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EVALUATION OF ALTERNATIVE FUNGICIDES FOR CONTROL OF CERCOSPORA SPOT ON 'FUERTE'

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Cercospora spot caused by *Pseudocercospora purpurea* is the most serious pre-harvest disease on 'Fuerte' and 'Ryan' avocados in South Africa. The disease is typically controlled by high volume applications of copper oxychloride (CuOCl), which may cause a build up of copper in soils. Alternative products to CuOCl have been evaluated at Westfalia Estate since 1999 to present and until the 2003/4 season, the only feasible alternative treatments were other copper containing fungicides. However in the 2004/5 season, good control of cercospora spot was obtained when either azoxystrobin or chlorothalonil was applied in combination with CuOCl. In the 2005/6 season the aim was to further evaluate these alternative fungicides for the control of cercospora spot and post-harvest diseases. The experiment was carried out at Westfalia Estate and treatments were applied with mist-blowers. Fruit were evaluated for the incidence of cercospora spot, sooty blotch and visible spray residues at harvest. Fruit samples from each treatment were cold-stored for 28 days, and evaluated for post-harvest diseases and disorders upon ripening. The best control of cercospora spot was obtained when two applications of azoxystrobin (October and November) were followed by two applications of CuOCl (December and January). This treatment resulted in 50% less copper being applied than the commercial treatment of CuOCl applied four times. Incidence of visible spray residues was similar for both of these treatments. Incidence of post harvest diseases was zero in the commercial treatment and also in the treatment where azoxystrobin applications were in December and January. Azoxystrobin can be considered an alternative fungicide that can replace two applications of CuOCl.

Key words: *Pseudocercospora purpurea*, pre-harvest disease, avocado, Fuerte, copper.

EVALUACIÓN DE FUNGICIDAS ALTERNATIVOS PARA EL CONTROL DE MANCHA DE CERCOSPORA EN 'FUERTE'

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Las manchas por cercospora provocadas por la *Pseudocercospora purpurea* es la enfermedad previa a la cosecha más grave que afecta a aguacates 'Fuerte' y 'Ryan' en Sudáfrica. La enfermedad se controla generalmente con aplicaciones de gran volumen de oxicloruro de cobre (CuOCl), lo que puede provocar una acumulación de cobre en el suelo. Desde 1999 a la fecha, los productos alternativos al CuOCl se han estado analizando en el estado de Westfalia y, hasta la temporada 2003/2004, los únicos tratamientos alternativos posibles fueron otros fungicidas que contienen cobre. Sin embargo en la temporada 2004/2005, se obtuvo un buen control de manchas de cercospora cuando se aplicó azoxistrobin o clorotalonil en combinación con CuOCl. En la temporada 2005/2006, el objetivo fue analizar con más profundidad estos fungicidas alternativos para el control de las manchas de cercospora y las enfermedades posteriores a la cosecha. El experimento se llevó a cabo en el estado de Westfalia y se aplicaron los tratamientos con nebulizadores. Las frutas se analizaron por la incidencia de la mancha de cercospora, manchas de hollín y residuos visibles de la aspersión en la cosecha. Las muestras de frutas de cada tratamiento fueron almacenadas en frío durante 28 días y se evaluaron en busca de enfermedades después de la cosecha y durante la maduración. El mejor control de manchas por cercospora se obtuvo cuando se realizaron dos aplicaciones de azoxistrobin (en octubre y noviembre) seguidas de dos aplicaciones de CuOCl (en diciembre y enero). Este tratamiento dio como resultado un 50% menos de cobre en la aplicación que el tratamiento comercial de CuOCl aplicado cuatro veces. La incidencia de los residuos de la aspersión visibles fue similar para estos dos tratamientos. La incidencia de las enfermedades posteriores a la cosecha fue nula en el tratamiento comercial y como así también en el tratamiento con aplicaciones de azoxistrobin realizadas en diciembre y enero. El azoxistrobin puede considerarse como un fungicida alternativo que puede reemplazar dos aplicaciones de CuOCl.

