Evaluation of ultra-low volume (ULV) fungicide applications for the control of diseases on avocado fruit – Results from the 2009/10 season

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ABSTRACT

Cercospora spot, anthracnose and stem-end rot are the main diseases affecting the quality of avocado fruit in South Africa. They are controlled by high volume pre-harvest fungicide applications. Ultra-low volume application technology could reduce the amount of fungicide applied per hectare for disease control by reducing the amount of run-off, while still giving good disease control. During the 2009/10 avocado season, a prototype ULV spray machine was used in trials to apply copper oxychloride to 'Fuerte', 'Ryan' and 'Hass' trees. The machine was compared to commercial mist blowers with regards to copper residues deposited on the leaves and the level of disease control achieved. Fruit of the various cultivars were picked at the commercial harvest stage and evaluated for Cercospora spot control at harvest while evaluation for post-harvest diseases were done after 28 days' storage at 5.5°C, followed by ripening at 22°C. Copper residue analyses on all cultivars indicated that the ULV machine deposited statistically lower amounts of copper on the leaves compared to the mist blower. Despite this, results on 'Fuerte' showed that by using the ULV machine, diseases could be controlled by using 50% less copper oxychloride compared to the mist blower applications. On 'Hass' and 'Ryan' disease control results with this machine were also similar to that achieved with the mist blower. These results indicate that this technology has great potential for use in avocado disease control.

INTRODUCTION

Several diseases occur on avocado fruit (Lonsdale & Kotzé, 1989), including Cercospora spot, anthracnose and stem-end rot (Darvas & Kotzé, 1981; Lonsdale & Kotzé, 1989). These diseases are controlled in the South African avocado industry by the pre-harvest application of high volume copper oxychloride fungicides (Boshoff *et al*., 1996; Willis & Mavuso, 2009). Initially, these applications were done using hand gun sprayers but have been replaced by mist blowers. Mist blowers allowed the application of lower volumes of spray mixture per hectare to achieve the same level of disease control. This was due to less run-off, that was a big problem with the high volume hand gun applications.

Ultra-low volume (ULV) fungicide application of fungicides was first developed as thermal fogging. This entails that the chemical the user wants to apply, is in a liquid formulation subjected to high temperature in the fogging machine. This turns the chemical formulation into a vapour, which is released into the atmosphere. On interaction with the cold air, the vapour condenses to form clouds of tiny droplets that collectively form a fog that settles on the target plant surface (Mabbett, 2007). Apart from being used to great effect in grain storage for sanitation and to disinfect poultry houses, it has also been used successfully in tropical crops such as cocoa, rubber and bananas for disease control. In rubber plantations, copper fungicides have especially been applied with great effect (Mabbett, 2007).

This method of application 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 carben-

dazim 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 at Westfalia Fruit Estates, Tzaneen. 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 same company that developed the thermal pulsFOG® machines, has developed in Brazil the Pulsfog Agrofog 400F fogger. This is a non-thermal, compressed air aided ULV fogging machine used with great effect in poplar and *Eucalyptus* plantations for the control of insects and fungal diseases. This new technology has not been tested in avocado production and could possibly reduce the amount of fungicide needed per hectare in avocado disease management, compared to the currently used mist blowers. The aim of this project is therefore to evaluate this machine and ULV spray application technology for the control of fruit diseases on avocado. This paper reports on the results of the first season's disease control trials.

MATERIALS AND METHODS

TracFog 100F machine

The TracFog 100F machine was developed in Brazil in 2009 for testing in orchard crops. The design of this machine is based on the TracFog 400F used in *Eucalyptus* plantations for the control of pests and diseases. To be operated it needs a tractor with at least 50 hp, a clockwise turning PTO delivering 540 rpm and a normal 3-point hitching system.

