

## **Using ultra-low volume (ULV) application technology in the control of diseases on avocado fruit**

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### **ABSTRACT**

Cercospora spot, anthracnose and stem-end rot is diseases affecting the quality of avocado fruit in South Africa. They are controlled by high volume preharvest 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 2009/2010 avocado season a 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 based on copper residues on the leaves and the level of disease control achieved. For disease control evaluation, fruit of the various cultivars were picked at the commercial harvest stage. Fruit were evaluated for Cercospora spot control at harvest while evaluation for postharvest diseases were done after 28 days' storage at 5.5 °C and ripening at 22 °C. Copper residue analyses 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.

La mancha de Cercospora, antracnosis y pudrición del pecíolo son las principales enfermedades que afectan a los aguacates en Sudáfrica. Están controladas por aplicaciones de alto volumen de fungicidas de pre-cosecha. La tecnología de ULV puede reducir la cantidad de fungicidas aplicados por hectárea para el control de enfermedades a través de la disminución del escurrimiento, dando aún así un adecuado control de la enfermedad. Durante la temporada 2009/2010 una máquina de ULV se usó en ensayos de aplicación de oxiclورو de cobre a árboles de Fuerte, Ryan y Hass. La máquina fue comparada a la nebulizadora en términos de residuos de cobre depositados en las hojas y a nivel de control de enfermedad logrado. Para evaluar el control de enfermedades, las variedades se cosecharon en el índice de cosecha comercial. La fruta se evaluó para el control de mancha de Cercospora, mientras que el control de enfermedades de post-cosecha se llevó a cabo después de 28 días de almacenaje a 5.5°C, seguidos de una maduración a 22°C. Análisis de residuos de cobre indicaron que la máquina de ULV estadísticamente depositó menores cantidades de cobre en las hojas en comparación con la nebulizadora. A pesar de esto, en Fuerte los resultados mostraron que utilizando máquinas de ULV las enfermedades se pueden controlar usando 50% menos de oxiclورو de cobre en comparación con aplicaciones con nebulizadora. En Hass y Ryan los resultados de control de enfermedades con esta máquina fueron similares a los obtenidos con la nebulizadora.

### **Key words**

Cercospora spot, post harvest diseases

### **Introduction**

Avocado fruit is affected by several diseases (Lonsdale & Kotzé, 1989), including Cercospora spot, anthracnose and stem-end rot (Darvas & Kotzé, 1981; Lonsdale & Kotzé, 1989). In the South African avocado industry these diseases are managed by the preharvest application of high volume copper oxychloride fungicides using mist blowers (Boshoff, Kotzé & Korsten, 1996; Willis & Mavuso, 2009).

Ultra-low volume (ULV) application of fungicides was first developed as thermal fogging. This entails that the applied chemical is in a liquid formulation that is 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 cold air, the vapour condenses to a fog that settles on the target plant surface (Mabbett, 2007). This technique has 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 & Köhne (1999). They applied systemic fungicides as well as copper ammonium acetate and copper oxychloride to 'Fuerte' trees for the control of *Cercospora* spot. They used hand-held thermal foggers from pulsFOG®. Results of 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 using ULV thermal fogging. These two treatments both gave 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. Under low disease pressure conditions 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).

In Brazil the Pulsfog Agrofog 400F fogger was developed. 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 using ULV spraying. This new technology had not been tested in avocado production and could possibly reduce the amount of fungicide needed per hectare in avocado disease management. The aim of this project is therefore to evaluate this machine and ULV application technology for the control of fruit diseases on avocado. This paper reports on the first disease control results obtained with this machine.

## Materials & methods

### *Fungicide application and treatments*

The trial was conducted at Westfalia Fruit Estate, Tzaneen, South Africa, during the 2009/2010 season and was repeated on 'Fuerte', 'Ryan' and 'Hass'. In the trial the TracFog 100F, specially developed for tree crops, 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 (3g/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 51.25x (150g/L), water and 20% di-ethylene glycol (VKII Spezial). On 'Hass' and 'Ryan' the same mixture was used but the copper oxychloride concentration was 37.5x (112.5g/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 were compared by picking leaves from trees of all three cultivars sprayed with the different machines. 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 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 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'*

Cercospora spot symptom ratings indicated that mist blower and TracFog 100F applications of copper oxychloride resulted in statistically similar levels of Cercospora spot control, both being better than the untreated control (Figure 1). At the top of the trees 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 control at the top and bottom of the trees. Copper residue analyses from the leaves 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. With regards to control of postharvest diseases, the TracFog 100F obtained almost exactly the same levels of anthracnose and stem-end rot (SER) control compared to the mist blower (Figure 2).

