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Thermal fogging of fungicides for the control of *Pseudocercosporo purpurea* on avocado

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ABSTRACT

Results of two years are given on the use of ultra low volume application by thermal fogging for control of black spot (caused by *Pseudocercospora purpurea*) on avocado cv. Fuerte, as compared to conventional ultra high volume spraying with hand guns. Thermal fogging (using pulsFOG® machines) gave promising results, and the best disease control was obtained with the use of systemic fungicides, e.g. benomyl, carbendazim or carbendazim/flusilazole. Under high disease pressure these treatments resulted in ±80% fruit free from black spot, compared to 93% obtained with conventional ultra high volume CuOCl sprays. Thermal fogging of copper ammonium carbonate (non-systemic) was only effective under low disease pressure.

INTRODUCTION

Fruit diseases of avocado remain a concern for growers, while consumers are becoming more critical of the use of fungicides. In South Africa the most problematic pre-harvest disease of avocado cv. Fuerte is still black spot (caused by *Pseudocercospora purpurea).* It is currently well controlled with two to three ultra high volume copper or benomyl sprays (up to 10,000ℓ spray mix/ha per application) applied during the rainy season. However, ultra high volume sprays are expensive in terms of labour and chemical costs, and cause high levels of chemical wastage. Methods to reduce the amount of copper applied, or that make the application of environmentally safer chemicals economically feasible (biodegradable, but more expensive), are needed. This project was carried out to evaluate the efficacy of ultra low volume application of fungicides by thermal fogging (using pulsFOG® machines; ±30ℓ spray mix/ha per application), in comparison to standard ultra high volume copper sprays, for the control of black spot under different climatic conditions. Thermal fogging machines are generally used in greenhouses, stores and factories to apply various insecticides, fungicides, sanitisers, and fertilisers, or in tropical plantation crops like rubber and coffee to apply insecticides and fungicides.

METHOD AND MATERIALS

The pulsFOG® machines were used to apply different fungicides, in comparison to standard copper (oxychloride, or ammonium carbonate) sprays and an untreated control treatment. Of the triazole fungicides, flusilazole (Capitan from Du Pont de Nemours,

which has known effectivity against black spot) was tested, while cyproconazole (Atemi from Sandoz) (which previously gave variable results), and triflumizole (experimental product, which was previously shown to be effective, but could not be obtained for trials) were excluded (Duvenhage 1994, 1995, 1996; Lonsdale 1991, 1992). Under high disease pressure the pulsFOG® treatments were applied in early November, December, January, and February, while the standard CuOCl sprays were applied in early November and January (Table 1 and 2). Under low disease pressure the pulsFOG® treatments were applied in early November, December, and January, while the standard copper ammonium carbonate sprays were applied in early November and January (Table 3). For pulsFOG® applications, VKII 2 glycol carrier (a fogging enhancer, which is recommended by the pulsFOG® manufacturer) was added to the mixtures (Table 1, 2 and 3). The experiments were carried out at Westfalia Estate near Duivelskloof (high disease pressure), and in the Mooketsi valley (low disease pressure). Ten Fuerte trees were used for each treatment, and a pulsFOG® machine in use is shown in Figure 4.

RESULTS

Two hundred fruits from each treatment were evaluated for incidence of black spot, sooty blotch and visible spray residues respectively (during April of each year). A 0-3 scale was used for evaluations:

For: **black spot:**

0 = no symptoms
1 = 1-5 black spot lesions
2 = 6-10 black spot lesions
3 = more than 10 black spot lesions

For: **sooty blotch:**

0 = totally unaffected fruit
1 = less than 20% of fruit surface affected
2 = 20-50% of fruit surface affected
3 = more than 50% of fruit surface affected

For visible spray residues the same scale was used as for sooty blotch. After harvest, 70 fruits of each treatment were stored at 5.5°C for 28 days, ripened at 20°C, and evaluated externally and internally for postharvest diseases and disorders

Table 1: Chemical treatments applied under high disease pressure.

