Ultra-low volume fungicide applications for the control of diseases on avocado

– A three year review

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ABSTRACT

The TracFog 100F ultra-low volume (ULV) machine from Brazil has been tested in the South African avocado industry over the past three years. Results from research in the 2009/10 and 2010/11 seasons have shown that this machine and technology has great potential to be used successfully in avocado production. More trials were done in the 2011/12 season and these results are presented in this paper. However, the results obtained in the last season of testing confirmed the previous two season's results and have shown conclusively that this technology can be used successfully in avocado production and that it can bring about cost savings while maintaining fruit quality.

INTRODUCTION

Post-harvest diseases of avocado are an important factor in the reduction of fruit quality of export fruit. In some cases losses due to anthracnose (ANT) and stem-end rot (SER) were reported as being 29% and 10%, respectively (Bezuidenhout & Kuschke, 1983). In South Africa, these diseases are controlled by pre-harvest fungicide applications, especially copper based fungicides (Willis & Mavuso, 2009). Over the years, the machines used to apply these fungicides went through various stages. Initially all applications was done by hand, but in the mid-eighties the shift towards using mist blowers started (Rowell, 1986). This shift was due to spraying costs being lower with the mist blowers, while over spraying of trees (and therefore wasting chemical) was also reduced (Rowell, 1986).

However, despite this shift starting in the mid-eighties, it was not until the late nineties and early 2000's that mist blowers were starting to be used extensively in avocado production. This shift was further pushed by changing pruning practices and the use of growth inhibitors to control re-growth. More intensive pruning led to orchards being more accessible to mist blowers while growth inhibitors also do not need to be applied at high volumes (Bruwer, 2003).

ULV application of fungicides was tested in avocado by Duvenhage and Köhne (1999). They applied different systemic fungicides as well as copper ammonium acetate and copper oxychloride to 'Fuerte' trees for the control of Cercospora spot (black spot). In their trials they used hand-held thermal foggers from pulsFOG®. Results obtained in these trials indicated that, in comparison to the standard commercial practice of two high volume copper oxychloride applications, reasonable results were obtained with either four benomyl or four carbendazim applications applied by ULV thermal fogging. These two treatments both had ≥80% fruit clean from Cercospora spot, compared to the 90+% clean fruit obtained with the high volume copper applications (Duvenhage & Köhne, 1999). These results were quite promising, given the fact that they were obtained under high disease pressure conditions in the Tzaneen area. Under low disease pressure conditions in the Mooketsi valley, three applications of copper ammonium acetate using the pulsFOG® machines gave exactly the same disease control, compared to the two high volume copper ammonium acetate applications used commercially (Duvenhage & Köhne, 1999).

The pulsFOG® TracFog 100F machine was developed specifically for orchard crops and was imported to South Africa in 2009. The aim of importing this machine was to conduct research to determine if this machine and technology represents the next step in agrochemical application technology in avocado production. The first disease control trials using this machine were conducted in the 2009/10 season on 'Fuerte', 'Hass' and 'Ryan' in the Tzaneen area. Results from these trials indicated that on all cultivars the level of disease control achieved using the ULV TracFog 100F to apply copper oxychloride was the

same and in some cases better than that achieved with the commercial copper applications using mist blowers (Van Niekerk & Mavuso, 2011).

Based on these promising results, the trials were repeated in the 2010/11 season. Additional disease control trials were conducted in the Howick area, KwaZulu-Natal (KZN), to determine if other copper formulations can also be applied with this machine. Uniconazole is registered on avocado as a foliar spray for control of vegetative growth after midsummer pruning when re-growth is 10 to 15 cm long. On 'Hass', uniconazole was applied for re-growth control to the spring and summer flush using the TracFog 100F, again to test the principle of using ULV applications for the application of this chemical. The results from the second season of testing showed again that the TracFog 100F machine compared very favourably with mist blowers in controlling post-harvest diseases on avocado fruit and that by using this machine copper fungicides can be applied at very low volumes while still effective in controlling fruit diseases of 'Fuerte', 'Ryan' and 'Hass'. The trials conducted in KZN indicated that, apart from copper oxychloride, copper hydroxide and copper oxide can also be applied using this ULV machine (Van Niekerk & Mavuso, 2012). In the uniconazole trial the application of uniconazole using the TracFog 100F at 124 L/ha (150 g/ha active ingredient [a.i.]), achieved the same level of growth control of 'Hass' summer flush as the application using the mist blower at 600 L/ha (150 g/ha a.i.) (Van Niekerk & Mavuso, 2012).