### *'Hass'*

In terms of pepper spot control on 'Hass', mist blower and TracFog 100F applications both controlled the 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 on leaves compared to the mist blower while still giving good control of pepper spot (Figure 3). With respect to the control of postharvest 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 4).

### *'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. 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 this, the control achieved with only 99 mg/kg copper on the leaves was still excellent (Figure 5). The control of SER achieved by the TracFog 100F on 'Ryan' was also statistically the same as that achieved with the mist blower application. Anthracnose control with the TracFog 100F was significantly better than that achieved with the mist blower (Figure 6).

## 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 postharvest 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 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.

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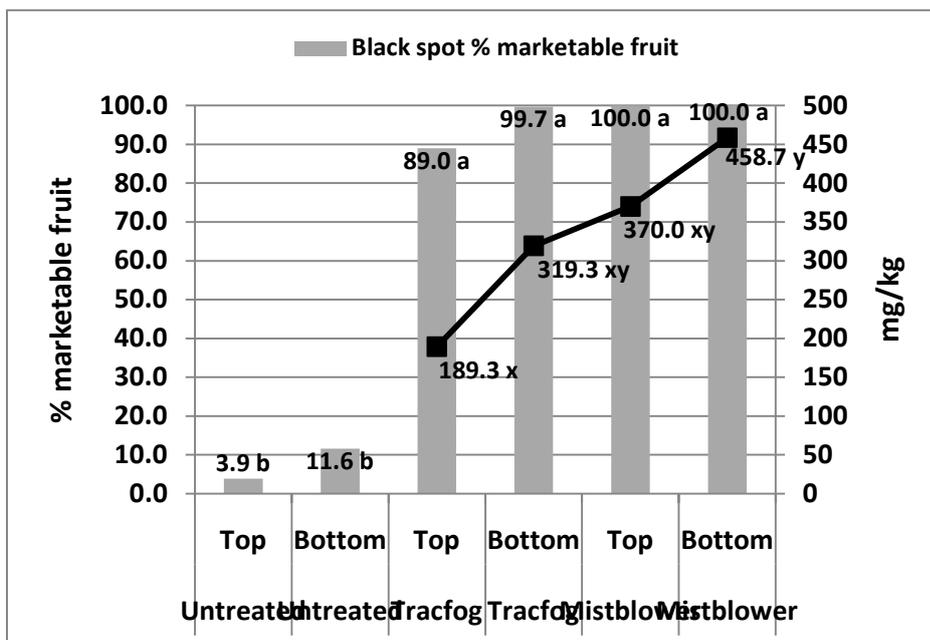
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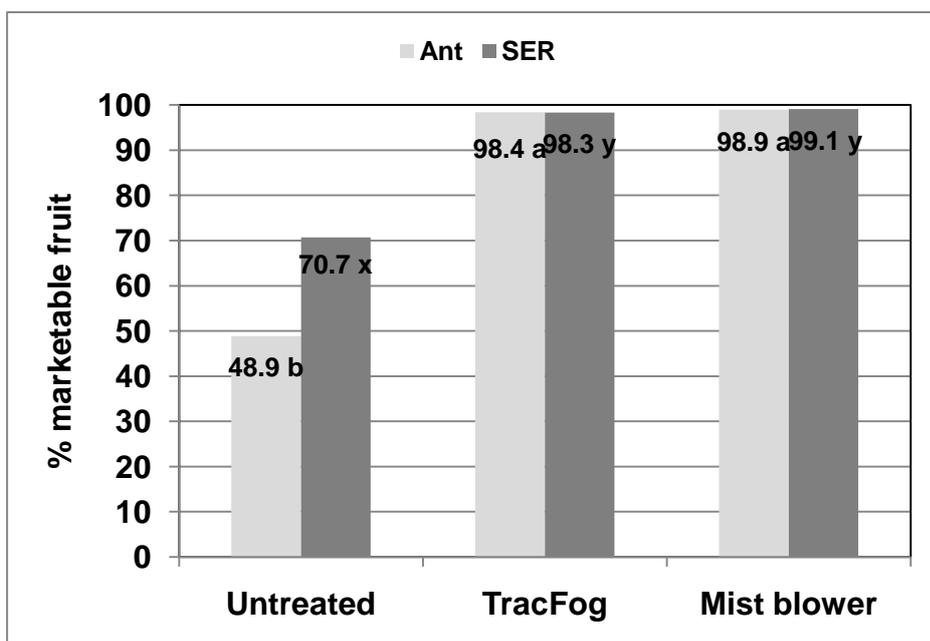
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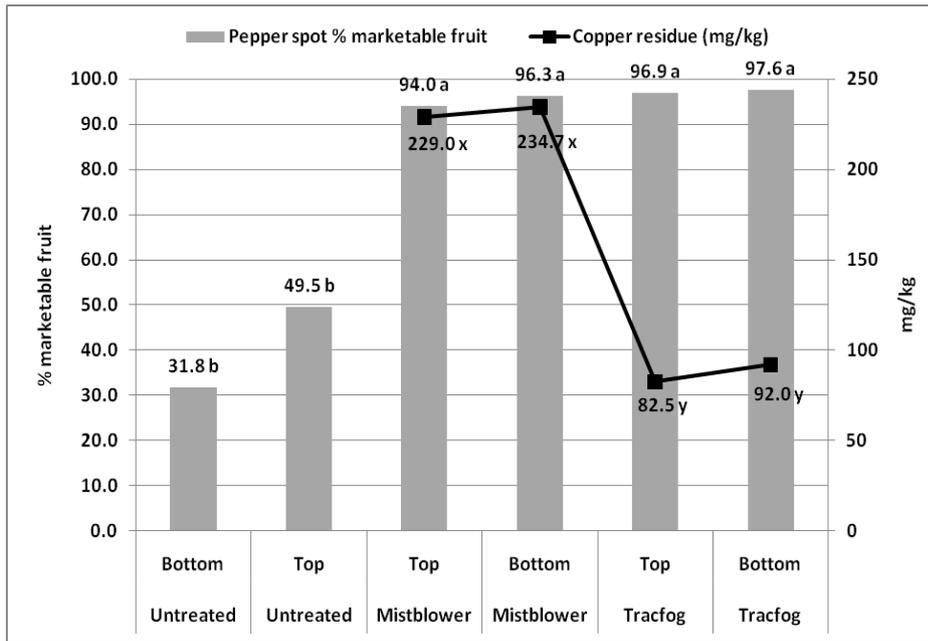
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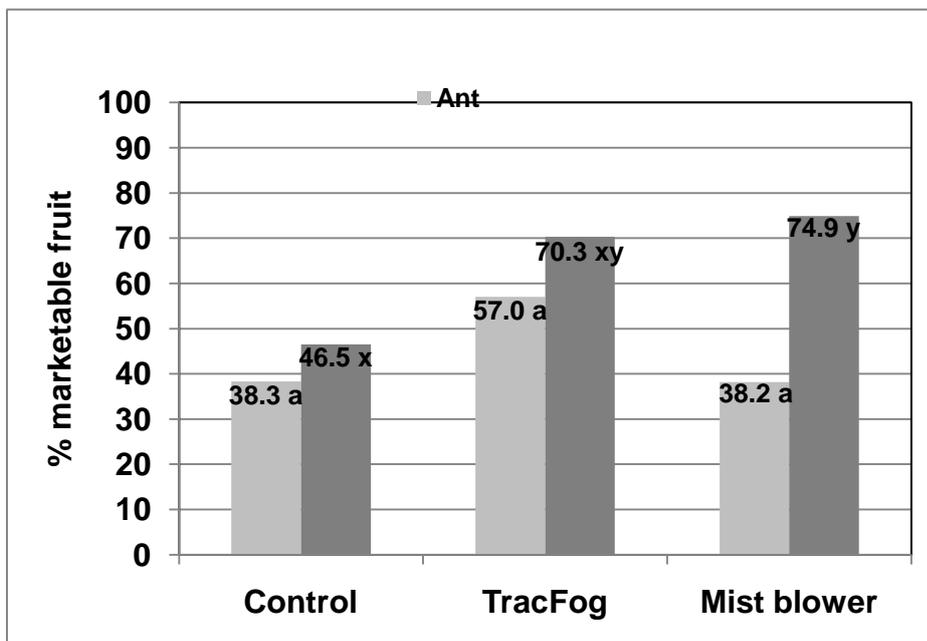
**Figure 1.** Mean percentage marketable fruit, based on black spot symptom ratings, and copper residue on leaves resulting from TracFog 100F and mist blower copper oxychloride applications on 'Fuerte' trees.



