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Crop manipulations during and after a heavy blossom

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Citrus orchards are experiencing an intense blossom period, especially in the cooler production regions in the Eastern and Western Cape. Producers are reminded of the importance of the following cultural practices to manipulate the crop to ensure acceptable fruit size and quality.

Irrigation and fertilization

The period during and immediately after flowering (September to December) is the cell division stage of fruit development. It is the period in which most cells of the fruit are formed. Flowers and fruit are particularly sensitive to water stress, carbohydrate depletion, and mineral nutrient deficiency during this period. The tree needs water, light energy and CO_2 to synthesize sugars, which are used in the growth of the roots, shoots, flowers and fruitlets. In the process, sunlight drives water transport through the plant, which carries all the soil-applied mineral nutrients to where they are required. Any water stress, lack of sunlight, or mineral nutrient stress will negatively affect the cell division period, the fruit yield, and most of the fruit quality attributes, i.e. small fruit, thin rinds, creased/split fruit. Too high or low temperatures and/or strong, dry winds will have the same negative impact.

During and after a heavy blossom period, the competition between fruitlets for water, carbohydrates and mineral nutrients is high. It is therefore important to fertilize and irrigate trees according to their increased demand. There are leaf nutrient norms that were developed for certain citrus varieties, which could be used to determine if the tree nutrient status is at an optimum or if it is responding to mineral nutrient applications (**Table 1**). However, citrus leaves are sampled from February to March, 6 to 7 months before flowering, and a more intense flowering can be obtained than what was anticipated after the leaf analysis has been completed. In that case, it is important to adjust the fertilizer amount and frequency. If a bigger than normal crop is expected, it is important to do an accurate crop estimate as soon as possible and adjust the fertilization practice accordingly to apply the amount of fertilizer that will be required by the high number of fruit (see **Table 2** for crop removal factors). Not only should more nutrients be applied for the development of the current crop, but harvesting of a heavy crop will remove a larger than normal amount of mineral nutrients from the soil and tree reserves which should be replaced for the development of the crop of the next season.

Fruit thinning

Alternate bearing could develop if too high fruit set is obtained from intense blossoming. This could typically happen during a cool and mild spring and early summer, or when Progibb applications were successful. Excessive flowering and fruit set (like in “on” years), results in little to no root growth, and very few new vegetative shoots and new potential floral positions develop, leading to an “off” year. It is therefore important to determine the optimum fruit load for each orchard, taking into consideration the history of the orchard, the age of the tree, and bearing potential of the tree canopy.

There are various chemical fruit thinning options such as 2,4-DP (an earlier option in some cultivars) and 3,5,6-TPA (a late option in some cultivars) to reduce fruit load (**Table 3**). Application of chemical thinning agents normally reduces fruit load by stimulating abscission of the fruitlets smaller than the average fruitlet diameter at time of application. It is therefore important to determine the average fruit size at time of treatment, but also the fruit size distribution representative of the orchard, to know what amount of thinning is anticipated. To determine the optimal timing of application, select two to three representative trees per uniform block and measure the diameter of at least 50 fruit per tree. Select a part of the tree with the highest density of fruit. Measure all the fruit from small to large, but not the yellow fruit. Spray immediately when the fruitlets reach the desired fruitlet diameter.

Application of 2,4-DP or 3,5,6-TPA at an early stage (smallest diameter on product label) can result in 20-30% thinning of fruit, and improve fruit size. Early application results in more thinning and a better response. Later application (larger diameter on product label) can improve fruit size without thinning, or only 5-10% thinning. The timing of application (small or large diameter) is determined by the fruit set achieved, e.g. where gibberellins were applied to improve fruit set, or when intense flowering was followed by mild climate conditions. Be cautious during periods of heat waves and/or water stress as it could cause excessive drop of small fruit, and do not apply chemical thinning agents with potassium (K), or when leaf K concentration is high.