Introduction

In South Africa the most problematic pre- harvest disease of avocado is still avocado black spot (Cercospora spot- caused by *Pseudocercospora purpurea*) (Darvas and Kotzè, 1979). The disease is characterized by raised shiny black spots, 1-6mm in diameter in the early stages, with spots becoming sunken in later stages (Darvas, 1982). Alternative products to copper oxychloride have been evaluated at Westfalia Estate since 1999 (Willis, 2005; Willis and Mabunda, 2004; Willis and Duvenhage, 2003; Duvenhage, 2002) and in the 2004/5 season, the best control of Cercospora spot was obtained with two applications of Ortiva™ (October and November) followed by two applications of Demildex (December and January) (Willis, 2006). In the 2003/4 season Bravo® alternated with Demildex was just as effective as the standard Demildex treatment and in the 2004/5 season the same treatment was as effective as the Ortiva / Demildex treatment mentioned above (Willis, 2005 and 2006). Since both these products showed potential as alternative fungicides that could replace two Demildex applications in a season, and both have proven efficacy against Cercospora organisms on other crops, further evaluation was necessary (Nel *et al.*, 2003). The use of avirulent or attenuated strains of either pathogenic or saprophytic micro-organisms to induce systemic acquired resistance in plants has been well researched (Kùc, 2000). Messenger is a relatively new product (EDEN Bioscience Corp., USA) that is based on the harpin protein derived from the bacterium that causes fire-blight of pear, apple and related plants. The presence of the harpin protein serves as a signal to the host plant that a pathogen is present. This "host recognition" leads to an activation of biochemical defenses throughout the plant that can reduce disease development and new infections, a phenomenon known as systemic acquired resistance (SAR) (Terry and Joyce, 2004). This induced resistance could provide systemic protection against infection, to substitute for, or supplement control by standard fungicides (Johnston *et al.*, 2004). Another means of reducing the amount of copper applied to our orchards is by reducing the application volumes currently used, but avocado growers face particular challenges when it comes to achieving coverage of very large trees. The use of super-spreader adjuvants has allowed growers to reduce pesticide spray volumes and improve pest control in a variety of crops, e.g. onions, potatoes, kiwifruit and grapes (Gaskin *et al*., 2002). Therefore the addition of a super-spreader like Break-thru® could counteract the effect of reduced coverage when spray volumes are reduced. The long term aim of this project was to reduce the amount of copper applied to orchards by further evaluation of alternative fungicides, additives and copper products for the control of Cercospora spot and post-harvest diseases on 'Fuerte'.

Materials and Methods

The application volumes employed in this trial were based upon commercial application rates used at Westfalia Estate for large 'Fuerte' trees. Ortiva™ (Azoxystrobin, Syngenta (Pty) Ltd) applied in various programs with Demildex (Copper oxychloride, Delta Chemicals (Pty) Ltd) and on it's own; Bravo® 720SC (Chlorothalonil, Syngenta (Pty) Ltd) alternated with Demildex; Copstar 120 SC (Copper hydroxide, Agchem Africa (Pty) Ltd); Messenger (Harpin protein, AroBiz Africa (Pty) Ltd) alternated with Demildex; Break-thru® (Polyether-polymethylsiloxane-copolymer, Degussa Africa (Pty) Ltd) added to lowered volumes of Demildex and a lowered rate of Demildex (2g/L) were compared with the standard Demildex rate (3g/L) and with a lower volume application of Demildex (4000L/ha) (Table 1). The experiment was carried out in a high disease pressure orchard on Westfalia Estate. Trees were about 26 years old and planted at a spacing of 10m x 10m (<100 trees / ha). A row of about 8 trees, was used for each treatment and treatments were applied using an Ultima mistblower and a Bateleur mistblower in order to obtain efficient coverage of the large trees. Two buffer rows were allowed between each treated row in the block. The trial was harvested at the end of May 2006 in order to allow for maximum disease development. In each treatment, 20 fruit from each quarter of the tree canopy from each of the data trees were evaluated for the incidence of Cercospora spot, sooty blotch and visible spray residues. A 0-3 rating scale was used for evaluations as follows:

Cercospora:	0= clean	1= 1-5 lesions	2= 6-10 lesions	3= >10 lesions
Sooty blotch:	0= clean	1= <20% fruit surf.	2= 21-50% fruit surf.	3= >50% fruit surf.
Spray residue:	0= clean	1= <20% fruit surf.	2= 21-50% fruit surf.	3= >50% fruit surf.

Fruit samples from each treatment were stored at 5.5°C for 28 days, and evaluated for post-harvest diseases and disorders after ripening at 20°C. Statistical analysis of data was done using the data analysis software system STATISTICA version 6 (StatSoft, Inc. 2003 www.statsoft.com).

