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The effect of growth inhibitors on fruit production in Hass avocado trees

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ABSTRACT

One of the major factors currently affecting production in the South African avocado industry is the problem of excessive vegetative growth in avocado orchards. This vigorous growth leads to problems of orchard encroachment, poor fruit set and retention, poor fruit size and a possible reduction in fruit quality. Orchard encroachment can be eliminated by corrective pruning — an approach pioneered by the ITSC and now widely adopted in the industry. Regular pruning is also vital for the ongoing maintenance of open, readily managed orchards — a practice now widely accepted by avocado growers. Despite the progress brought about by the pruning programme, a number of problems still exist in the industry and it is apparent that a successful pruning program needs to be supplemented with other cultural practices.

In 1997 the ITSC implemented a growth inhibitor spraying program to be used in conjunction with tree pruning. The current season's work has shown that these products confer a number of benefits on avocado growers. Firstly, it has been shown that significant improvements in yield can be obtained. In one cultivar, a yield increase of 130% was achieved. Secondly, several of the products give improved fruit size. This is particularly noticeable when the growth inhibitor is used in conjunction with pruning — one of the trials gave an average fruit size two counts larger than the controls. In several cases undersized fruit was almost eliminated. The current paper discusses these findings

INTRODUCTION

Before mentioning any of the uses of growth inhibitors, it must be pointed out that chemical manipulation of fruit trees is only a small part of a manipulation program. Such a program incorporates practices such as pruning, girdling, fruit and flower thinning, correct fertilisation and irrigation and a host of other practices (Stassen & Davie, 1996a; Stassen & Davie, 1996b; Stassen *et al*., 1997). It is vital that all of these factors be correctly carried out at the optimum time in order to maximise the production of export-quality fruit. It is also important that all of them are used on an ongoing basis — not one of these treatments provides a one-off solution to any given problem. While most of these practices have been researched at the ITSC over several years, chemical manipulation is relatively new in the field of avocado production. Despite their short

history in the avocado industry, these compounds have rapidly gained in popularity and have become a valuable tool whereby a number of problems facing the industry can be addressed.

Some of the problems currently under investigation in the Hass avocado are excessive growth and encroachment, poor fruit set and retention, poor fruit size and, in some cases, poor quality. The primary cause of most of these problems is the growth habit of the avocado tree. This is a substory rain forest species (Whiley & Schaffer, 1994) and, as is typical of such trees, is capable of extremely rapid vegetative growth. This growth has both direct and indirect effects on avocado production.

The first effect of this growth is orchard encroachment which can occur in less than 5 years (Köhne, 1988). This encroachment is aggravated by the high potential soils in many avocado growing areas, and makes orchard management more difficult and expensive. This problem can be largely overcome by effective pruning — an approach now widely adopted in the South African avocado industry (Stassen *et al*., 1995; Snijder & Stassen, 1997; Snijder & Stassen, 1999). However, pruning stimulates regrowth and it is vital that this regrowth be minimised. Growth inhibitors can have a direct effect on this regrowth. The reduction of shoot length by these compounds can lead to an overall reduction in vegetative growth (Sachs & Hackett, 1972). Besides encroachment, there are a number of other problems experienced in the avocado industry. These include poor yields, poor fruit size and poor quality. These are also related to the strong flush and arise as a result of competition between vegetative and reproductive growth. The strong vegetative flushes are an extremely strong sink for minerals, water and photo-assimilates. As a result, developing fruit is deprived of the nutrients required for their growth. This can lead not only to smaller fruit, but also to poor quality fruit. In addition to this, the competition can lead to poor fruit set and retention. Wolstenholme *et al.*. (1990) have estimated that up to 60% of set fruit drop as a result of competition by the summer flush. By reducing the vegetative flush, growth inhibitors eliminate a lot of this competition. This can lead to better fruit set and retention as well as an improvement in fruit size and possibly quality.

The aim of this trial was to examine the effects of several growth inhibitors on vegetative and fruit growth in Hass avocados. Two of these compounds (Cultar and Sunny) are currently registered for use in avocados but only at flowering. Their effect on later vegetative flushes has not yet been determined, nor has the effect of multiple applications been examined. Furthermore, these products are relatively expensive and no work has been done with the cheaper growth inhibitors currently registered in other fruit crops. This trial was set up to examine these issues.

