The effect of concentration of Austar (paclobutrazol) sprayed at flowering on fruit retention, fruit yield, fruit size, post flowering bud-break, and new shoot vigor and leaf development in Maluma Hass avocado

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Paclobutrazol (Australia , Mexico) or uniconazole (South Africa) or are used extensively to reduce new shoot vigor and increase tree-flowering and tree yield in avocado. Paclobutrazol at 0.7% (product 250 g a.i. per L, v/v), or uniconazole 1% (product 50 g a.i. per L, v/v), are generally spray applied during flowering, once or twice. Root drench applications may be made. The objective of the current study was to assess the effect of 0.35, 0.7 or 1.4 % sprays of Austar (250 g / L paclobutrazole formulation) during flowering, on fruit retention, fruit yield, fruit size, post flowering bud-break, and new shoot vigor and leaf development. The study was carried out in Tzaneen, South Africa. 1.5 to 2 m high, Maluma Hass avocado on the export farm of Nick Human were used. Fruit retention was increased by the 1.4 % spray. The 0.7 and 1.4 % applications apparently gave rise to an increase in fruit yield. Fruit weight (size) was increased by the 0.35 and 0.7% applications, but apparently not by the 1.4% application. New shoot length was reduced, this being clearly evident following 0.7% application. There was no apparent effect of the paclobutrazol sprays on number of new shoots developing or the weight of the leaves on the new shoots. Shoot length was reduced, but apparently not at the expense of new leaf surface area resulting from new shoot growth at and after flowering. The results of the study indicate a benefit in terms of yield in inflorescence-spraying at 0.7 or at 1.4%. Further trial research is justified in assessing paclobutrazol applications, both in relation to concentration and number. Previous studies have shown benefits, both in relation to fruit size and tree yield. Increased fruit retention has not been generally observed.

Introduction

Fruit drop after flowering can be excessive in avocado, and is considered to be a problem of most avocado cultivars grown commercially. The extent of drop is considered to be related positively to the vigour of the new shoots emanating from and close to the inflorescences at and after inflorescence development and flowering (Kalmar and Lahav, 1976). Paclobutrazol, applied by spraying or to the soil during inflorescence development and flowering, is effective in reducing new shoot vigour in it being a gibberellic acid synthesis inhibitor. Reduced vigour is considered to lessen competition between the newly developing fruits and new shoots for assimilates, and is thus associated with reduced fruit drop and increased fruit numbers and yield at harvest (Wolstenholme et al., 1988). Increased fruit size in the absence of an increase in fruit number was reported by Whiley et al. (1992). Generally, however, in avocado, monetary income per kg for small fruit is substantially less than that for large fruit. Fruit size generally declines and increase in number of fruits set, as observed by Oosthuyse and Donkin (2001) in avocado. Published research indicating differences in response to inflorescence-spray application of paclobutrazol in relation to rate of application is generally lacking.

The objective of the current study was to assess the effect of 0.35, 0.7 or 1.4 % sprays of Austar (250 g / L paclobutrazol formulation) during flowering, on fruit retention, fruit yield, fruit size, post flowering bud-break, and new shoot vigor and leaf development.

Materials and Methods

Twenty trees of uniform size were selected in a Maluma Hass orchard block on the farm of Nick Human, located near Tzaneen, South Africa. On August 31, when the anthesis was generally occurring (Fig. 1) the trees were sprayed.

Fig. 1 Maluma Hass avocado tree appearance on the date of spraying – August 31, 2019.

The following light cover spray applications were made using 16 L knapsack sprayers:

A_0: Control (unsprayed)
A_1: Austar spray 0.35% (v/v) - 56 ml/16 L
A_2: Austar spray 0.7 % (v/v) – 112 ml/16 L
A_3: Analogous product spray 0.7 % (v/v) – 112 ml/16 L
A_4: Austar spray 1.4 % (v/v)- 224 ml/16 L

The non ionic wetter, LI 700 (phosphatidylcholine, methylacetic acid, alkyl polyoxyethylene ether - 80%) was used. 32 ml was added to the solution in each knapsack sprayer used. LI 700 is stated t be a penetrant, acidifier, deposition aid, and drift control agent. 16 L covered 5 to 6 trees. Light cover leaf wetting occurred (Fig. 2). Conditions were cool when spraying.

Fig. 2 Spraying was done at “light-cover.” Run off did not occur. 16 L of solution covered 4 to 5 trees.

There were four single tree replicates of five treatments (incl. Control) in a Randomized Complete Blocks experiment.

Just after spraying, 10 inflorescences evenly distributed on the tree, were labelled on each tree. Fruits set, and new shoots grew from the inflorescences and buds located below their bases. At harvest on March 28, 2017, these “units” were removed from the trees, placed in large paper bags, and taken to the laboratory for data collection (Fig. 3).

Fig. 3 The 10 bearing units (unit = fruits and new shoots having developed from and just below the inflorescence) per tree were removed at harvest on and taken to the laboratory for data collection.

The fruit on each unit were individually weighed, and the length of the shoots on them measured. In each unit, the new shoot leaves were detached and weighted. In the laboratory, the units were paced in plastic bags prior to data collection to prevent drying. The data were recorded in two days, and subjected to Analysis of Variance. Mean separation was based on the 5% LSD criterion.