Results and Discussion

There was extremely high disease pressure in the trial orchard as indicated by the high incidence of Cercospora spot in the untreated control (Figure 1). The best control of Cercospora spot was obtained with two applications of Ortiva (October and November) followed by two applications of Demildex (December and January). The control obtained with this treatment was not significantly different from Ortiva alternated with Demildex nor from the commercial standard treatment of Demildex (3g/L) applied four times in a season. Two applications of Demildex (October and November) followed by two applications of Ortiva (December and January) was ineffective in controlling Cercospora spot, as was Ortiva applied on it's own. Bravo alternated with Demildex was less effective (9.6% Cercospora spot) than two applications of Ortiva followed by two applications of Demildex (3.2% Cercospora spot), but the difference was not statistically significant. Previous work showed that there was no difference between Bravo and Ortiva when they were applied in a program with Demildex (Willis, 2006).

Copstar, Demildex alternated with Messenger and the lowered volumes of Demildex with Break-thru treatments all achieved a similar level of control, which amounted to about 10% less control than the standard commercial and best treatments, however this difference was not statistically significant.

The addition of Break-thru to the lowest volume of Demildex (4000L/ ha) did result in better control when compared to 4000L /ha Demildex without Break-thru, but this was not a significant difference. However, when comparing these treatments to the commercial standard treatment, the lower volumes with Break-thru did not provide sufficient control. Gaskin *et al*. (2004) found that the use of a super-spreader adjuvant achieved equivalent spray deposits on avocado fruit when using 3-5 times less spray volume than standard practice. The authors did not however, report on disease incidence in this study.

Incidence of spray residues was similar for two applications of Ortiva followed by two applications of Demildex and the standard commercial treatment, therefore use of Ortiva in the beginning of the season does not lead to significantly less visible spray residues on the fruit at harvest. In contrast, when Ortiva was applied at the end of the season (December and January), significantly less sprays residues were visible on the fruit at harvest (Figure 2). The lowered volume application of Demildex (4000L/ha) with Break-thru resulted in significantly less spray residues at harvest than the commercial standard treatment. This implies that spray coverage was less efficient in this treatment, which is in contrast with the findings of Gaskin et al (2004). Incidence of sooty blotch was high in all treatments and differences between treatments were not significant (results not shown).

Incidence of post harvest diseases was zero when Ortiva was applied in December and January, however this treatment was ineffective for Cercospora spot control. Anthracnose incidence was high in the Demildex / Bravo, Ortiva alone and Copstar treatments. Stem end rot was also high in these treatments as well as in the untreated control. The addition of Break-thru to lowered volumes of Demildex reduced stem end rot incidence to zero. This treatment could be useful on other cultivars, such as Hass, which is not very susceptible to Cercospora spot (Figure 3).

Conclusions

This is the second season in which Ortiva was shown to be a feasible alternative fungicide that could replace two applications of copper oxychloride (Demildex) in a spray program. Bravo, when alternated with Demildex, was less effective for the control of both Cercospora spot and post harvest diseases in this study. Based on these findings Syngenta South Africa is pursuing the registration of Ortiva on avocados. It must be noted that the use of strobilurin fungicides must be managed in a manner which reduces resistance development. This is done by limiting their use and by using them as a component of an integrated program with other fungicides.

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Table 1: Treatments and amount of copper applied per ha per year in the 2005-06 season
La mesa 1: Los tratamientos y la cantidad de cobre aplicado por ah por año en la 2005-06 temporada