METHODS AND MATERIALS

The trials were set up at three sites. The first was at Kiepersol, where the effects of several growth inhibitors from other crops were compared to Sunny, which is registered for avocados. This trial was conducted on Hass trees. The second trial, also in an orchard in the Kiepersol area, examined the effect of application timing for three different products. Again, the trial was carried out on the Hass cultivar. The third trial, in Levubu, was done on a semi-commercial scale and compared three different products.

This trial utilised both Hass and Fuerte trees.

Trial 1: Kiepersol (Panorama farm) —

6 x 4m Hass planting

Products tested included:

1. Sunny® 0.7%
2. Cycocel (CCC) 2500 $mg.L^{-1}$
3. Pix 1500 ppm, 2500 $mg.L^{-1}$
4. Cycocel 2500 $mg.L^{-1}$ + Ethephon 250 $mg.L^{-1}$

Full cover sprays were used with Nu-Film P as a wetter. All applications were made at flowering, using 4 replicates comprising 5 trees apiece.

Trial 2: Kiepersol (Panorama farm) —

5 x 2.5m Hass planting

Products tested included:

1. Sunny 0.7%
2. Cycocel 2000 $mg.L^{-1}$, 3000 $mg.L^{-1}$, 4000 $mg.L^{-1}$
3. Cultar 0.4%

Each product was tested at

A. Flowering

B. Flowering + on summer flush

Full cover sprays were applied with Nu-Film P as a wetter. Treatments again comprised 4 replicates of 5 trees apiece.

Trial 3: Levubu (Schoonuitzicht farm) —

9 x 6m Hass and Fuerte plantings

Products tested included:

1. Pruning + Sunny 1%
2. No pruning + Sunny 1%
3. Pruning + Cycocel 2000 $mg.L^{-1}$, 3000 $mg.L^{-1}$, 4000 $mg.L^{-1}$
4. Pruning + Cultar 0.4%
5. Pruned control
6. Unpruned control

Each product was applied as a full cover spray at flowering with Nu-Film P as a wetter.

Hass treatments comprised 10 replicates of 5 trees apiece, Fuerte had 5 replicates of 5 trees apiece.

In each trial, data collected included the following:

1. Number of fruit harvested per tree.

2. Total weight of fruit harvested per tree.

3. Fruit size distribution based on 1 tree per replicate where all fruit harvested were individually weighed.

Residue analysis: Sunny®

Sampling for residue analysis:

Two kilogrammes of mature Hass fruit were taken for each sample. These were frozen and delivered immediately to the SABS for analysis. Samples were taken randomly around each sampled tree.

RESULTS AND DISCUSSION

TRIAL 1:

As shown in Figure 1, three of the treatments gave higher yields than the controls but only two of these are statistically significant. One of the significant improvements is due to Sunny, a product registered for avocados. The other improvement is due to Pix at 2500 ppm.

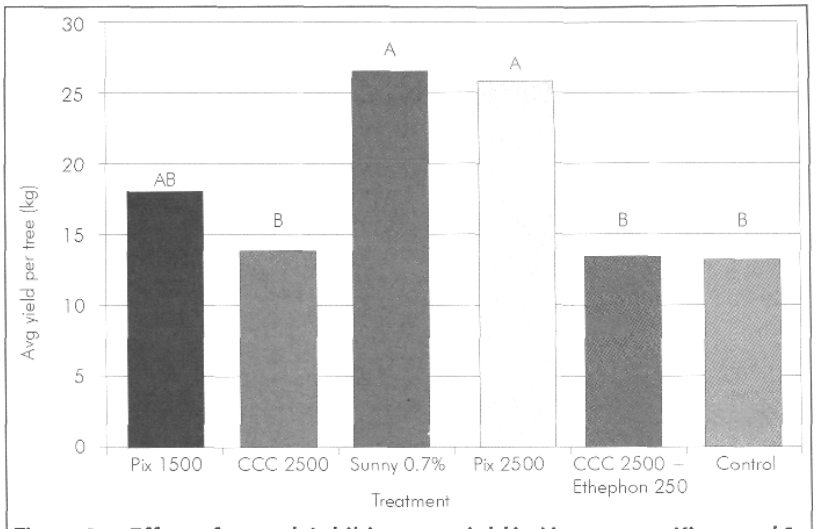

Figure 1 Effect of growth inhibitors on yield in Hass trees - Kiepersol 1

Figure 2 indicates that only the Sunny treatment gave an improvement in fruit size.

