Evaluation of fungicides for *Pseudocercospora* control – final report

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ABSTRACT
Tests on combinations of previously promising fungicides, plus products successful in similar situations allied to a reduced copper rate, were conducted. Copper plus Ortiva (azoxystrobin) was most successful under severe conditions. Adjuvants appeared to have a synergistic effect, but the trial did not allow of positive conclusions for these.

INTRODUCTION
Last year's trials confirmed that there is no fungicide better than copper for the control of *Pseudocercospora* on avocados. However, Knowin, Ortiva and a triazole were all effective if combined with copper sprays in a program. This trial was designed to test these as tank mixes with reduced copper doses. As a subsidiary, two adjuvants were tested against oil. Other potential chemicals, which have since come to our notice, were tested.

METHODS
The trial was laid out as a randomised block design with three replicates of two tree plots, so constructed that a factorial was included to specifically test the effects of spray adjuvants and Ortiva when combined with copper. The trial was conducted at Schagen, near Nelspruit, in a 15-year-old 'Fuerte' orchard planted at a spacing of 3 m x 6 m (555 trees/ha), thanks to Dr Anton Hough.

Treatments are listed in **Table 1**. Only three sprays were applied during the season, the first two according to the treatments in **Table 1** on 3 November and 17 December, 2008. These were followed by a blanket copper spray at 200 g/hl plus oil at 250 ml/hl on 2 February, 2009.

Fruit were harvested on the 28th of April, 2009. Thus, 132 days elapsed between application and harvest of any chemical which might pose residue problems.

In each treatment, thirty fruit were harvested from

Table 1. Treatments and dose rates.

Treatment and rate per hectolitre	Code
Untreated control	Nil
Sporekill 100 ml	Sk
Fighter 570 ml + Sporekill 100 ml	FtrSk
Knowin 50 ml + Ortiva 20 ml + Sporekill 100 ml	KnoOrtSk
Bellis 30 g + Sporekill 100 ml	BelSk
Demildex 175 g + Knowin 50 ml + Sporekill 100 ml	CuKnoSk
Demildex 175 g + Tilt 50 ml + Sporekill 100 ml	CuTltSk
Demildex 175 g + Nil	Cu
Demildex 175 g + Oil 250 ml	CuOil
Demildex 175 g + Sporekill 100 ml	CuSk
Demildex 175 g + Breakthru 2.5 ml	CuBt
Demildex 175 g + Ortiva 20 ml + Nil	CuOrt
Demildex 175 g + Ortiva 20 ml + Oil 250 ml	CuOrtOil
Demildex 175 g + Ortiva 20 ml + Sporekill 100 ml	CuOrtSk
Demildex 175 g + Ortiva 20 ml + Breakthru 2.5 ml	CuOrtBt

Products used: Demildex = Copper oxychloride 85% (50% Cu); Oil = BP medium light oil; Sporekill = didecyldimethyl ammonium chloride 12%; Breakthru = polyether trisiloxane; Ortiva = azoxystrobin 25%; Tilt = propiconazole 25%; Knowin = carbendazim 50%; Bellis = pyraclostrobin 12.8% + boscalid 25.2%; Fighter = potassium phosphite 55.5%, with additives.

the two trees of each two tree plot, from all parts of the canopy. Fruit were evaluated for *Pseudocercospora* incidence using a scale of 0-3 where 0 = no symptoms, 1 = 1-5 lesions, 2 = 6-10 lesions and 3 = more than 10 lesions. All fruit from each treatment were subsequently washed in a 0.5% calcium hypochlorite solution, rinsed in water, waxed with Avoshine and fan dried to mimic standard commercial packhouse procedures, except prochloraz was excluded. The fruit were stored for 28 days at 5.5°C to allow for post-harvest disease development, ripened at room temperature and evaluated for anthracnose and stem-end rot when eat-ripe. A rating scale of 0-3 was again used, 3 being severe. Rating data was expressed as a disease index on a scale ranging from 0 to 100, according to McKinney (1923).

RESULTS

Three replications is low for an avocado disease trial because of the high variation which exists in the field, but at this stage many options are still being investigated and replicates had to be sacrificed. Inspection of the data revealed obvious outliers, where some plots had values substantially different from the other two plots in the same treatment. These, as determined by the Dean and Dixon (1951) Q test, were removed and the trial analysed by regression.

Results for the *Pseudocercospora* index are given in **Table 2**. Anthracnose results were significant, but only in that the control (index = 13.6) was different from the rest, which ranged from zero to an index of four. The same results were obtained with stem-end rot (SER), where the control had an index of ~17, FtrSk ~13 and the rest were similar at indices of 0-4. Thus these latter tables are not presented.

Built into the main trial was a factorial trial (last eight treatments in **Table 2**) to specifically investigate the effects of Ortiva and adjuvants, all on a low copper oxychloride base. This has the advantage of more internal replication, effectively twelve for Nil vs Ortiva, and six for adjuvants, instead of three.