Tmt	Oct 05	Nov 05	Dec 05	Jan 06	Cu/ha/yr
1	Ortiva 0.3ml/L 5500L/ha	Ortiva 0.3ml/L 5500L/ha	Demildex 3g/L 8200L/ha	Demildex 3g/L 8200L/ha	24.6
2	Demildex 3g/L 8200L/ha	Demildex 3g/L 8200L/ha	Ortiva 0.3ml/L 5500L/ha	Ortiva 0.3ml/L 5500L/ha	24.6
3	Ortiva 0.3ml/L 5500L/ha	Demildex 3g/L 8200L/ha	Demildex 3g/L 8200L/ha	Ortiva 0.3ml/L 5500L/ha	24.6
4	Ortiva 0.3ml/L 5500L/ha	Demildex 3g/L 8200L/ha	Ortiva 0.3ml/L 5500L/ha	Demildex 3g/L 8200L/ha	24.6
5	Demildex 3g/L 8200L/ha	Bravo 3ml/L 5500L/ha	Demildex 3g/L 8200L/ha	Bravo 3ml/L 5500L/ha	24.6
6	Ortiva 0.3ml/L 5500L/ha	Ortiva 0.3ml/L 5500L/ha	Ortiva 0.3ml/L 5500L/ha	Ortiva 0.3ml/L 5500L/ha	0
7	Copstar 3.5ml/L 8200L/ha	Copstar 3.5ml/L 8200L/ha	Copstar 3.5ml/L 8200L/ha	Copstar 3.5ml/L 8200L/ha	13.7
8	Demildex 3g/L 8200L/ha	Messenger 8200L/ha	Demildex 3g/L 8200L/ha	Messenger 8200L/ha	24.6
9	Demildex 3g/L +Brk-thru 0.25ml /L 6000L/ha	Demildex 3g/L +Brk-thru 0.25ml /L 6000L/ha	Demildex 3g/L +Brk-thru 0.25ml /L 6000L/ha	Demildex 3g/L +Brk-thru 0.25ml /L 6000L/ha	36.0
10	Demildex 3g/L +Brkthru 0.25ml /L 4100L/ha	Demildex 3g/L +Brkthru 0.25ml /L 4100L/ha	Demildex 3g/L +Brkthru 0.25ml /L 4100L/ha	Demildex 3g/L +Brkthru 0.25ml /L 4100L/ha	24.0
11	Demildex 3g/L 4100L/ha	Demildex 3g/L 4100L/ha	Demildex 3g/L 4100L/ha	Demildex 3g/L 4100L/ha	24.0
12	Demildex 2g/L 8200L/ha	Demildex 2g/L 8200L/ha	Demildex 2g/L 8200L/ha	Demildex 2g/L 8200L/ha	32.8
13	Demildex 3g/L 8200L/ha	Demildex 3g/L 8200L/ha	Demildex 3g/L 8200L/ha	Demildex 3g/L 8200L/ha	49.2
14	Untreated				0

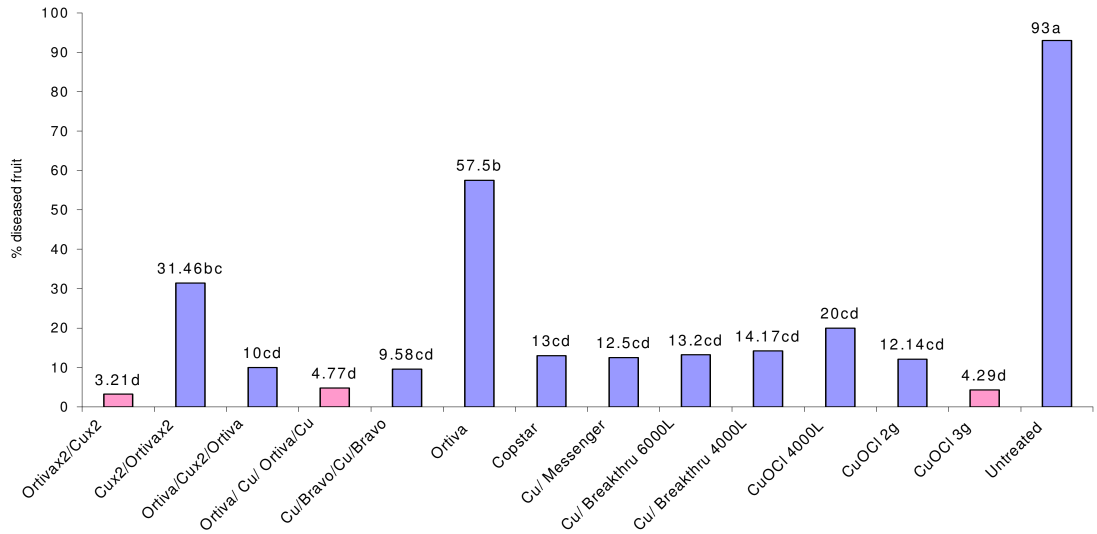

Figure 1: Percentage fruit affected by Cercospora spot in 2005-06 (CuOCl or Cu = Demildex)
La figura 1: La fruta del porcentaje afectada por el lugar de Cercospora en 2005-06 (CuOCl o Cúbico = Demildex)