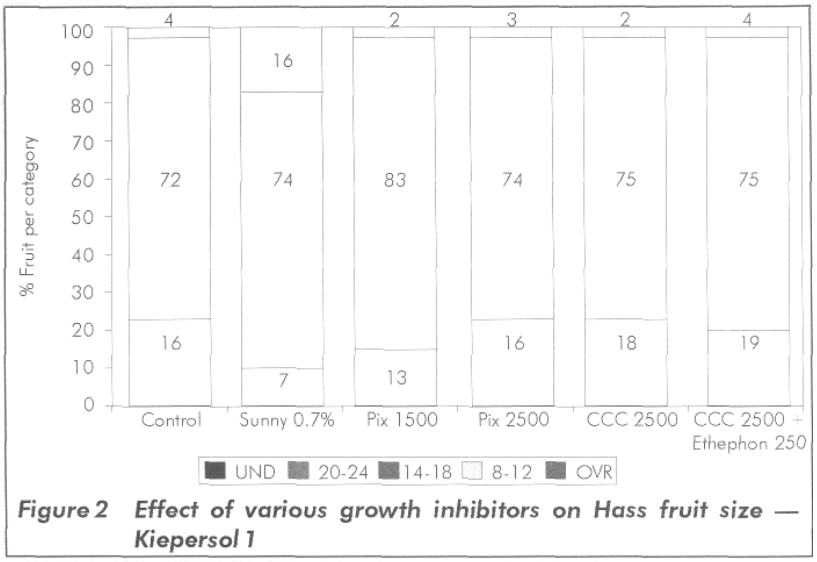

Figure 2 Effect of various growth inhibitors on Hass fruit size — Kiepersol 1

Pix at 2500 ppm did not increase fruit size relative to the controls. Since Pix at this rate is no cheaper than Sunny, it cannot be recommended as an alternative to the registered product. Cycocel and Ethephon offered no significant improvements in either yield or fruit size. Thus at the moment, it appears that no alternatives to the registered product (Sunny) are available. This trial indicates that Sunny is still an excellent product. It gave yield increases of 100% and gave fruit of a significantly larger size. Final yield in Sunny-treated trees was in the region of 12 t/ha — this is an excellent yield for a 3.5-year-old orchard bearing its first commercial crop.

TRIAL 2:

Yields in this orchard were disappointingly low due to a high potential soil which resulted in exceptional tree vigour. Figure 3 shows that none of the chemicals used gave significant increases in yield, regardless of the application tinning.

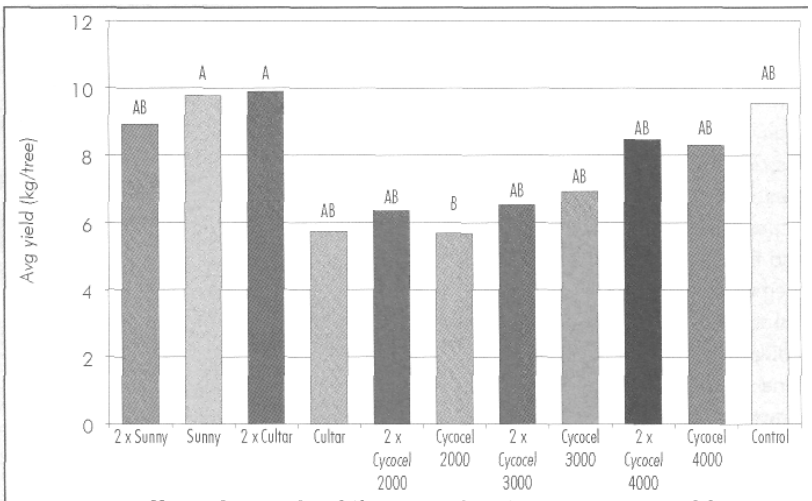

Figure 3 Effect of growth inhibitor application timing on yield in Hass — Kiepersol 2

However, the fruit size data (Figure 4) showed some interesting trends.