Fungicide application

The trial was conducted at Westfalia Fruit Estate, Tzaneen during the 2009/10 season and was repeated on 'Fuerte', 'Ryan' and 'Hass'. In the trial the TracFog 100F was compared to mist blowers with regards to copper residue deposition on leaves and levels of disease control achieved. The treatments applied were the following:

1. Untreated fruit
2. Standard commercial copper oxychloride application (3 g/L, 50% metallic copper) with mist blowers 'Hass' = 3000 L/ha; 'Fuerte' = 8200 L/ha; 'Ryan' = 3500 L/ha
3. TracFog 100F, application at 80 L/ha. In the case of 'Fuerte' the spray mixture consisted of copper oxychloride at a concentration of 51.25*x* (150 g/L), water and 20% di-ethylene glycol (VKII Spezial). On 'Hass' and 'Ryan' the same mixture was used, but the copper oxychloride concentration was 37.5*x* (112.5 g/L).

The treatments were applied according to the following spray schedule:

- 'Hass' – November 2009 and January 2010
- 'Fuerte' – November 2009, December 2009, January 2010
- 'Ryan' – November 2009, December 2009, January 2010, February 2010.

Trial evaluation

Copper residue depositions resulting from TracFog 100F and mist blower applications were compared by picking leaves from the trees of all three cultivars sprayed by the different machines. Within each treatment, leaves were picked from three uniform trees. The leaves were picked from the bottom and top of the tree, outside and 2 m inside the tree canopy. Leaves were analysed for copper residues and the results statistically analysed. For the evaluation of disease incidence and severity, 80 fruit were picked from the top of the trees (inside and outside of the canopy) and 80 fruit from the bottom of the trees (also inside and outside of the canopy). At harvest 'Fuerte' and 'Ryan' fruit were evaluated for the severity of Cercospora spot symptoms, while 'Hass' was evaluated for the severity of Pepper spot symptoms. The observed symptoms were rated based on a scale of 0 – 3, where fruit with a 0 and 1 rating is regarded to be marketable and fruit with a 2 and 3 rating are unmarketable. After harvest, fruit were stored for 28 days at 5.5°C before being ripened at 22°C. After ripening fruit were rated for the presence and severity of stem-end rot and anthracnose symptoms, using abovementioned rating scale. Following evaluation, the percentage marketable fruit, based on disease symptom ratings, for each treatment was calculated and the results statistically analysed.

RESULTS

'Fuerte'

The Cercospora spot symptom ratings indicated that the mist blower and TracFog 100F applications of copper oxychloride resulted in statistically similar levels of Cercospora spot control, with both machines being statistically better than the untreated control (**Figure 1**). At the top of the trees, disease control achieved by the TracFog 100F was 10.7% lower compared to the bottom of the tree. The mist blower gave the same levels of disease control at the top and bottom of the trees. Copper residue analyses from the leaves also indicated that the highest copper residues occurred at the bottom and top of trees sprayed by the mist blower and at the bottom of trees sprayed with the TracFog 100F. The lowest copper residue was observed on leaves in the top of trees sprayed with the TracFog 100F. This result explains the difference in disease control obtained between the different positions in the tree. With regards to control of post-harvest diseases, the TracFog 100F obtained almost exactly the same levels of anthracnose and stem-end rot (SER) con-

trol compared with the mist blower. Control of these two machines was for both diseases better than the untreated control (**Figure 2**).

'Hass'

In terms of pepper spot control on 'Hass', the results followed similar trends to the results observed on 'Fuerte'. Mist blower and TracFog 100F applications both controlled this disease significantly better than the untreated control. Both machines resulted in more than 94% marketable fruit in the bottom and top of the sprayed trees. Copper residue analyses indicated that the TracFog 100F deposited significantly lower levels of copper residues on leaves compared to the mist blower, while still giving good control of pepper spot (**Figure 3**). Black spot symptoms were also observed on 'Hass' fruit and a symptom rating were therefore done and the percentage marketable fruit calculated. Similar to the results on 'Fuerte', the TracFog 100F resulted in control statistically similar to the control achieved by mist blower applications. Again the worst control of black spot on 'Hass' was obtained in the top of trees sprayed with the TracFog 100F. This was again the position where the lowest