After two seasons of testing, it became evident that this technology and machine might represent the next generation of spray equipment to be used in avocado production. It slowly became evident that this equipment has the potential to replace mist blowers, as was the case with hand guns in the mid to late nineties being replaced by mist blowers. However, in order to further confirm the findings of the 2009/10 and 2010/11 seasons, further trials were done during the 2011/12 season. Results of these trials are reported here.

MATERIALS AND METHODS

Disease control trial

As in the 2009/10 and 2010/11 seasons, the disease control trials were done on cultivars 'Hass', 'Fuerte' and 'Ryan'. All the treatments were repeated on above mentioned cultivars with the TracFog 100F, compared in the trail with mist blowers based on the level of pre- and post-harvest disease control.

The treatments applied were the following:

1. Untreated fruit;
2. Standard production copper oxychloride application (3 g/L, 50% metallic copper) with mist blowers. The application volumes were: 'Hass' = 6 700 L/ha; 'Fuerte' = 8 200 L/ha; 'Ryan' = 3 500 L/ha;
3. TracFog 100F, application at 183 L/ha for 'Hass' and 'Fuerte' and in the case of 'Ryan' the TracFog 100F application volume was 202 L/ha. For 'Fuerte' the spray mixture consisted of copper oxychloride at a concentration of 150.0 g/L, water and 10% di-ethylene glycol (VKII Spezial). On 'Hass' and 'Ryan' the same mixture was used, but on 'Hass' the copper oxychloride concentration was 57.4 g/L and on 'Ryan' it was 52.0 g/L.

The treatments were applied according to the following spray schedule:

1. 'Hass' – November 2011, January 2012;
2. 'Fuerte' – November 2011, December 2011, January 2012;
3. 'Ryan' – November 2011, December 2011, January 2012, February 2012.

Fruit samples from the 'Fuerte' trial was picked in June 2012 and from the 'Hass' and 'Ryan' trials in July 2012. 'Fuerte' and 'Ryan' fruit were rated for the percentage marketable fruit based on the observed Cercospora spot symptoms. On 'Hass' fruit, this rating was done for the observed pepper spot symptoms. After these ratings were done, the fruit were stored at 5.5°C for 28 days to simulate export conditions. After storage the fruit were ripened at 22°C before being evaluated for the incidence of the post-harvest diseases stem-end rot and anthracnose.

Uniconazole application trial

Following on the uniconazole application trial done with the TracFog 100F during February 2011 (Van Niekerk & Mavuso, 2012), another trial was done to determine the suitability of using the TracFog 100F machine to apply uniconazole to the spring flush of 'Hass'.

Based on the similarity of the spring flush observed during September 2011, two 'Hass' orchards were selected. The one orchard was sprayed with a 1% uniconazole application (300 g a.i./ha) using a mist blower calibrated at 600 L/ha. The other orchard was sprayed with the TracFog 100F calibrated at 100 L/ha. The amount of a.i. applied was also 300 g/ha. After the applications were done, 100 flushes was marked and measured in each of the orchards.

The marked flushes was measured weekly for a period of four weeks after application. At harvest, yield for the two treatments was determined along with fruit size distribution and export packout percentage.

RESULTS

Disease control trial

'Fuerte'

In the 2011/12 season the control of Cercospora spot achieved by the TracFog 100F was statistically worse than that achieved by the mist blower applications. In trees where the copper oxychloride was applied with the TracFog 100F, only 75.5% of fruit was marketable, while in trees sprayed with the mist blower, it was 99.5% (Fig. 1). Further investigation of this big difference shows that in the top of trees sprayed with the TracFog 100F, only 28% fruit was market-