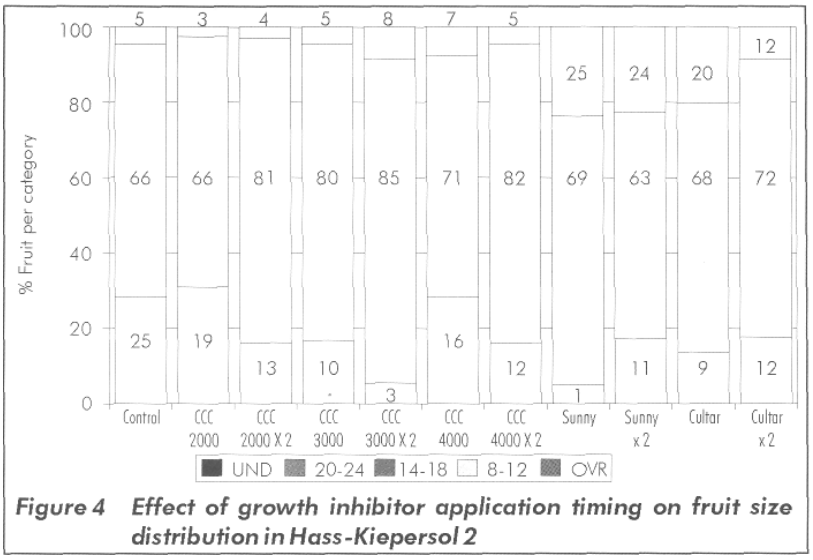

Figure 4 Effect of growth inhibitor application timing on fruit size distribution in Hass-Kiepersol 2

The onium compound (Cycocel) showed considerable increases in fruit size and a reduction in the percentage undersized fruit. The results were better for double applications (flowering + summer flush sprays) than for single applications (at flowering). This result was consistent for all application rates. The triazoles (Sunny and Cultar), on the other hand, tended to give better fruit size for the single applications. The best treatment was Cycocel at 2 x 3000 $mg.L^{-1}$ — a result which seems to hold under conditions of low crop load but not high crop loads (see next trial). This indicates that Cycocel may be a suitable alternative to the more expensive triazoles when a light crop is on the tree.

TRIAL 3:

Hass

The first noticeable result in this trial is that pruning may give a decline in yield (Figure 5).

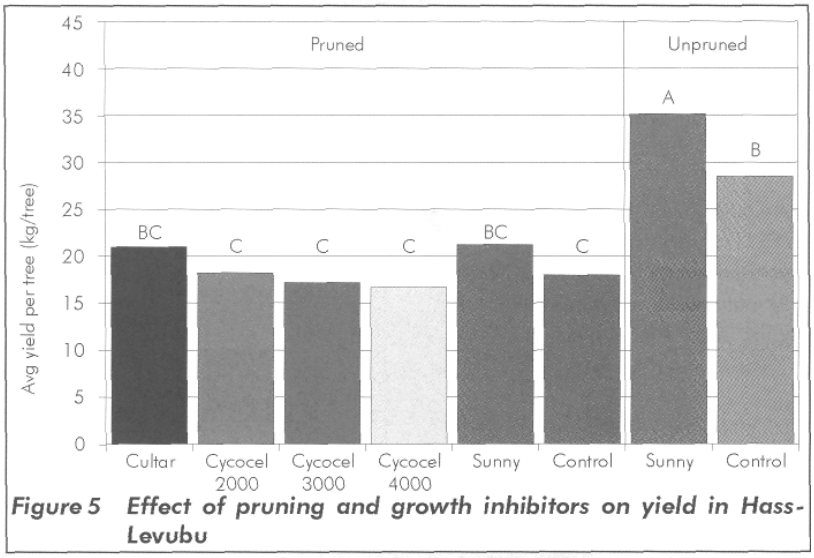

Figure 5 Effect of pruning and growth inhibitors on yield in Hass-Levubu

This was expected, since this was the first time these trees had been pruned and some of the cuts were quite large. As far as the growth inhibitors are concerned, it can be seen that Sunny improved yields by 20 - 30% in both pruned and unpruned trees. In the case of the unpruned trees this was a significant increase in yield. Cultar also gave a slight yield increase, while Cycocel gave no improvement at any application rate. A more important result here was the improvement in fruit size. Figure 6 shows that pruning alone improved average fruit size from a count 18 to a count 16.

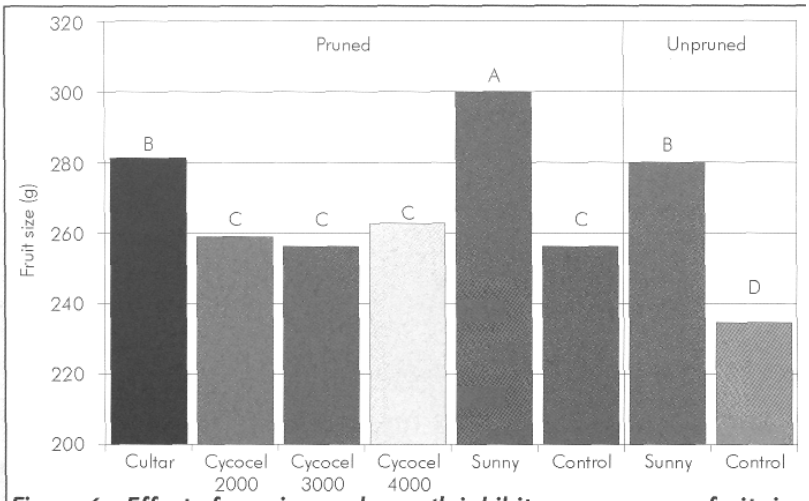

Figure 6 Effect of pruning and growth inhibitors on average fruit size in Hass-Levubu