Selective hand thinning of small fruitlets that won’t reach commercial fruit size is an option if chemical

fruit thinning was not sufficient. Removal of fruit during summer will stimulate new shoot flush and increase the size of remaining fruit. To determine which fruit to thin, growth curves can be used to calculate which percentage of your crop won't reach the desired fruit size (see **Figs. 1 and 2** for *growth curves*). Fruitlets can also be thinned by pruning before summer. Pruning reduces crop load and increases light distribution in the canopy which will lead to increased fruit size and internal fruit quality, better fruit colour, improved rind condition and less variation in fruit quality within the canopy.

Management of creasing sensitivity

Creasing incidence is usually greater on trees bearing a heavy crop and particularly if the average fruit size is small and the rind thickness relatively thin. In addition to crop load and fruit size, many other factors influence the sensitivity to creasing. Insufficient irrigation or extended intervals in irrigation between early December and harvest play a role in the development of creasing. Stress is aggravated if the water is saline. High N, high P and low leaf K concentration are associated with a high incidence of creasing. When summers are very hot and dry, creasing can also occur on some soft citrus cultivars. Recommendations for reducing creasing are as follows:

Increase irrigation frequency to not allow trees to suffer severe water stress from August to February.

Potassium (K) concentration in leaves should be raised to at least 0.9 % K by application of KCl or K_2SO_4 to the soil, or with KNO_3 foliar sprays. Both soil and foliar K are applied in the spring to early-summer period.

High **nitrogen (N)** concentrations in leaves have been found to be associated with high creasing incidence - probably because of its role in inducing larger yields of smaller fruit. Fertilizer applications must be aimed at achieving leaf N concentrations within the ranges in Table 1.

Nematodes and soilborne pathogens reduce the ability of roots to absorb nutrients and water.

Soil conditions for healthy root growth and development are essential. Soil layers into which roots cannot penetrate within the top 600 mm of soil need to be broken up, saline conditions should be avoided by regular controlled leaching, heavy clay soils should be avoided, and *Phytophthora* root problems should be attended to as soon as possible.

ProGibb (gibberellic acid or GA_3) is a plant growth regulator/hormone that facilitates cell division and expansion. It can be effective in reducing creasing in orchards where creasing is a severe problem. A Progibb foliar spray has to be applied long before any creasing is evident, 70 to 100 days after petal drop when the fruit (oranges) is 35 – 55 mm in diameter (golf ball size).

The recommended ProGibb spray concentrations are as follows:

- Navels x Rough lemon rootstock: 10 ppm (2.5 g Progibb 40% per 100 L water) + non-ionic surfactant.
- Navels x Troyer/Carrizo: 20 ppm (5.0 g Progibb 40% per 100 L water) + non-ionic surfactant.
- Valencia x All rootstocks: 20 ppm (5.0 g Progibb 40% per 100 L water) + non-ionic surfactant.

A Progibb foliar spray later than the recommended timing may cause a delay in rind colour development.

Table 1. Leaf mineral nutrient norms for Valencia, Navels, grapefruit and lemon in South Africa.

Element		Valencia		Navel	Grapefruit	Lemon
		Cool area	Hot area			
N	%	2.0 - 2.4	2.1 - 2.7	2.4 - 2.8	2.3 - 2.6	1.90 - 2.20
K	%	0.95 - 1.50	0.70 - 1.20	0.9 - 1.1	0.9 - 1.6	1.1 - 1.4
N/K		1.6 - 2.2	3.0 - 4.5	2.2 - 3.1	1.6 - 2.9	1.6 - 2.0
P	%	0.11 - 0.16				0.11 - 0.15
Ca	%	3.5 - 5.5				
Mg	%	0.30 - 0.55				
Cu	mg/kg	5 - 16				
Zn	mg/kg	20 - 70				
Mn	mg/kg	30 - 150				
B	mg/kg	50 - 150				
Fe	mg/kg	80 - 300				

Table 2. Crop removal factors for Valencia and mandarin.