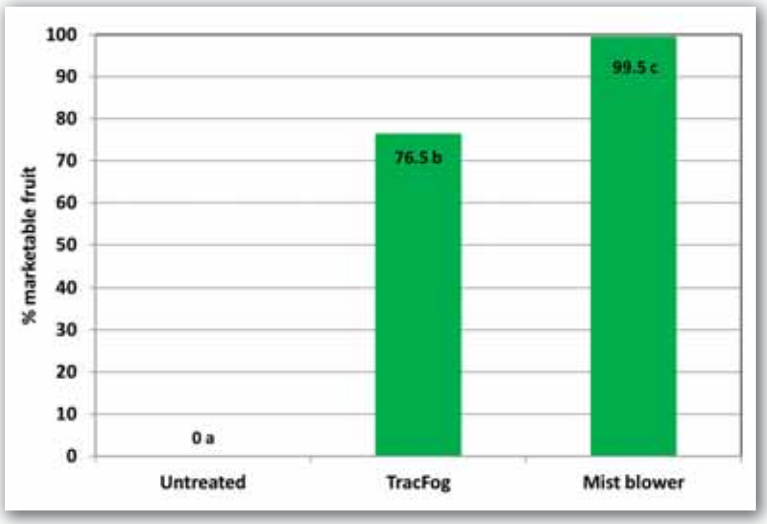

Figure 1. Mean percentage clean fruit based on Cercospora spot symptom ratings obtained with TracFog 100 and mist blower copper oxychloride applications on 'Fuerte' trees.

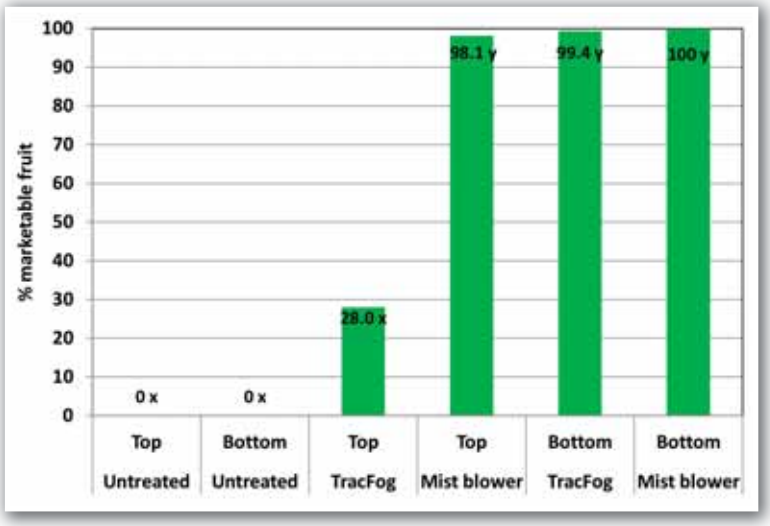

Figure 2. Mean percentage clean fruit based on Cercospora spot symptom ratings obtained with TracFog 100 and mist blower copper oxychloride applications in different positions in 'Fuerte' trees.

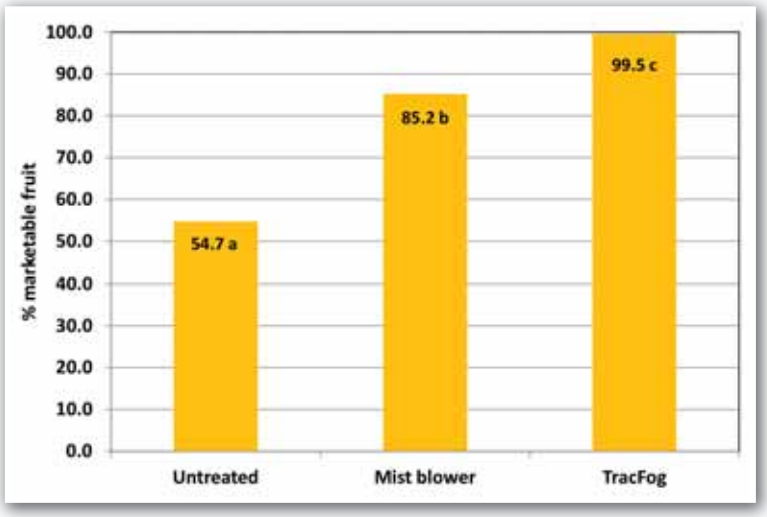

Figure 3. Mean percentage clean fruit based on pepper spot symptom ratings obtained with TracFog 100F and mist blower copper oxychloride applications in 'Hass' trees.

able, compared to the 98.1% marketable fruit in the top of trees sprayed with the mist blower. However, if you compare the disease control achieved with the TracFog 100F in the bottom of trees, it is statistically the same as with the mist blower applications (Fig. 2).

In terms of post-harvest diseases, the disease pressure of anthracnose and stem-end rot was very low, as seen from the high percentage marketable fruit in the untreated control (results not shown). Consequently, no statistical difference could be observed between the mist blower, TracFog 100 and the untreated control when looking at anthracnose and stem-end rot control achieved (results not shown).

