removal of sunburnt fruit after the hazardous period (up to March). Alternatively, where good pruning systems have developed fruiting wood inside the canopy, fruit can be removed from the outside or at least the northern and western faces in December to effectively complete the thinning process.

There are a number of limitations to hand thinning, including the high labour cost and the extra growth achievable in those years with moderate crop loads. However it remains an option if the crop load is excessive and no other means of crop manipulation has been performed prior to this period.

## Harvest Timing

The timing of fruit harvest can have a significant impact on flowering and fruit set the following season. A crop load that is left to hang late in the season for a given variety will reduce flowering the following season. This is especially true in many mandarin varieties. The management of harvest timing can also increase fruit size in the current season.

For mandarins, harvest the largest, most coloured fruit in the first pick. Fruit on the outside of the tree will mature first with fruit on skirts and inside the canopy maturing several weeks later. An early harvest takes the load off the tree and allows the smaller remaining fruit to increase in size.

Imperials in Queensland left to hang into late June will reduce the following season's crop significantly. GA sprays applied after the first harvest to control rind ageing will have the effect of prolonging the harvest season. If GA is applied too early, fruit will retain any green colour and will be difficult to degreen. Timing is critical so as not to induce a very late harvest.

**Sources of Information**


- Murray Valley – Citrus Fruit Size Field Day, November 2001 Dareton NSW
- Pruning for Fruit Size Leaflet. K. Bevington, S. Falivene and A. Krajewski. NSW Agriculture, 2003.

# Key Elements of Nutrition for Fruit Size

## **Floral Initiation – Flowering – Initial Set** (June-October)

- Apply 40-50% of annual nitrogen in 2 split applications at bud swell;
- Use a 1% urea spray when soil temperatures are low;
- Apply 50% (fertigation) or 100% (banding) of annual phosphorous before and during bloom;
- Apply 30-40% of annual potassium;
- Apply N-P-K mixes between September and November;
- Zinc is critical, apply foliar sprays as required;
- After fruit set apply magnesium and manganese foliar sprays as required;
- Adding low biuret urea (0.5%) to micronutrient sprays of zinc and manganese helps uptake.

## **Stage I Fruit Growth** (November-December)

- Apply 25% of annual nitrogen in November after fruit set and at the end of the vegetative growth flush;
- Calcium nitrate is preferable to ammonium nitrate and urea as these forms of nitrogen compete with the uptake of calcium;
- If fertigating apply the remaining phosphorous (50%) at monthly intervals from October onwards;
- Ensure adequate supply of calcium to reduce albedo breakdown;
- Apply 30-50% annual potassium after fruit reach 10mm in size;
- Apply foliar micronutrient sprays of magnesium, manganese and zinc as needed;
- Overseas experience shows foliar sprays of potassium phosphite or MAP and potassium nitrate in November have improved fruit size.

## **Stage II Fruit Growth** (January-April)

- Nitrogen is important, apply 25% of annual requirement (adjust for crop load) throughout this period; High levels of nitrogen delay maturity;
- Ensure adequate nitrogen levels for carbohydrate reserves for next seasons flower initiation in winter;
- Potassium is also important, apply 30% of annual requirement after final fruit drop stage in January-February;
- Maintain good nitrogen: potassium ratios (2≈1).

# Tree Nutrition for Improving Fruit Size

## Introduction

Nutrition in citrus has become a key management practice for growers to achieve maximum fruit size in their orchards.

In relation to fruit size there are major and minor nutrients which all play important roles and interact with each other. Some are obviously more important in relation to fruit size than others, but at the same time they may also play an important role in relation to fruit quality e.g. calcium and its role in reducing albedo breakdown.

At the core of all good fertilizer and nutrition programs should be regular leaf analysis and good record keeping which can be used to monitor changes.

Citrus require optimum nutrition at each growth stage to promote better fruit size and tree health.

Following is a summary of the major growth stages that are related to fruit size and the nutritional requirement of trees. This is based on information provided by Tienie du Preez during his visit to South Australia in September 2001.

## Floral Initiation, Flowering & Initial Fruit Set (June- October)

### Nitrogen

The first application of nitrogen should be applied at budswell and should be up to 40-50% of the total nitrogen applied for the year. Apply in two split applications 14-21 days apart especially on sandy soils. Also apply a 1% urea spray especially when soil temperatures are low (less than13$^{o}$C). Urea should not be ground applied at this time of the year due to its slow conversion time to ammonium. N:P:K mixes are best applied between September and November.

### Phosphorous

Phosphorous is important at this time and should be applied just before and during the bloom period. If you are banding the phosphorous to the soil apply 100% of the annual requirement now. If you are using fertigation apply 50% at this time and the remainder at monthly intervals.

### Zinc

Zinc at this stage is also very important. Zinc sulphate is the preferred form. Zinc can be added to all foliar sprays 3-4 times per season. The recommended rate is 100-150gm/100litres. Low zinc levels or trees deficient in zinc will develop poor growth, have small leaves, lower crop yields and develop small fruit. Apply the first spray at about 1/3 – 1/2 leaf expansion and then as needed during fruit development. Always add 0.5% low biuret urea to all these foliar sprays.

