METAMITRON:
Novel Mandarin Thinning Agent

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Opsomming

Metamitron is die aktief van ŉ chemiese uitdunmiddel, Nevis® [Adama (Pty) Ltd], wat in appels en pere gebruik word. In appels en pere inhibeer metamitron blaar fotosintese vir 7 tot 10 dae, wat koolhidraat-beskikbaarheid verminder en gevolglik die kleinste en swakste vruggies laat afspeen. Die effekte van metamitron in sitrus is nog nie ge-evalueer nie. Die doel van hierdie studie was om die potensiaal van metamitron as ŉ chemiese uitdunmiddel vir die Suid-Afrikaanse sitrusindustrie te evalueer. ŉ Medium-dek blaarspuit van 300 dele per miljoen metamitron in 'Nadorcott' mandaryne 4 tot 6 weke na volblom en op vrugdiameter van 8 tot 12 mm het blaarkoolhidraat konsentrasie en die aantal vrugte per boom met tussen 20 en 25% verminder. Metamitron het geen effek op vrugkwaliteit gehad nie en geen simptome van fitotoksiteit in enige van die eksperimente getoon nie. Indien die produk suksesvol geregistreer word kan die produk as ŉ alternatief vir handuitdunning en die huidige hormoon-gebaseerde chemiese uitdunmiddels in mandaryne gebruik word.

Background

South African citrus producers currently make use of two formulations of synthetic auxins to chemically thin citrus fruitlets, viz. Corasil®P [Nufarm Agriculture (Pty) Ltd] and Maxim® [Arysta LifeScience SA (Pty) Ltd]. They are applied during or directly after phase I of citrus fruit development, i.e. from a few days after full bloom in October until middle December. They act by inducing ethylene-related abscission of fruitlets which alters the leaf-to-fruit ratio and makes more carbohydrates, mineral nutrients and water available to the remaining fruit. These products also cause direct stimulation of cell growth which further increase fruit growth, but could result in granulated fruit with thick and coarse rinds if not applied correctly.

The commercial use of some of these synthetic auxins is in danger of being discontinued due to the reduction in the minimum residue levels (MRLs) permitted by some of the fruit export markets for certain plant growth regulators. Metamitron is the active ingredient of a commercial chemical fruit thinning agent, Nevis® [Adama (Pty) Ltd], that was recently developed for use in apple and pear cultivars. Unlike the current chemical thinners, a foliar application of metamitron disrupts the photosynthetic apparatus which leads to a short period of carbohydrate stress. A shortage of carbohydrates can lead to abscission of fruitlets, i.e. fruit thinning. In apple and pear, metamitron is usually applied 2 to 3 weeks after full bloom and at a fruitlet diameter of 10 mm when fruitlets have the highest demand for carbohydrates. The product is only active for 7 to 10 days after application and thinning of fruitlets is thought to be a result of a temporal limitation in carbohydrate supply to developing fruitlets. The effects of metamitron on citrus trees and on fruit quality are unknown. The objectives of this study were to determine the effects of different concentrations of metamitron foliar spray treatments on the concentration of leaf carbohydrates in citrus, and the potential of different timings of metamitron treatments as a chemical fruit thinning agent.

Materials and methods

Plant material and experimental site: 'Nadorcott' mandarin trees were used in a commercial orchard in the Western Cape Province. The orchard was cultivated, pruned, and sprayed according to good agricultural practices.

Treatments and experimental design: The experiment was set up in a randomised complete block design. In season 1 300 ppm metamitron [Nevis® (15% w/w metamitron), Adama (Pty) Ltd, Cape Town, South Africa] was applied to eight whole-tree replicates (n=8) on 5 Nov. 2015, 30 days after full

Metamitron is a non-hormone related active ingredient of a chemical fruit thinning agent in apple and pear.

bloom (DAFB) when the fruitlets had an average transverse diameter of 8 mm, and on 5 Dec. 2015, 60 DAFB when the fruitlets had an average transverse diameter of 15 mm. In season 2, 300 and 150 ppm metamitron were applied to seven whole-tree replicates (n7) on 7 Nov. 2016, 30 DAFB when the fruitlets had an average transverse diameter of 8 mm, and compared to an untreated control. The foliar spray treatments were applied until the point of runoff at a rate of 4 L spray solution per tree using a backpack mist-blow sprayer set at droplet size 2 (1 – fine droplet size, 5 – coarse droplet size). No wetting agent was added to spray mixtures as per recommendation by the registration holder of Nevis®. The trees were uniform in canopy size, trunk circumference, and had an evenly distributed fruit load.