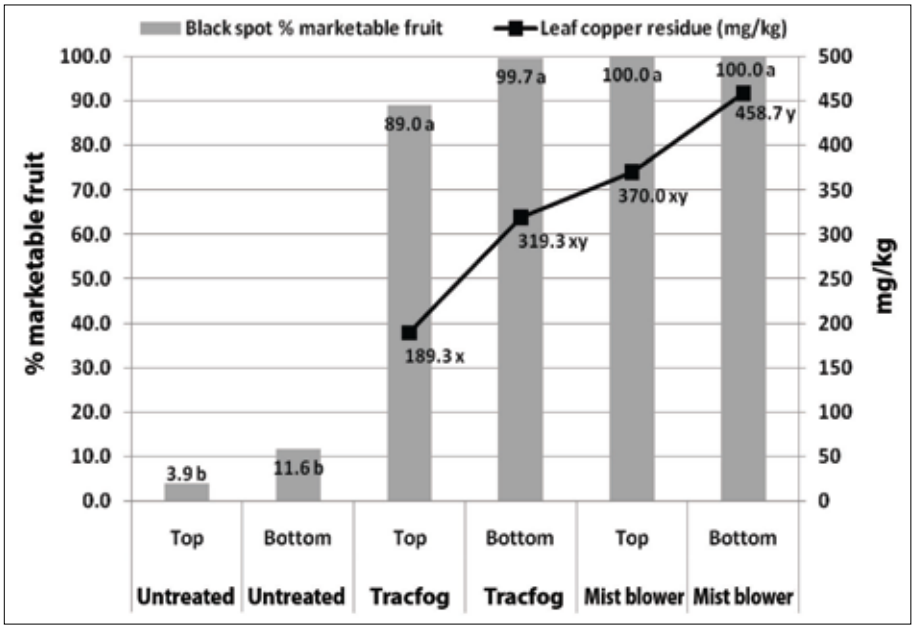

Figure 1. Mean percentage marketable fruit, based on black spot symptom ratings, and copper residue on leaves resulting from TracFog 100F and mist blower copper oxychloride applications on 'Fuerte' trees.

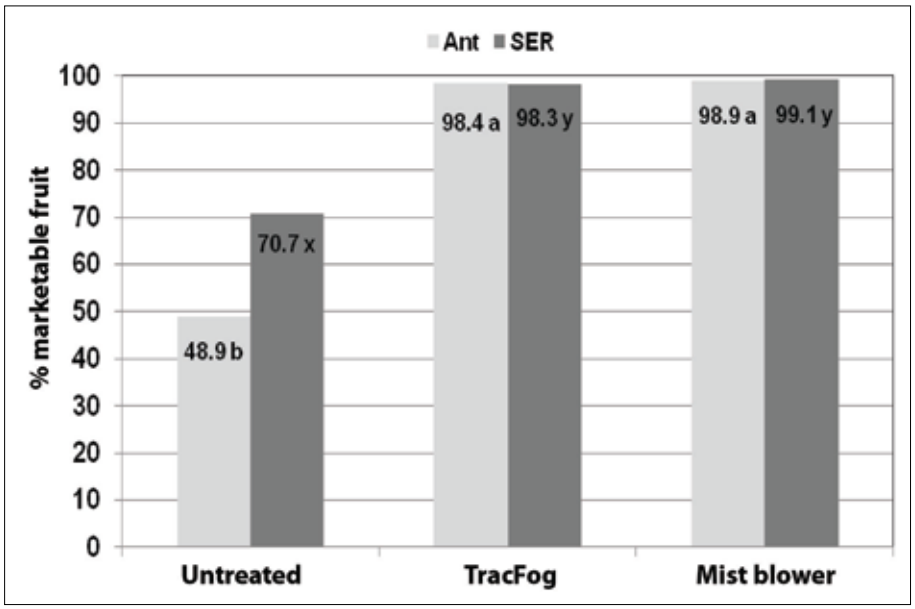

Figure 2. Mean percentage marketable fruit, based on post-harvest anthracnose and stem-end rot symptom ratings, resulting from TracFog 100F and mist blower copper oxychloride applications on 'Fuerte' trees.

copper residue on the leaves was recorded (**Figure 4**). With respect to the control of post-harvest diseases, the TracFog 100F controlled anthracnose and SER substantially better compared to the untreated control. The best control of SER was achieved with the mist blower, although not significantly better than the TracFog 100F. However, in the case of anthracnose control, the mist blower did not give good control compared to the TracFog 100F and untreated control (**Figure 5**).