Despite the drop in yield for the pruning treatment, this size increase should provide more export fruit and thus make up for any loss of income due to lower yields. Sunny alone also improved fruit size — more so than pruning. The best result was a combination of Sunny and pruning which gave an average fruit size in the count 14 range. Cultar also improved fruit size by one count. All of these treatments thus gave significantly more export fruit. Figure 7 gives a more detailed analysis of the fruit size distribution. It shows that all treatments gave significantly less undersized fruit than the control trees.

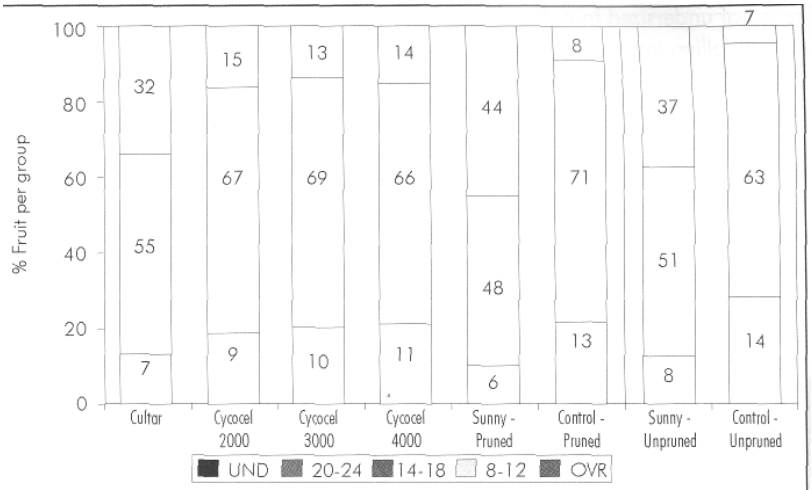

Figure 7 The effect of pruning and growth inhibitors on fruit size distribution in Hass - Levubu

In fact, a combination of pruning and Sunny almost eliminates the occurrence of undersized fruit. The volumes of fruit falling into the smaller (count 20 to count 24) classes was also reduced in all cases.

Fuerte

Fuerte generally have good sized fruit, and the data (Figure 9) indicates that the growth inhibitors cannot improve much on the fruit size. However, Sunny gave improvements in yield in both pruned and unpruned trees (Figure 8).