'Hass'

On 'Hass' the TracFog 100F results were better. In comparison with the mist blower (85.2%), the TracFog 100F applications of copper oxychloride led to 99.5% marketable fruit, which was significantly better (Fig. 3). Both the mist blower and the TracFog 100F applications were significantly better than the untreated control, in terms of marketable fruit based on pepper spot symptoms. In the 'Hass' trees that were of similar size as the 'Fuerte' trees, there was no difference in pepper spot control between the top and bottom of trees sprayed with the TracFog 100F. In this case, it was rather in trees sprayed with the mist blower that there was an obvious difference between the control achieved in the top and bottom of trees (Fig. 4).

Similar to the results on 'Fuerte', no conclusive results could be obtained for the control of post-harvest diseases, due to very low disease levels even in the untreated control.

'Ryan'

Somewhat different results were obtained on 'Ryan' compared to 'Fuerte'. On 'Ryan', the best control of Cercospora spot in terms of marketable fruit was obtained with the copper oxychloride applications done with the TracFog 100F. With the TracFog 100F applications, 100% marketable fruit was obtained compared to the 67% achieved with the mist blower applications (Fig. 5).

On 'Ryan' significant levels of anthracnose and stem-end rot were present in the trial orchard, as evident from the low levels of marketable fruit based on post-harvest disease symptoms (Fig. 6). This brought about that significant results could be achieved. Both the TracFog 100F and mist blower copper oxychloride applica-

tions led to more than 97% marketable fruit (Fig. 6).

Uniconazole application trial

Results from the flush measurements take over a period of four weeks after application, showed that on average the growth of the flushes on trees where the uniconazole was sprayed with the TracFog 100F was 5.4 cm, compared to the 4.2 cm average growth of flushes on trees sprayed using the mist blower (Fig. 7). This difference was shown not to be statistically significant.

With regards to yield, export packout and fruit size distribution, no statistical differences were observed for any of these factors (results not shown).

DISCUSSION

Over the last three years the new ULV machine, the TracFog 100F, was tested extensively for application of agrochemicals in avocado production. Results have shown conclusively that on 'Hass' and 'Ryan' this technology can be used effectively to apply various copper fungicides for the control of fruit diseases. It was also shown to be suitable to apply uniconazole for the control of growth flushes on 'Hass' during the spring and summer flushes. In the case of 'Fuerte', the control of Cercospora spot in the top of big trees were in all years seen to be poor. This is probably due to two reasons: the very big trees and the spray application not reaching the top of the trees, and the 2-nozzle design of the machine making it very difficult to set up to spray correctly.

New TracFog machines developed since 2009 in Brazil have 6 or 12 nozzles and are able to spray bigger trees more efficiently. Another factor that might solve the problem of poor disease control in the top of trees, is the fact that tree size in the South African industry is becoming smaller. These smaller trees are seen to be easier and more cost effective to manage. The new design of the machines, along with the smaller trees, should therefore solve the problem of variable disease control in the tree canopy.

The research done have shown conclusively that much lower spray volumes can be used in avocado production, while still maintaining fruit quality. This means that large savings on spray time and costs are possible, which is very important for the future financial sustainability of the avocado industry. It is therefore clear that ULV technology represents the next step in agrochemical application technology for use in the avocado industry in South Africa.

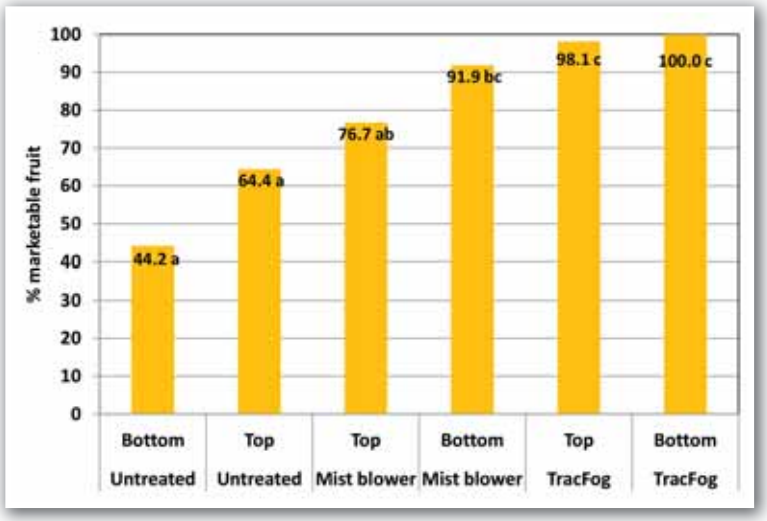

Figure 4. Mean percentage clean fruit based on pepper spot symptom ratings obtained with TracFog 100F and mist blower copper oxychloride applications in different positions in 'Hass' trees.