'Ryan'

On 'Ryan' the control of black spot achieved with the TracFog 100F was again statistically the same as that achieved with the mist blower and also significantly better than the untreated control. With regards to copper residues, the highest residue levels were achieved with the TracFog 100F at the bottom of trees. However, at the top of the trees the TracFog 100F resulted in copper residues that were significantly lower than at the bottom of the trees. Despite

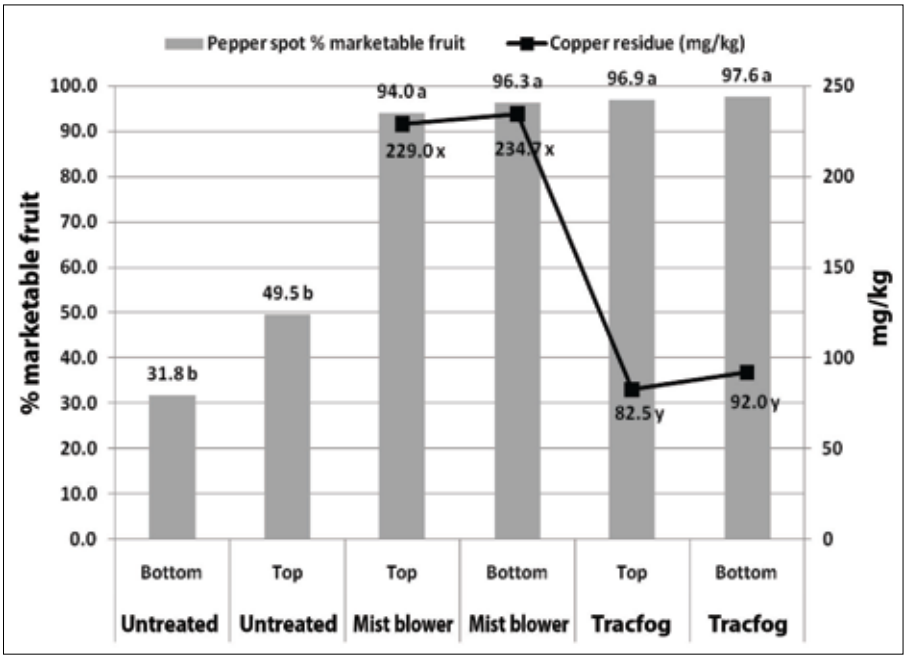

Figure 3. Mean percentage marketable fruit, based on pepper spot symptom ratings, and copper residues on leaves resulting from TracFog 100F and mist blower copper oxychloride applications on 'Hass' trees.

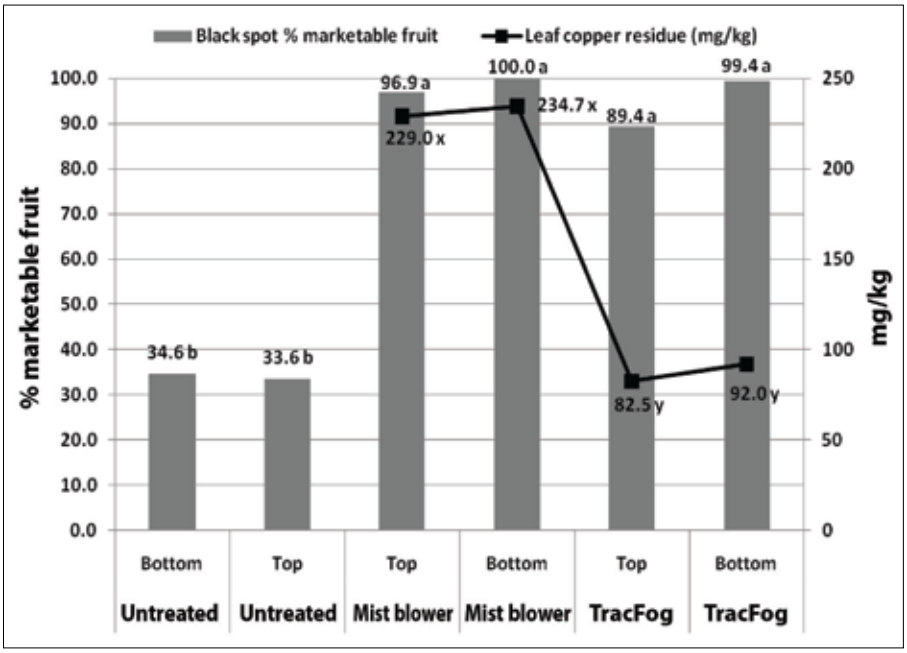

Figure 4. Mean percentage marketable fruit, based on black spot symptom ratings, and copper residues on leaves resulting from TracFog 100F and mist blower copper oxychloride applications on 'Hass' trees.