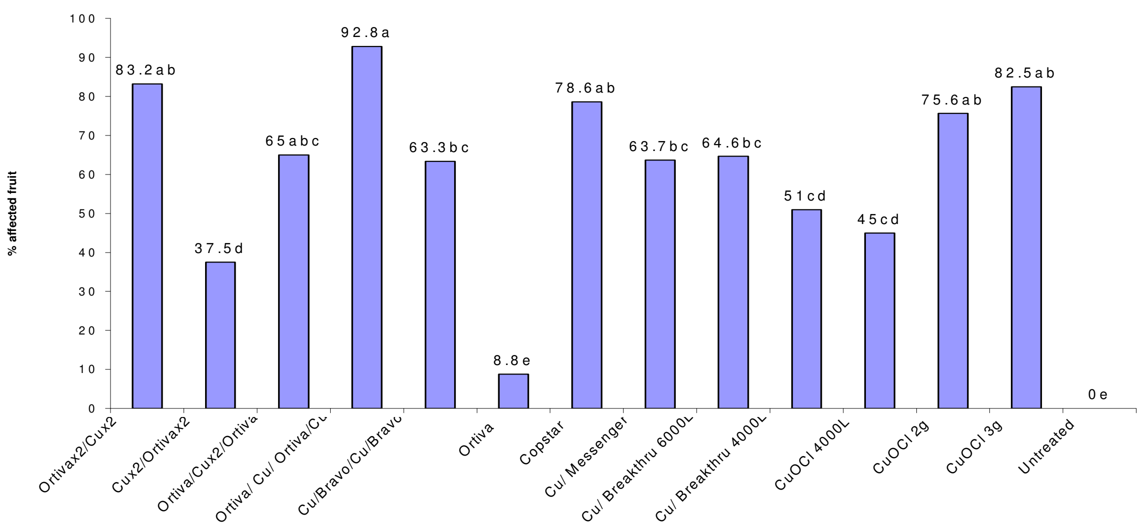

Figure 2: Percentage fruit affected by visible spray residues in 2005-06 (CuOCl or Cu = Demildex)
La figura 2: La fruta del porcentaje afectada por residuos visibles de rocío en 2005-06 (CuOCl o Cúbico = Demildex)

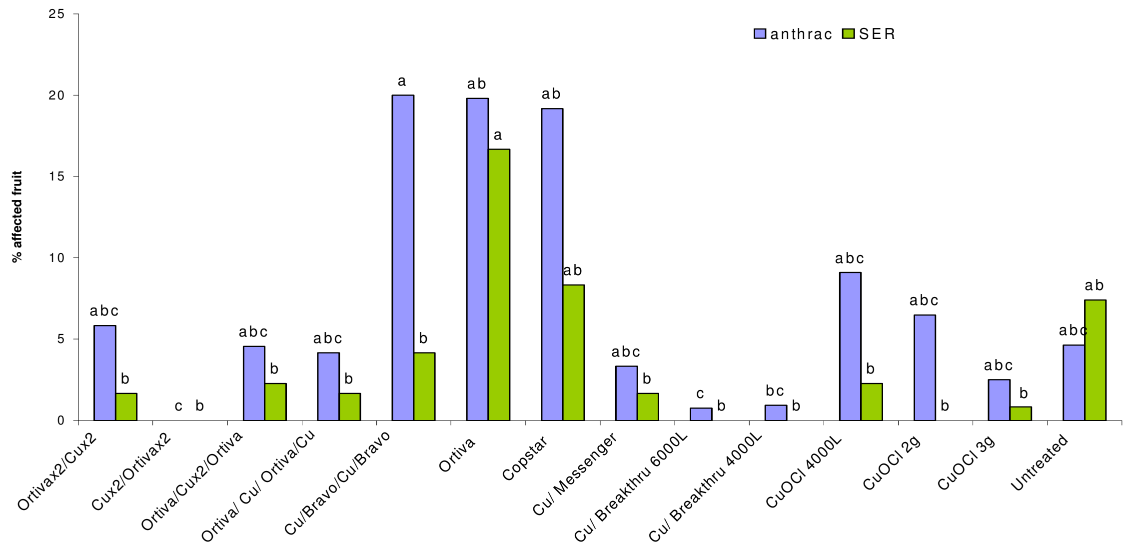

Figure 3: Percentage fruit affected by Anthracnose and Stem end rot (SER) in 2005-06 (CuOCl or Cu = Demildex)
La figura 3: La fruta del porcentaje afectada por Anthracnose y el Tallo termina la putrefacción (más SUDESTE) en 2005-06 (CuOCl o Cúbico = Demildex)