Valencia	Fruit mass (g)	g H_2O per fruit	mg mineral nutrient removed by a single fruit										
			N	P	K	Ca	Mg	Na	Mn	Fe	Cu	Zn	B
Small fruit	118	85	223	25	249	77	21	7	0.2	0.6	0.1	0.2	0.5
Medium fruit	195	144	398	44	438	108	11	8	0.3	0.7	0.1	0.2	0.7
Large fruit	286	214	675	63	689	117	39	13	0.4	1.0	0.1	0.3	0.9

Mandarin	Fruit mass (g)	g H_2O per fruit	N	P	K	Ca	Mg
Small fruit	66	48	175	22	230	82	26
Medium fruit	125	93	155	22	215	66	20
Large fruit	205	154	172	20	205	71	21

Table 3. A summary of product labels of available chemical fruit thinning agents

Product information	Corasil®P	Maxim®
Registration holder	Nufarm Agriculture (Pty) Ltd	Arysta LifeScience SA (Pty) Ltd
Active ingredient	25 g/L Dichlorprop (2,4-DP)	100g/kg Trichlopyr (3,5,6-TPA)
Withholding period	90 days	120 days
Dosage	150 ml/100L water	10 g/100L water
Timing		
Satsuma	15-20 mm	
Clementine		
Nules	8-12 mm	15-18 mm
Oroval	12-15 mm	15-18 mm
SRA	8-10 mm	12-15 mm
Marisol	None	15-18 mm
Nova, Mor, Affourer	11-14 mm	None
Orange		
Delta Valencia	18-25 mm	20-24 mm
Seeded Valencia	18-25 mm	16-20 mm
Navels	18-25 mm	20-24 mm
Grapefruit	16-28 mm	Do not use

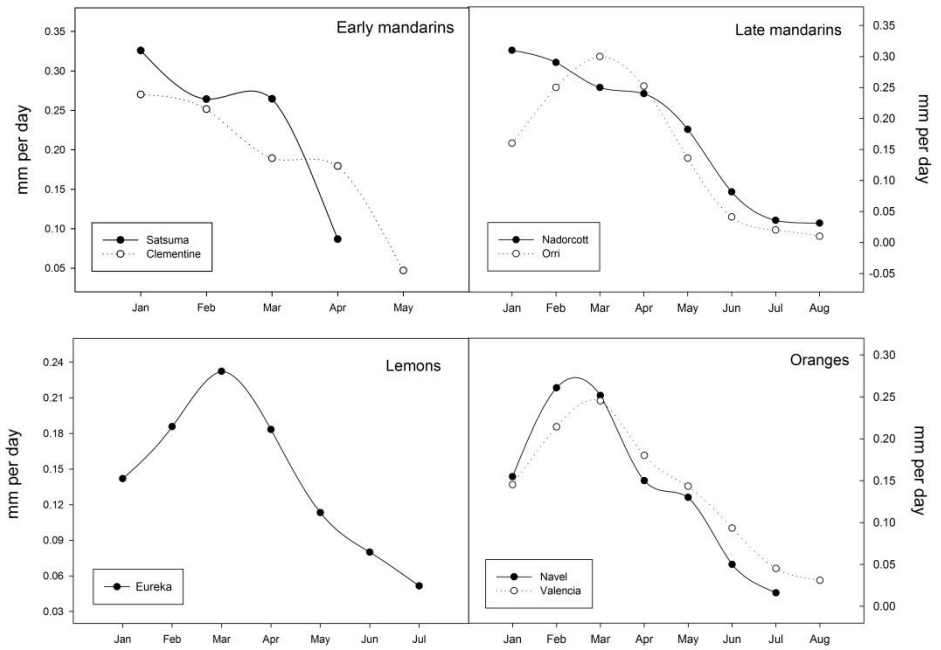

Figure 1. Historical fruit growth rates (mm per day) of different citrus cultivars in the Western Cape.