this, the control achieved with only 99 mg/kg copper on the leaves was still excellent (**Figure 6**). The control of SER achieved by the TracFog 100F on 'Ryan' was statistically the same as that achieved with the mist blower application and both machines were significantly better than the untreated control. Anthracnose control with the TracFog 100F was significantly better than that achieved with the mist blower (**Figure 7**).

CONCLUSION

Previous trials using ULV thermal fogging showed that this application technology had potential for avocado disease control. The TracFog 100F machine evaluated in the current study represents the next generation ULV application technology. The results obtained in the first season of disease control trials clearly showed that this machine has even bigger potential than the old thermal foggers. On 'Fuerte' Cercospora spot and post-harvest diseases was controlled effectively by applying 50% less copper fungicide and substantially less spray mixture compared to the mist blowers. In the case of 'Hass' and 'Ryan' the amount of copper fungicide applied with the TracFog

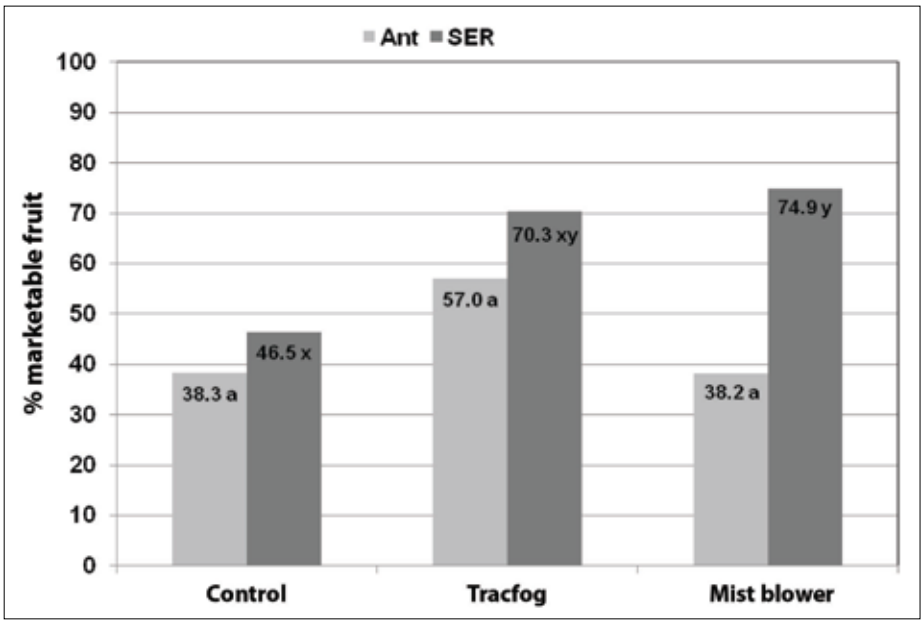

Figure 5. Mean percentage marketable fruit, based on post-harvest anthracnose and stem-end rot symptom ratings, resulting from TracFog 100F and mist blower copper oxychloride applications on 'Hass' trees.