Data collection: On the day of treatment, five fruit were randomly selected and tagged on each replicate at a height of 1.5 m above the orchard floor. Initial fruit diameter was measured using an electronic caliper, and thereafter monthly measurements were made using electronic fruit size measure (EFM) and data logger instruments. The measurements were used to calculate treatment effects on fruit growth rate. Mature leaves were sampled to analyse carbohydrate content using the phenol-sulphuric acid assay. One week before the 'Nadorcott' orchard was to be commercially harvested, a sample of 12 randomly selected fruit per data tree was collected to determine the effects of treatments on fruit quality attributes, i.e. fruit size (diameter and weight), rind thickness, total soluble solids (TSS), titratable acidity (TA), and juice percentage (%).

Results and discussion

A foliar application of 300 ppm metamitron in November or December successfully thinned 'Nadorcott' fruitlets and reduced the total number of fruit per tree by 20 to 25% compared to an untreated control and a 150 ppm metamitron treatment (Table 1). Both the 150 and 300 ppm metamitron treatments reduced leaf sugars and leaf total carbohydrates 1 day after treatment compared to the untreated control, but the effects of a 300 ppm metamitron treatment were more persistent, and lower total sugars, starch and total carbohydrates were measured in leaves up to 7 days after treatment in the preliminary experiment and up to 60 days after treatment in the whole-tree experiment (Fig. 1).

Metamitron efficacy to thin fruitlets depends on the length of time the photosynthetic apparatus is inhibited, the extent to which the assimilate level in the tree is reduced,

Table 1. Effects of metamitron on fruit yield in 'Nadorcott' mandarin.

Treatments	Fruit yield (kg/tree)	Fruit yield (no./tree)
2016 (n=8)		
Control (no thinning)	32 ns	313a
300 ppm metamitron[z] 5 Nov. 2015	27	241b
300 ppm metamitron 8 Dec. 2015	27	257b
P-value	0.3383	0.0241
2017 (n=7)		
Control (no thinning)	61a	545a
300 ppm metamitron 7 Nov. 2016	50b	431b
150 ppm metamitron 7 Nov. 2016	59a	556a
P-value	0.0264	0.0456

[z] Nevis^{TM}, containing 15% w/w metamitron, Adama (Pty) Ltd.

Table 2. Fruit quality attributes of control and metamitron treatments in 'Nadorcott' mandarin trees.

Treatments	Fruit diameter (mm)	Rind thickness (mm)	Fruit TSS (%)	Fruit TA (citric acid %)	Fruit juice content (%)
2016 (n=8)					
Control (no thinning)	66.7ns	2.41ns	9.4ns	1.0ns	49ns
300 ppm metamitron[z] 5 Nov. 2015	69.0	2.17	8.8	1.0	49
300 ppm metamitron 8 Dec. 2015	68.5	2.20	9.2	1.0	51
P-value	0.4245	0.7910	0.1245	0.6470	0.1516
2017 (n=7)					
Control (no thinning)	64.6ns	2.90ns	11.1ns	1.0 ns	48ns
300 ppm metamitron 7 Nov. 2016	65.7	3.40	10.9	1.0	48
150 ppm metamitron 7 Nov. 2016	63.6	3.20	11.0	1.0	48
P-value	0.1930	0.0574	0.8651	0.5972	0.3995

[z] Nevis^{TM}, containing 15% w/w metamitron, Adama (Pty) Ltd.

and the vulnerability of the crop to lower carbohydrate levels in the tree. The influence of environmental conditions on the leaf photosynthetic capacity would therefore affect the efficacy of a metamitron treatment. In this study, clear weather and high temperatures were experienced when the treatments were applied and conditions were conducive for optimal photosynthesis rates in both seasons. A 150 ppm metamitron treatment had no effect on fruit thinning and suggests that the treatment did not affect carbon assimilation to the same extent as a 300 ppm treatment. If the treatments were applied during a period of low temperature and/or low ambient light, the 150 ppm treatment could possibly have resulted in more thinning and the 300 ppm treatment in excessive fruit thinning.

Surprisingly, fruit thinning by a 300 ppm metamitron treatment did not result in an increase in the growth rate of remaining fruit (Fig. 2) and the treatment did not increase fruit size and had no direct effects on other fruit quality attributes (Table 2). To thin fruitlets, metamitron treatments rely on a mechanism that is not related to a hormonal action. Therefore, although a 300 ppm treatment successfully thinned fruitlets, it did not have a direct stimulating effect on the sink strength of remaining fruit which is achieved by the application of synthetic auxins. In addition, the effects of metamitron on leaf carbohydrates appeared to have nullified the gain in carbohydrates and the possible fruit size increase that typically results from fruit thinning. Although a 300 ppm metamitron treatment in this study did not influence fruit quality, the accompanied reduction in fruit number prior to the summer vegetative shoot flush could significantly impact alternate bearing by limiting the inhibiting effects of a heavy fruit load in season 1, on return bloom and fruit load in season 2.