### Magnesium and Manganese

If needed magnesium and manganese can be applied to the developing spring flush or after fruit set. When applying these foliar sprays always add 0.5% low biuret urea, as this aids in the uptake of zinc and manganese.

## Stage I Fruit Growth (November-December)

### Nitrogen, Phosphorous and Potassium

Do not over stimulate trees during this period, because any growth flush will compete with the fruitlets and will result in poor fruit set. Just enough nutrients are needed to maintain biological activity.

It is preferable to apply nitrogen (25%) at the end of the vegetative growth flush in November, especially if trees are well fed with nitrogen in previous stages. The rest of the nitrogen can be

applied in January. The ideal source of nitrogen at this time is calcium nitrate, however other forms can be used.

Potassium (30%) can be applied after fruit set (10mm size). The rest of the potassium should be applied in December and at the end of January when it is necessary for cell enlargement.

**Calcium**
In this period calcium is important to reduce albedo breakdown. Nitrogen applications should be kept to a minimum as it competes with the uptake of calcium especially the ammonium nitrate and urea forms (which need to be converted to ammonium).

**Other**
Magnesium, nitrogen, phosphorous and potassium all compete with the uptake of calcium and therefore their applications should be closely related to leaf analysis and should not be over supplied in the cell division stage.

Weak trees or those showing yellowing should receive a foliar application of low biuret urea, zinc and manganese sulphate.

Iron chelates may be needed especially in calcareous and high pH soils or in very wet conditions.

## **Stage II Fruit Growth** (January – April)

**Potassium**
Potassium should be applied during January & February after the final fruit drop stage. However too much or too little potassium will inhibit calcium uptake therefore increasing the likelihood of albedo breakdown. Aim for leaf levels of 1.0-%-1.5%. The higher the nitrogen levels are, the higher the potassium levels should be, to ensure that good N: K (2≈1) ratios are achieved. Potassium sprays should occur in December, January, and February (3% potassium nitrate depending on historical leaf-K levels). Potassium is especially important from February onwards.

**Nitrogen**
Aim to provide 25% of the annual nitrogen requirements. If you are broadcasting apply as a single dose in January. If you are using fertigation apply at monthly intervals from January through to April. It is important to be careful at this stage for those varieties which you wish to harvest early, as high nitrogen levels will delay maturity. Applications should always be based on leaf analysis and leaf colour.

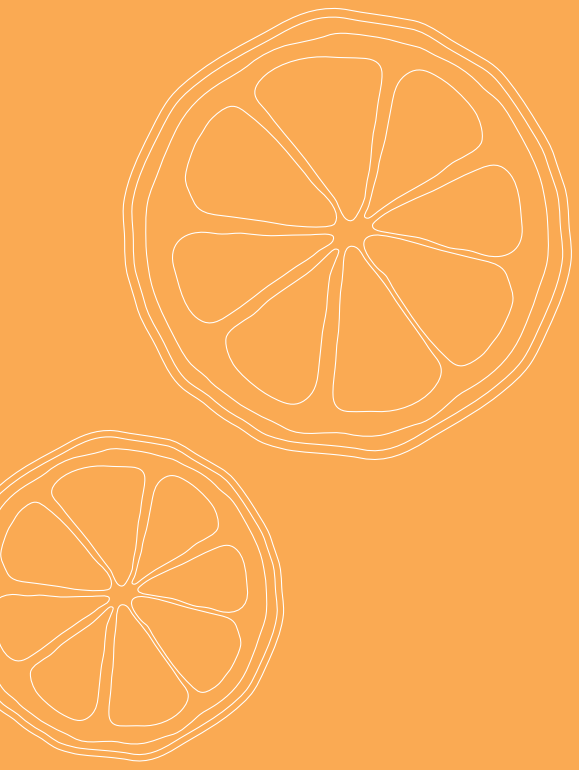
**Other**
Research from California shows that foliar sprays of potassium phosphite in November and January significantly improved fruit size even at optimum phosphorous and potassium leaf levels. South African growers use foliar sprays of MAP (0.5%) and potassium nitrate (3-4%) in November and January to provide phosphorous and potassium when demand is high.

### Other Information

Previous leaf nutrient standards for citrus are now considered too low to achieve the best fruit size. Growers should therefore aim for the following leaf nutrient levels:

| | | |
|---|---|---|
| Nitrogen 2.4-2.8% | Phosphorous 0.14-0.18 | Potassium 1.0-1.5% |
| Magnesium 0.3-0.7% | Zinc 30-100ppm | Manganese 25-100ppm |
| Boron 50-150ppm | Iron 60-120ppm | Copper 6-15ppm |

Sodium and chloride inhibit fruit size and interfere with overall tree health and nutrient balance. Leaf sodium levels should be less than 0.16% and chloride levels below 0.3%. Nutrient ratios for Nitrogen : Potassium of 2 ≈ 1 and Nitrogen : Phosphorous of 20-15 ≈ 1



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