1996/7 SEASON*⬠		1997/8 SEASON**⬠	
TREATMENT	**CODE**	**TREATMENT**	**CODE**
Untreated control	**C**	**Untreated control**	**C**
2x Std. CuOCl sprays: (300g/100l)	**Stdx2**	**2x Std. CuOCl sprays:** (300g/100ℓ)	**Stdx2**
4x Copper ammonium carbonate: 2,5ℓ water; 1,5ℓ VKII; 2ℓ CopperCount-N (sc 661g a.i./ℓ)	**CC**	**4x Copper ammonium carbonate:** 2,5ℓ water; 1,25ℓ VKII; 1,25ℓ CopperCount-N (sc 661g a.i./ℓ)	**CC**
4x Benomyl: 3ℓ water; 2ℓ VKII; 400g Benlate (wp 500g a.i./kg)	**B**	**4x Benomyl:** 3ℓ water; 1,5ℓ VKII; 200g Benlate (wp 500g a.i./kg)	**B**
4x Benomyl: 3ℓ water; 1,5ℓ VKII; 400g Benlate (wp 500g a.i./kg) (use nr. nozzle)	**B (no20)**	**4x Flusilazole:** 3ℓ water; 1,5ℓ VKII; 200mℓ Capitan (ec 250g a.i./ℓ)	**F**
4x Flusilazole: 3ℓ water; 2ℓ VKII; 130ml Capitan (ec 250g a.i./ℓ)	**F**	**4x Carbendazim:** 3ℓ water; 1,5ℓ VKII; 200mℓ Derosal (sc 500g a.i./ℓ)	**Car**
4x Carbendazim: 3ℓ water; 2ℓ VKII; 400ml Derosal (sc 500g a.i./ℓ)	**Car**	**4x Carbendazim/Flusilazole:** 3ℓ water; 1,5ℓ VKII; 400mℓ PunchX-stra (sc 250/125g a.i./ℓ)	**Car+F**
4x Carbendazim/Flusilazole: 3ℓ water; 2ℓ VKII; 260ml PunchX-stra (sc 250/125g a.i./ℓ)	**Car+F**	**1x Carbendazim -> 3 x Copper ammonium carbonate**	**Car/ 3xCC**
1x Std. CuOCl spray -> 1x Copper ammonium carbonate	**Std/pCC**	**1x Copper ammonium carbonate -> 1 x Carbendazim -> 2x Copper ammonium carbonate**	**CC/ Car/ 2xCC**

* In the 1996/97 season, the pulsFOG® treatments were applied with number 13 nozzles (except one benomyl treatment for which number 20 nozzles were used).

** In the 1997/98 season, all pulsFOG® treatments were applied with number 20 nozzles.

⬠ All treatments were applied with pulsFOG® machines except the Std. CuOCl sprays, which were applied as ultra high volume sprays with hand guns.

Figure 4: PulsFOG® machine used in an avocado orchard.

Table 2: Chemical treatments applied under low disease pressure

	1996/7 SEASON*°
Untreated control	
2x Std. Copper ammonium carbonate sprays: (500g/100ℓ)	
3x Copper ammonium carbonate: 2,5ℓ water; 1,25ℓ VKII; 1,25ℓ CopperCount-N (sc 661g a.i./ℓ)	

* The pulsFOG® treatments were applied with no. 13 nozzles.
° All treatments were applied with pulsFOG® machines except the standard copper ammonium carbonate sprays, which were applied as ultra volume sprays with handguns.

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Under high disease pressure, pulsFOG® application of copper ammonium carbonate (non-systemic) was not as effective as the systemic fungicides (Benomyl, Carbendazim, or Flusilazole) or standard copper sprays (Fig. 1 and Fig. 2). The best disease control obtained with pulsFOG® was with Benomyl, Carbendazim, or Carbendazim/Flusilazole, and resulted in ±80% disease free fruit in comparison to 93% obtained with standard CuOClsprays (Fig. 1 and Fig. 2). During the 1996/7 season, the bigger nozzle size (no. 20) and lower concentration of VK2 glycol carrier (resulting in bigger droplet size) tended to improve the disease control obtained with pulsFOG® application of Benomyl (Fig. 1). Therefore, no. 20 nozzles and reduced VK2 concentration were used for application of all treatments in the 1997/8 season. Under low disease pressure, PulsFOG® applications of copper ammonium carbonate gave the same level of disease control (97%) as standard CuOCI sprays (Fig. 3).

CONCLUSION

The use of thermal fogging for disease control on less susceptible cultivars eg. Hass, Edranol, and Ryan may prove to be adequately effective and should be evaluated

further. No statistical significant differences were found in the occurrence of sooty blotch, or post-harvest diseases and disorders (results not shown), and can be attributed to the low incidence there-of on all fruit used in the trial. In contrast to standard sprays of CuOCl, all pulsFOG® applications as well as standard sprays of copper ammonium carbonate exhibited no visible spray residues at harvest. Copper oxychloride (wp) was not suitable for use with pulsFOG® machines as it clogged the resonator tube, while benomyl (wp) caused less of a problem and can be used. In general, flowable formulations are more suitable for pulsFOG® application eg., copper ammonium carbonate, carbendazim or flusilazole. Outdoor use of thermal fogging is limited to use during wind still, cool times of the day (before sunrise or after sunset, or in cool overcast weather), or during the night.