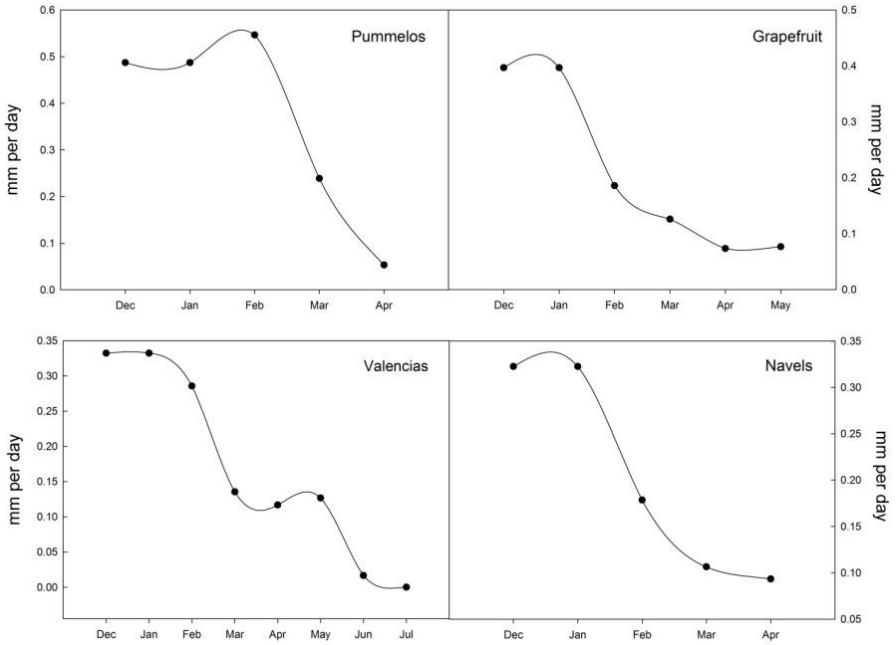

Figure 2. Historical fruit growth rates (mm per day) of different citrus cultivars in Limpopo

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Oesmanipulasies tydens en na swaar blom

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Sitrusboorde ervaar tans intense blom, veral in die koeler produksiegebiede in die Oos- en Wes-Kaap. Produsente word herinner aan die belangrikheid van die volgende kulturele bestuurspraktyke om die oeslading te manipuleer om voldoende vruggrootte en -gehalte te verseker.

Besproeiing en bemesting

Die tydperk gedurende en onmiddelik ná blom (September tot Desember) is die seldelingsfase van vrug-ontwikkeling. Dit is die periode waarin die meeste selle van die vrug gevorm word. Blomme en vrugte is veral sensitief vir waterstres, koolhidraatuitputting en minerale voedingstekorte gedurende hierdie tydperk. Die boom het water, lig-energie en CO_2 nodig om suikers te sintetiseer, wat gebruik word in die groei van die wortels, lote, blomme en vrugte. In die proses dryf sonlig watervervoer deur die plant, wat al die grond toegediende minerale voedingstowwe vervoer na waar dit benodig word. Enige waterstres, gebrek aan sonlig of minerale voedingsstres sal die seldelingsperiode benadeel en dus ook die vrugopbrengs en die meeste vrugtkwaliteitskenmerke nadelig beinvloed, dws klein vrugte, dun skille, kraakskil/gesplete vrugte. Te hoë of lae temperature en/of sterk, droë winde sal dieselfde negatiewe impak hê.