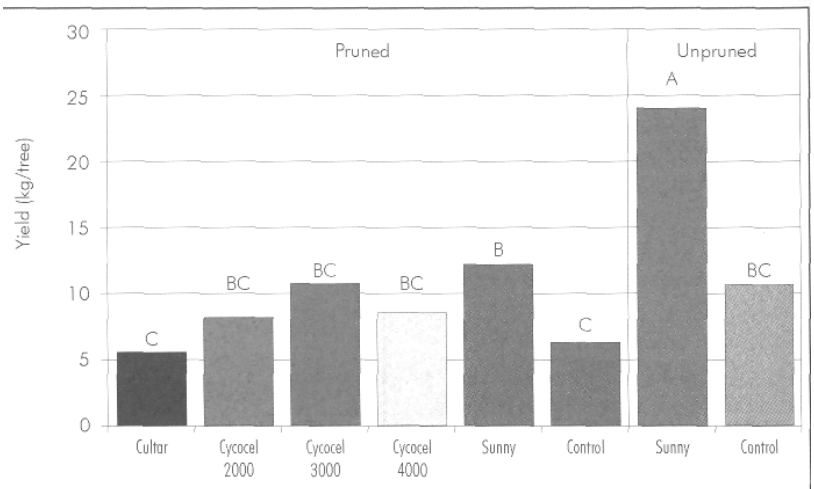

Figure 8 The effect of pruning and growth inhibitors on yield in Fuerte - Levubu

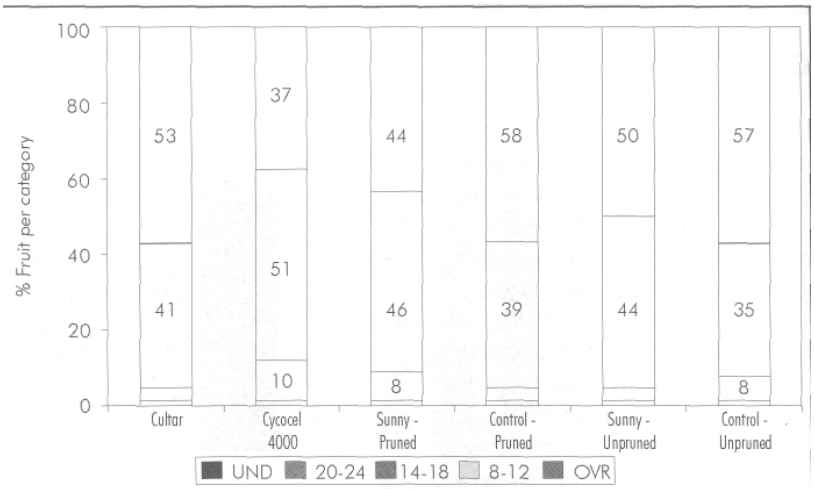

Figure 9 The effect of pruning and growth inhibitors on fruit size distribution in Fuerte avocados - Levubu

In the case of the unpruned trees the yield increased by 130%, while in the pruned trees the increase was approximately 100% relative to the pruned controls. These results were, once again, statistically significant. None of the other products gave significant yield improvements in the Fuerte trial. It thus seems that under conditions of heavier crop load, Sunny is the only growth inhibitor which gives improved yields (in both cultivars) as well as improved fruit size (particularly in Hass).

Residue analysis: Sunny®

The residue breakdown curve for Sunny is depicted in Figure 10.

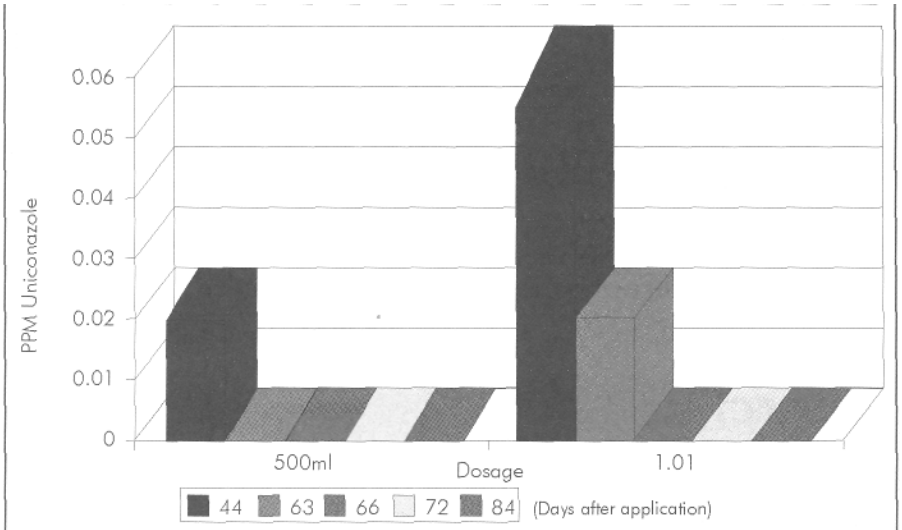

Figure10 Residue breakdown curves for Sunny® in avocado fruit at dosages of 500 ml/100L and 1000 ml/100L

Residues were not detectable after 63 and 66 days for the 500 ml/ 100 L and 1000 ml/ 100 L application rates respectively. The harvest interval for Sunny as registered in South Africa is 84 days to ensure that residues are not detectable on the fruit at harvest.

CONCLUSIONS

In general, it would appear that Sunny is the best product for improving both yield and fruit size in avocados. The cheaper products like Cycocel confer an increase in fruit size when the crop load is fairly light, but do not give yield improvements. Despite the benefits of using Sunny, this product is still relatively expensive (although the yield improvements justify this expense). Since a cheaper alternative to Sunny has not been found, it seems to be worthwhile finding cheaper ways of using Sunny. This includes the optimisation of application rates as well as optimising the application timing. It is also important to find adjuvants which increase the product uptake and thus reduce the minimum application rate. All of these factors will be examined in the forthcoming season.

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