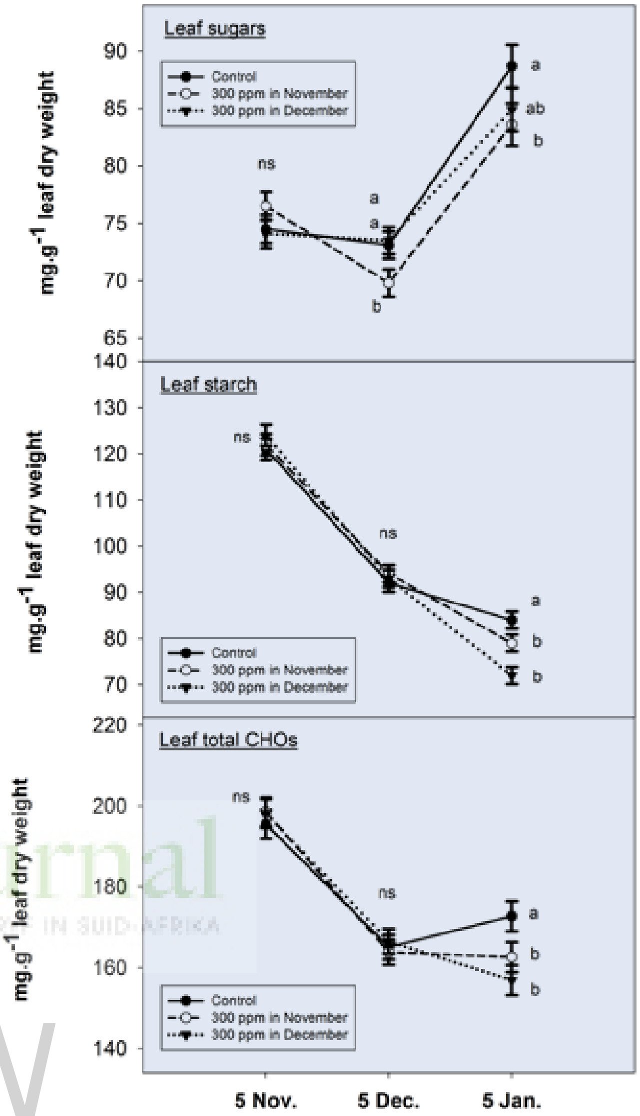

Fig. 1. The effects of two different timings of a 300 ppm metamitron treatment in Nov. 2015 and Dec. 2015 to 'Nadorcott' trees on leaf sugars, starch and total carbohydrates.

Conclusion

A single, medium-volume foliar spray of 300 ppm metamitron in a heavy-set year at 4 to 6 weeks after full bloom when fruitlet size was 8 to 12 mm in transverse diameter, consistently reduced fruit number by 20 to 25%. A 300 ppm treatment in November thinned more aggressively compared to a 150 ppm treatment, in which the fruit yield was not different from the control. Metamitron treatments did not increase fruit size of 'Nadorcott' mandarin and had no direct effect on other fruit quality attributes. Metamitron could therefore potentially be used as a chemical fruit thinning agent to reduce fruit numbers and possibly also control alternate bearing in 'Nadorcott' mandarin, but an increase in fruit size or quality will not occur. This is a report on preliminary experiments for effects of metamitron on citrus that were conducted in heavy-fruiting 'Nadorcott' mandarin trees in the Western Cape. Similar rates of foliar metamitron treatment should be evaluated for fruit thinning efficacy in different cultivars, and under typical spring field-conditions in different South African citrus production regions.

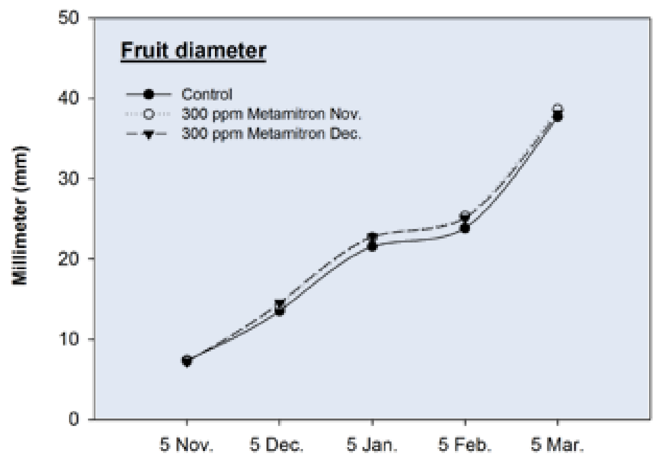

Fig. 2. The effects of 300 ppm metamitron treatments in Nov. 2015 and Dec. 2015, respectively, on fruit growth rate.