Tydens en na 'n swaar blom is die kompetisie tussen vrugte vir water, koolhidrate en minerale voedingstowwe hoog. Dit is dus belangrik om bome te bemes en te besproei volgens hulle verhoogde aanvraag. Daar is blaarnormes wat vir sekere sitrusvariëteite ontwikkel is, wat gebruik kan word om vas te stel of die boomvoedingstatus op ’n optimale vlak is, of, sou dit op minerale nutriënt toedienings reageer (**Tabel 1**). Sitrusblare word egter van Februarie tot Maart, 6 tot 7 maande voor blom gemonster, en ’n meer intense blom kan verkry word as wat verwag is nadat die blaaranalise alreeds voltooi is. In daardie geval, is dit belangrik om die bemestingshoeveelheid en-frekwensie aan te pas. Indien ’n groter as normale oes verwag word, is dit belangrik om so gou as moontlik ’n akkurate oesskatting te doen en die bemestingspraktyk dienooreenkomstig aan te pas om die hoeveelheid kunsmis wat deur die hoër hoeveelheid vrugte benodig word, te voorsien (sien **Tabel 2** vir oesverwyderingsfaktore). Nie net moet meer nutriënte toegedien word vir die ontwikkeling van die huidige oes nie, maar die oes van ’n swaar lading vrugte sal ’n groter as normaal hoeveelheid minerale voedingstowwe uit die grond- en boomreserwes verwyder, wat dan vervang moet word vir die ontwikkeling van die oes van die volgende seisoen.

Vruguitdunning

Alternerende drag kan ontwikkel as ’n te hoë vrugset verkry word vanuit intense blom. Dit kan tipies gebeur tydens ’n koel en matige lente en vroeë somer, of wanneer Progibb-toedienings suksesvol was. Oormatige blom- en vrugset (soos in "aan" jare), lei tot min of geen wortelgroei, met baie min nuwe vegetatiewe lote en nuwe potensiële blomposisie, wat dan tot ’n "af" jaar lei. Dit is dus belangrik om die optimum vruglading vir elke boord te bepaal, met inagneming van die geskiedenis van die boord, die ouderdom van die boom en die potensiaal van die boom se blaarkap.

Daar is verskeie chemiese vruguitdunning opsies soos 2,4-DP (’n vroeë opsie in sommige kultivars) en 3,5,6-TPA (’n laat opsie in sommige kultivars) om vruglading te verminder (**Tabel 3**). Toediening van chemiese uitdunningsmiddels verminder gewoonlik vruglading deur die afsnoer van die vrugte kleiner as die gemiddelde vrugdeursnee te stimuleer op die tyd van toediening. Dit is dus belangrik om die gemiddelde vruggrootte op die tyd van behandeling, maar ook die vruggrootteverspreiding verteenwoordigend van die boord te bepaal, om te weet watter hoeveelheid uitdunning verwag word. Om die optimale tydsberekening van die toediening te bepaal, kies twee tot drie verteenwoordigende bome per eenvormige blok en meet die deursnee van minstens 50 vrugte per boom. Kies ’n deel van die boom met die hoogste digtheid van vrugte. Meet al die vrugte van klein tot groot, maar nie die geel vrugte nie. Spuit dadelik wanneer die vruggies die gewenste vrugdiameter bereik.

Toediening van 2,4-DP of 3,5,6-TPA op ’n vroeë stadium (kleinste deursnee op produketiket) kan tot 20-30% vruguitdunning lei en vruggrootte verbeter. Later toediening (groter deursnee op produketiket) kan vruggrootte verbeter sonder uitdunning, of slegs 5-10% uitdunning tot gevolg hê. Die tydsberekening van toediening (klein of groot deursnit) word bepaal deur die vrugset wat bereik is, bv. waar gibberelliene toegedien is om vrugset te verbeter, of wanneer intense blom opgevolg is deur matige klimaatstoestande. Wees versigtig tydens periodes van hittegolwe en/of waterstres, aangesien dit oormatige uitdunning van klein vrugte kan veroorsaak, en moenie chemiese

uitdunmiddels saam met kalium (K) gebruik nie, of wanneer blaar K konsentrasie hoog is.