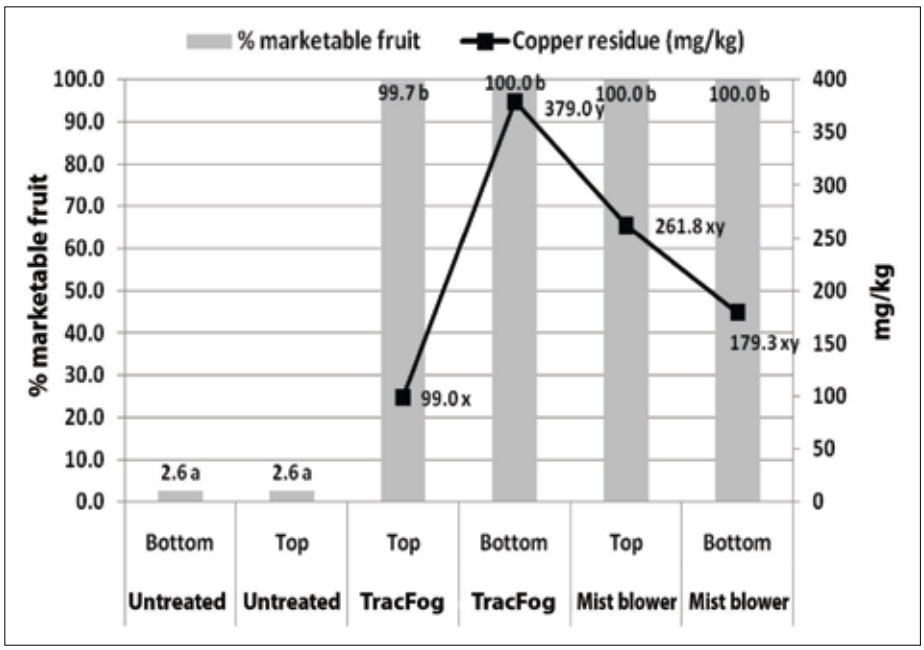

Figure 6. Mean percentage marketable fruit, based on black spot symptom ratings, and copper residue on leaves resulting from TracFog 100F and mist blower copper oxychloride applications on 'Ryan' trees.

100F was the same as with the mist blower. However, the total volume of spray mixture applied during the season was again substantially reduced. Despite this reduction, the disease control achieved by the ULV application on these two cultivars was the same, and in some cases better, than the mist blower. This machine therefore has the potential to reduce the cost of disease control on avocado by reducing the amount of fungicide used, reducing application time due to one tank mixture doing more hectares, and reducing tractor costs as this machine can be operated by a much smaller tractor compared to the large mist blowers.

In the 2010/11 season these disease control trials are being repeated. Further research using this technology will included evaluating its use for the application of plant growth regulators and insecticides on avocado trees.

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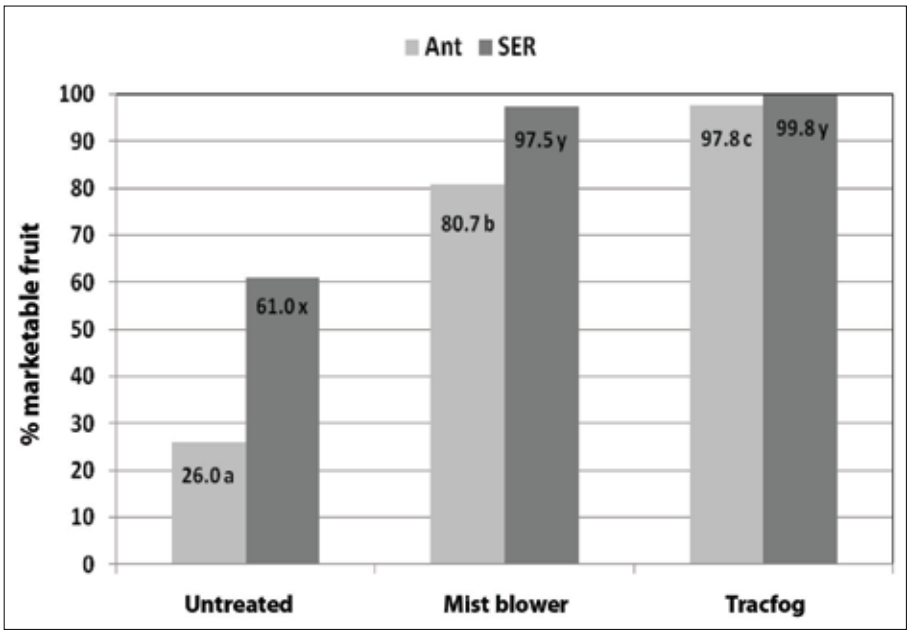

Figure 7. Mean percentage marketable fruit, based on post-harvest anthracnose and stem-end rot symptom ratings, resulting from TracFog 100F and mist blower copper oxychloride applications on 'Ryan' trees.