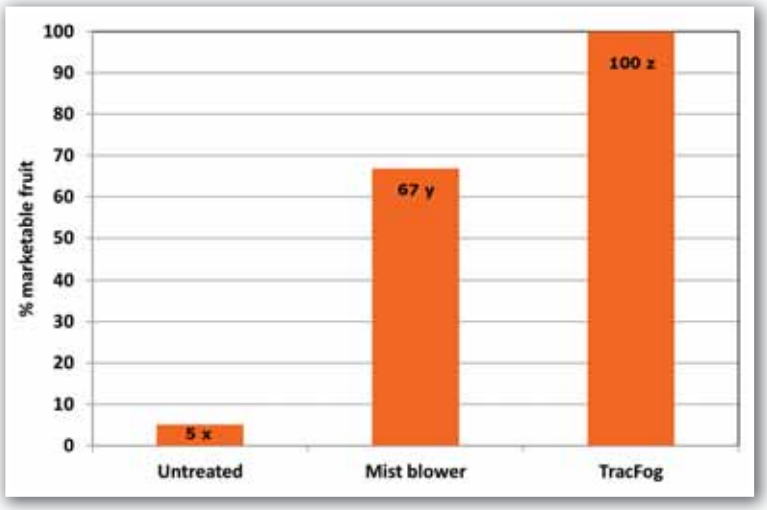

Figure 5. Mean percentage clean fruit based on Cercospora spot symptom ratings obtained with TracFog 100F and mist blower copper oxychloride applications in 'Ryan' trees.

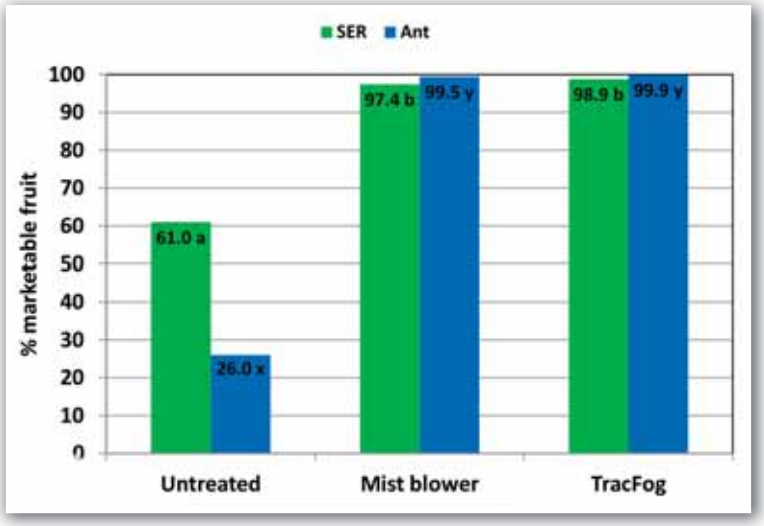

Figure 6. Mean percentage marketable fruit based on stem-end rot and anthracnose symptom ratings obtained with TracFog 100F and mist blower copper oxychloride applications in 'Ryan' trees.

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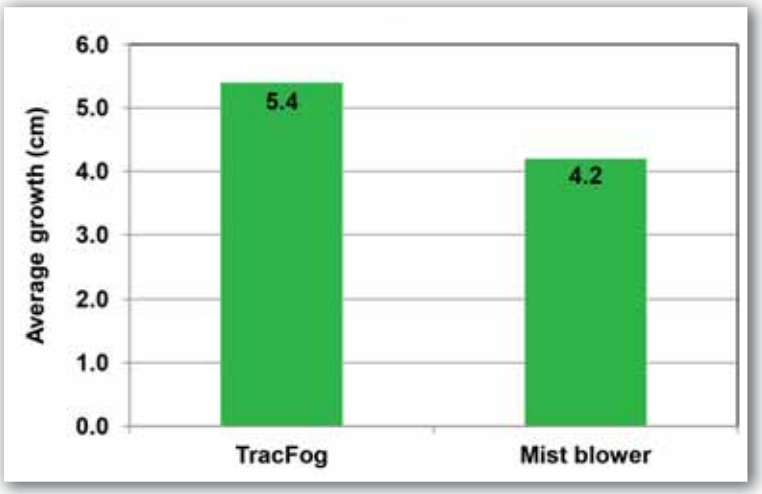

Figure 7. Average growth of the spring flush of 'Hass' at flowering following uniconazole applications with the TracFog 100F and mist blower.