Selektiewe handuitdunning van klein vrugte wat nie kommersieële vruggrootte gaan bereik nie, is 'n opsie indien chemiese vruguitdunning nie voldoende is nie. Verwydering van vrugte gedurende die somer sal nuwe lootgroei stimuleer en verhoog die grootte van die oorblywende vrugte. Om te bepaal watter vrugte uitgedun kan word, kan groeikurwes gebruik word om te bereken watter persentasie van jou gewas nie die gewenste vruggrootte sal bereik nie (sien **Fig. 1 en 2** vir groeikurwes). Vrugte kan ook uitgedun word deur snoei van bome voor die somer. Snoei verminder oeslading en verhoog ligverspreiding binne die boom, wat tot verhoogde vruggrootte en interne vrugkwaliteit, beter vrugkleur en minder variasie in vrugkwaliteit binne die boom lei.

Bestuur van kraakskil sensitiwiteit

Die voorkoms van kraakskil is gewoonlik hoër op bome wat 'n swaar vruglading het, en veral wanneer vruggrootte klein is en die skille dun is. Benewens 'n swaar oeslading en klein vrugtegrootte, word kraakskil ook vererger deur onvoldoende besproeiing of verlengde tussenposes in besproeiingsiklusse tussen Desember en tyd van oes. Die stres kan vererger word as water sout is. Hoë N-, hoë P- en lae blaar K-konsentrasie word geassosieer met 'n hoë voorkoms van kraakskil. Wanneer somers baie warm en droog is, kan kraakskil ook op sommige sagte sitruskultivars voorkom. Aanbevelings vir die vermindering van kraakskil is as volg:

Verhoog **besproeiingsfrekwensie** om nie toe te laat dat bome swaar waterstres van Augustus tot Februarie ondervind nie.

Kalium (K) konsentrasie in blare moet verhoog word tot minstens 0.9% K deur toediening van KCl of K_2SO_4 tot die grond, of met KNO_3 blaarbespuitings. Beide grond en blaar K word toegedien in die lente tot vroeg-somer.

Hoë stikstof (N) konsentrasies in blare kan geassosieer word met 'n hoë voorkoms van kraakskil - waarskynlik as gevolg van die rol daarvan om groter opbrengs van kleiner vrugte te bewerkstellig. Bemestingspraktyke moet dus daarop gemik wees om blaar N konsentrasies binne die normes soos in Tabel 1 te bereik.

Nematodes en grondgedraagde patogene verminder die vermoë van wortels om voedingstowwe en water te absorbeer.

Grondtoestande vir gesonde wortelgroei en -ontwikkeling is noodsaaklik. Grondlae waarin wortels nie binne die boonste 600 mm grond kan binnedring nie, moet opgebreek word. Soutomstandighede moet vermy word deur gereelde beheerde uitloging toe te pas, swaar kleigrond moet vermy word, en *Phytophthora*-wortelprobleme moet aandag geniet.

ProGibb (gibberelliensuur of GA_3) is 'n plantgroeireguleerder / hormoon wat selverdeling en vergroting fasiliteer. Dit kan effektief wees in die vermindering van kraakskil in swaardraende boorde of boorde waarin kraakskil histories 'n hoë voorkoms het. 'n Progibb blaarbespuiting moet lank voor die voorkoms van kraakskil toegedien word. 70 tot 100 dae na blomblaarval, wanneer die vrugte (lemoene) 35 - 55 mm in deursnee is (gholfbalgrootte).

Die aanbevole ProGibb spuit konsentrasies is soos volg:

- Navels x Growweskil onderstam: 10 dpm (2.5 g Progibb 40% per 100 L water) + nie-ioniese benatter.
- Navels x Troyer / Carrizo: 20 dpm (5.0 g Progibb 40% per 100 L water) + nie-ioniese benatter.
- Valencia x Alle onderstamme: 20 dpm (5.0 g Progibb 40% per 100 L water) + nie-ioniese benatter.

'n Progibb blaarbespuiting later as die aanbevole tydsberekening kan 'n vertraging in die ontwikkeling van skildkleur veroorsaak.