Results and Discussion

Table 1 shows the averages for for total fruit number on the 10 units per tree, for total weight of the fruits on the 10 units per tree, average weight of the fruits on the 10 units per tree, and weight of fruits per unit.

Fruit retention was increased by the 1.4 % spray. Reductions were not evident. Both the 0.7 and 1.4 % applications apparently gave rise to an increase in fruit yield. An increase in this regard was not apparent following application at 0.35%. Individual fruit weight (directly related to size) was increased by the 0.35 and 0.7% applications, but apparently not by the 1.4% application. 400 to 515 grams of fruit were carried per unit, this representing 1 to 2 fruits, and sometimes 3.

Table 1 Averages for total fruit number on the 10 units per tree, for total weight of the fruits on the 10 units per tree, average weight of the fruits on the 10 units per tree, and weight of fruits per unit. Means followed by a different letter differ significantly according to 5% LSD.

Treatment	Total Fruit Number, Units	Total Fruit Weight, Units (g)	Average Fruit Weight, Units (g)	Weight of Fruits per Unit (g)
Control	16.25 ab	4028.2 a	248.8 a	402.8 a
Austar 0.35 %	14.75 a	4093.1 ab	278.8 b	409.3 ab
Austar 0.7 %	17.75 ab	4840.3 ab	272.6 ab	484.0 ab
PBZ Alt. 0.7 %	16.25 ab	4471.9 ab	275.9 b	447.1 ab
Austar 1.4 %	20.25 b	5127.6 b	256.7 ab	512.8 b

Table 2 shows the averages for the weight of the new shoot leaves on the 10 units per tree, the weight of the leaves per unit, the length of the extended (main) shoots on the 10 units per tree, the length of the non-extended (laterals) shoots on the 10 units per tree, and new shoot length.

Table 2 Averages for the weight of the new shoot leaves on the 10 units per tree, the weight of the leaves per unit, the length of the extended (main) shoots on the 10 units per tree, the length of the non-extended (laterals) shoots on the 10 units per tree, and new shoot length. Means followed by a different letter differ significantly according to 5% LSD.

Treatment	Weight of Leaves, Units (g)	Weight of Leaves per Unit (g)	Main Shoot Length, Units (cm)	Average Lateral Length, Units (cm)	Average Shoot Length, Units (cm)
Control	1069.1 a	106.9 a	45.0 a	26.8 a	40.8 ab
Austar 0.35 %	1203.8 a	120.4 a	47.0 a	25.3 a	40.7 ab
Austar 0.7 %	1199.8 a	120 .0 a	40.0 a	24.8 a	36.1 ab
PBZ Alt. 0.7 %	1143.3 a	114.3 a	38.9 a	23.5 a	34.2 a
Austar 1.4 %	1290.6 a	129.1 a	49.2 a	24.4 a	43.4 b

The weight of the leaves on the new shoots was apparently not affected by any of the treatments. 100 to 140 grams of new leaves (fresh weight) were present per unit.

Differences in shoot length resulting from treatment were not clearly apparent. Length of the extended shoots and average shoot length were evidently reduced following 0.7 % application. An effect on lateral shoot length was not apparent.

Table 3 shows averages for number of new shoots, number of extended (main) shoots and number of non-extended (lateral) shoots on the units per tree.

Table 3 Averages for number of new shoots, number of extended (main) shoots and number of non-extended (lateral) shoots on the units per tree. Means followed by a different letter differ significantly according to 5% LSD.

Treatment	Number of Shoots, Units	Number of Main Shoots, Units	Number of Lateral Shoots, Units
Control	18.7 a	14.5 a	4.2 a
Austar 0.35 %	19.0 a	14.2 a	4.7 a
Austar 0.7 %	19.2 a	13.7 a	5.5 a
PBZ Alt. 0.7 %	19.5 a	14.5 a	5.0 a
Austar 1.4 %	22.0 a	16.5 a	5.5 a

There was no clear effect of the paclobutrazol sprays on number of new shoots developing, either extended shoots, non-extended shoots or both shoot types. An increase in number of buds developing may have resulted from 1.4% application, however.

The results indicate the effects of increased fruit retention, fruits weight (size) and fruit yield resulting from 0.7% or 1.4% paclobutrazol-product application. New shoot vigour is apparently reduced, but not at the expense of leaf area, as reflected by leaf weight in the current study. An effect on number of new shoots developing per bearing unit was not clearly apparent. An increase may have occurred as a result of 1.4% application.

Increased fruit retention resulting from paclobutrazol application was indicated in the present study. Paclobutrazol spray application only affecting size without increasing or reducing fruit number was documented (Wolstenholme et al., 1988; Whiley et al., 1992). An increase in fruit retention may be an expected result in considering reduce completion between new shoots and newly developing fruits. The additional effect of increasing fruit retention in combining paclobutrazol with KNO_3 in spraying was indicated by Oosthuyse and Berrios (2015) in Mendez avocado grown in Mexico. Improved phloem translocation was postulated as a reason for the KNO_3-addition benefit.

In view of the general use of paclobutrazol or uniconazol in avocado, essentially to contain tree size and increase cropping, larger and more detailed study is justified. Varieties may respond differently with respect to concentration. The adjuvant used may also have a bearing on efficacy.

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