Results for the factorial trial are given in **Table 3**. Nil vs Ortiva was highly significant ($P < 0.01$). Adjuvants and differences in the body of the table failed significance. There were no differences of significance in the factorial analyses for anthracnose or SER.

Table 2. *Pseudocercospora* disease index results.

Treatment	Index	Sig. 5%
Nil	100.1	a
Sk	100.1	a
FtrSk	98.6	a
KnoOrtSk	91.9	a
BelSk	74.1	ab
CuKnoSk	71.8	b
CuTltSk	59.0	bcd
Cu	66.7	bc
CuOil	49.8	bcde
CuSk	57.4	bcd
CuBt	49.8	bcde
CuOrt	42.0	cde
CuOrtOil	40.5	de
CuOrtSk	26.4	e
CuOrtBt	40.1	de

Means with the same letter are not significantly different at the 5% level.
Short codes are: Cu = Demildex; Sk = Sporekill; Bt = Breakthru; Ftr = Fighter; Kno = Knowin; Bel = Bellis; Tlt = Tilt.

Table 3. Factorial, Ortiva and adjuvants, *Pseudocercospora* index analysed by regression.

	Nil	Oil	Sk	Bt	Mean
Cu + Nil	66.6	48.3	57.4	49.7	55.8 a
Cu + Ort	42.0	40.4	26.4	40.1	37.1 b
Mean	53.8	44.2	41.2	44.7	

DISCUSSION

In a previous article (Manicom & Schoeman, 2008) we argued that, based on data from Westfalia Estates in Tzaneen, the early spray in October was of low importance. This was thus excluded from this trial to test its importance and see whether treatments would have a "kick back" action.

Big mistake. The three copper spray programmes starting 3 November had 66% infection. Data from a nearby trial with a four copper program, starting 17 October, calculated according to the index we used here, gave ~5.5% infection. Applying Darvas' equation (ibid) and calculating a running weekly "Z" value (**Figure 1**, red line), spore release was rapidly climbing by the first third of October when the serious rains began.

A possible further reason for the poor control is that a low copper oxychloride rate of 175 g/hl was used. Previously we have argued that 160 g/hl is required (Manicom & Schoeman, 2008) and that 200 g/hl is adequate, even if not combined with other fungicides. In attempting to shave copper application, the rate used may have been too low for the severe inoculum pressure extant and 200 g/hl would have been safer.

Despite the dismal results, the trial did, however, apply a severe test to the mixes and a fair amount of information can still be gleaned. Good results with Sporekill as an adjuvant to other fungicides (carbendazim, azoxystrobin, triazoles, phosphite) have been obtained on citrus against *Guignardia* (T Schutte, pers. comm.), but this proved not to be the case in this situation. Bellis (pyraclostrobin + boscalid) too, proved

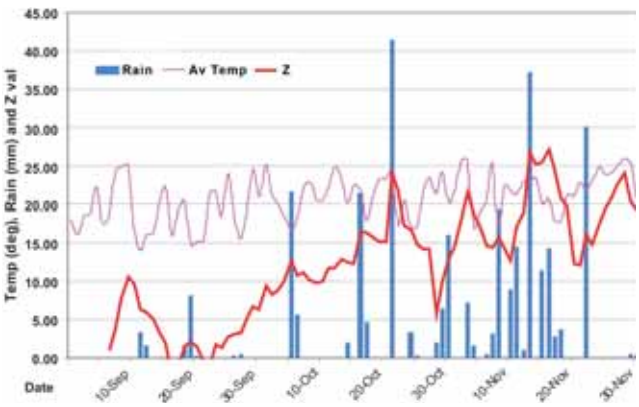

Figure 1. Daily rainfall (mm), mean temperature and running weekly Darvas' "Z" values for the early season.

disappointing, as did Knowin, although this site has a history of carbendazim usage and may harbour resistant fungal populations. Tilt marginally improved on the straight copper sprays and may need further investigation.

Table 1 shows that where copper was not a part of a program, control was poor. The best of these mixes all combined Demildex with Ortiva. According to the results of the factorial part of the trial, there is no difference among the adjuvants, nor without any. However, looking at the numbers in **Table 3**, we believe the jury is still out, and oil and Sporekill show advantages. There appears to be an interaction, where with Demildex alone, oil and Breakthru are most effective, but where Demildex and Ortiva are together, Sporekill is the most efficacious. It should be noted that there is a considerable price difference between oil and Sporekill (R4,15 versus R8,80/hl, when last checked).

Thus none of the programs outside those of copper and copper / Ortiva warrant further investigation and we reiterate that the use of copper products in a *Pseudocercospora* control program is believed to be essential. However, the dose rate can be reduced, especially when combined with Ortiva and should lie around 200 g/hl, as opposed to the standard 300 g/hl. Early Ortiva sprays followed by copper sprays could further halve the amount of copper per season and the investigation of copper rates and combinations / alternations with Ortiva is where future research should concentrate (some of this has been done by others and will hopefully be reported upon). Ortiva in the early season allows in excess of 120 days before harvest, thus residues should not be a problem. Later copper sprays still leave a dilemma with regard to packhouse residues.

LITERATURE CITED

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