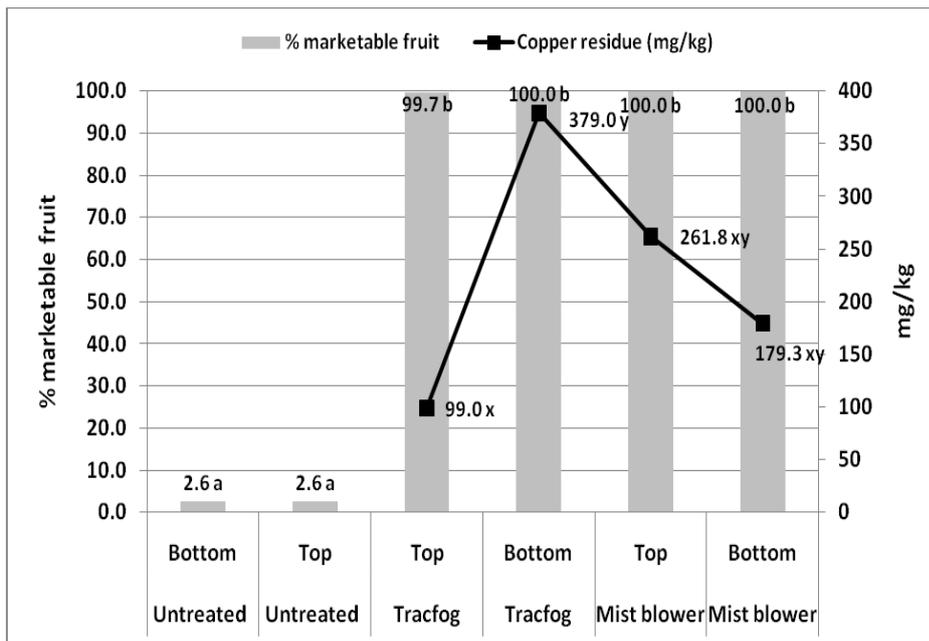
**Figure 2.** Mean percentage marketable fruit, based on postharvest anthracnose and stem-end rot symptom ratings, resulting from TracFog 100F and mist blower copper oxychloride applications on 'Fuerte' trees.



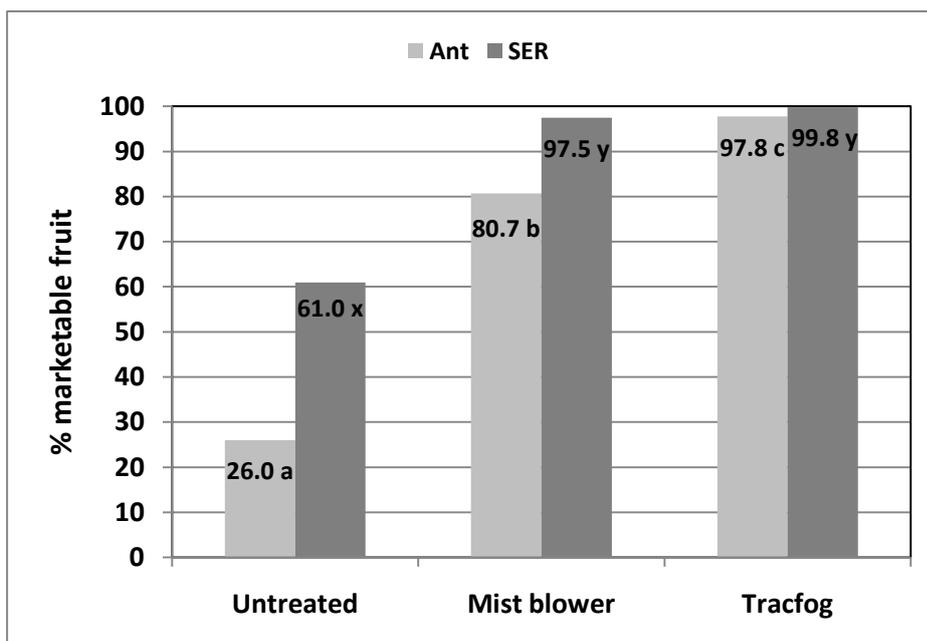
**Figure 3.** Mean percentage marketable fruit, based on pepper spot symptom ratings, and copper residues on leaves resulting from TracFog 100F and mist blower copper oxychloride applications on 'Hass' trees.



**Figure 4.** Mean percentage marketable fruit, based on postharvest anthracnose and stem-end rot symptom ratings, resulting from TracFog 100F and mist blower copper oxychloride applications on 'Hass' trees.



**Figure 5.** 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.



**Figure 6.** Mean percentage marketable fruit, based on postharvest anthracnose and stem-end rot symptom ratings, resulting from TracFog 100F and mist blower copper oxychloride applications on 'Ryan' trees.