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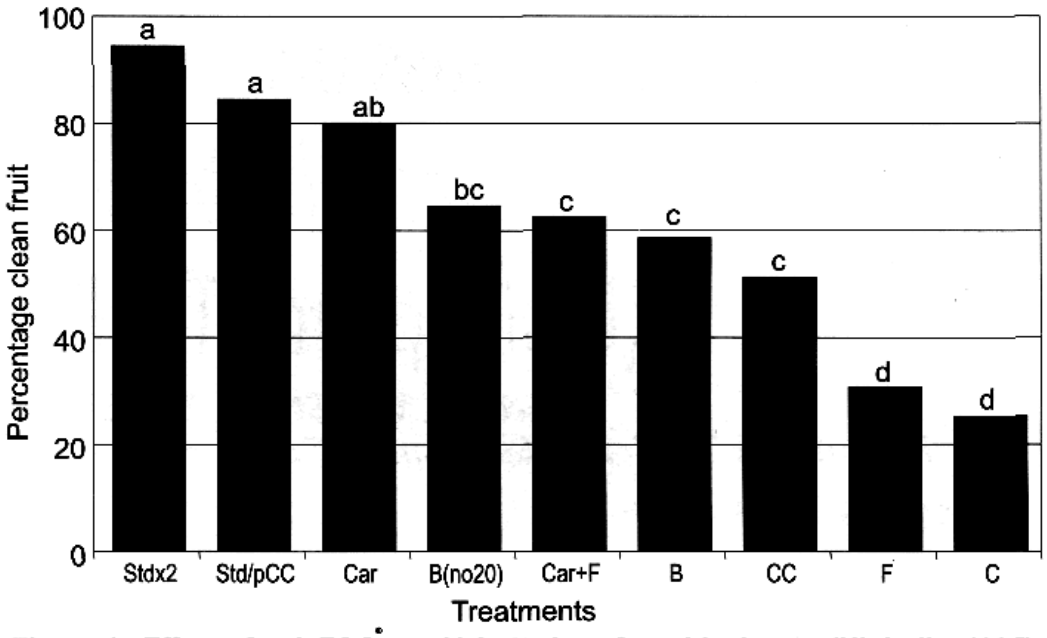

Figure 1: Effect of pulsFOG® on % fruit clean from black spot (High dis. 1997)

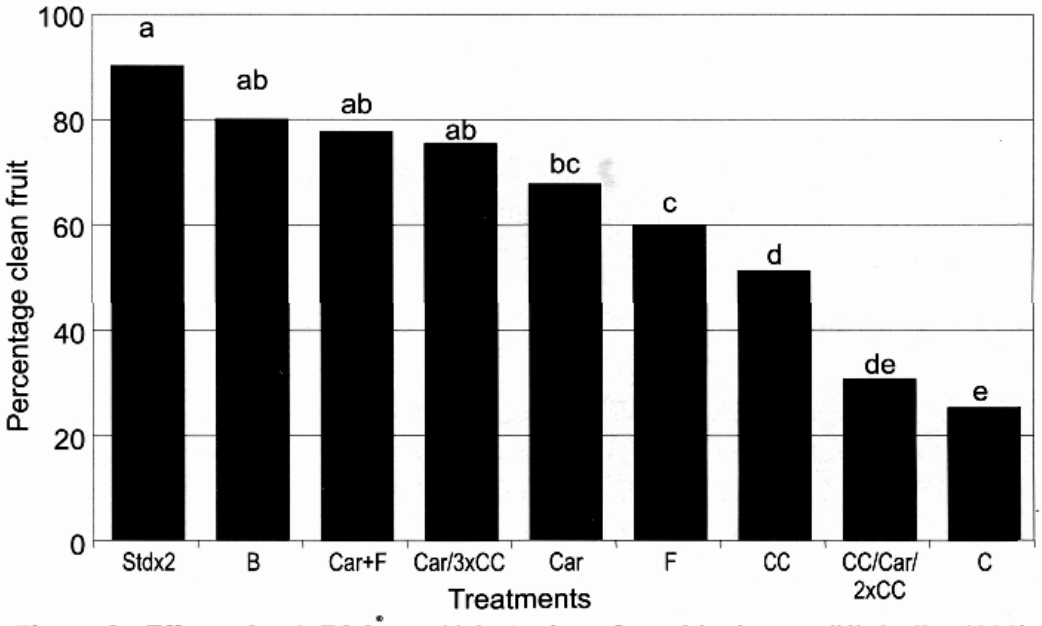

Figure 2: Effect of pulsFOG® on % fruit clean from black spot (High dis. 1998)

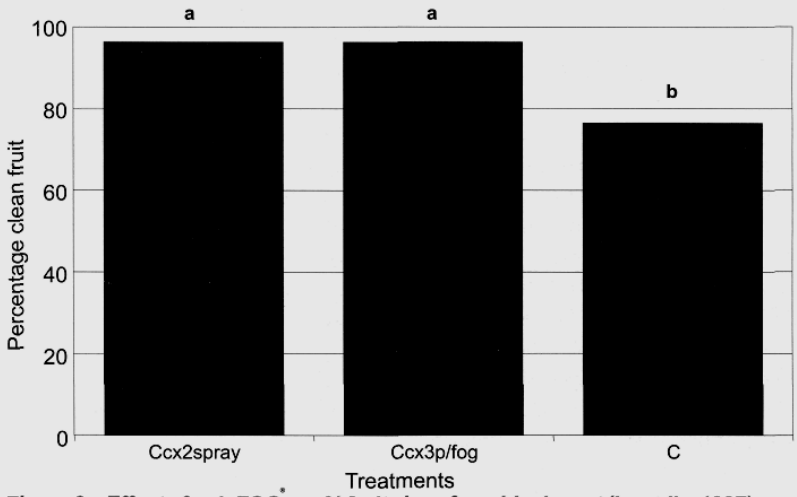

Figure 3: Effect of pulsFOG® on % fruit clean from black spot (Low dis. 1997)