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Title: Compare the efficacy of conventional spraying equipment with Electrostatic Spraying System (ESS), when applying standard fungicide programmes, for controlling mango diseases.

Aim: The aim of this project is to determine whether volume and/or concentration of fungicides applied per hectare can be decreased with new generation spraying equipment while maintaining acceptable or improved levels of disease control.

Crop:	**Mangoes**
Target Organism:	**Anthracnose (*Colletotrichum gloeosporiodes*) and Stem-end rot/Soft brown rot (*Botryosphearia* spp)**
Season:	**2006/2007**
Evaluation:	**March 2007**
Project Site:	**Hoedspruit**

Compare the efficacy of conventional spraying equipment with Electrostatic Spraying System (ESS), when applying standard fungicide programmes, for controlling mango diseases.

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Aim

The aim of this project was to determine whether volume and/or concentration of fungicides applied per hectare can be decreased with new generation spraying equipment while maintaining acceptable or improved levels of disease control.

Materials and Methods

The trial was conducted at Bavaria Estates, Hoedspruit, Limpopo Province on a commercial orchards, cv. Kent with 820 trees/ha. The standard programme of Bavaria Estates was sprayed with conventional spraying equipment (Cima sprayer) and the Electrostatic Spraying System (ESS) for disease control. The programme consisted of three systemic fungicides, mainly for control of powdery mildew, followed by copper applications every three weeks, until harvest for control of bacterial black spot, anthracnose, stem-end rot and soft brown rot. The first systemic application, Punch C (carbendazim/flusilazole, a.i. 125/250 g/ℓ) was sprayed on the 17th of July 2006, followed by Tilt (propiconazole, a.i. 250 g/ℓ) on the 7th of Augustus 2006. The last systemic application, Punch C was sprayed on the 1st of September 2006. Copper applications started on the 2nd of October 2006, at 3-week intervals, until the 15th of January 2007 when the last copper application was sprayed.

The trial consisted of 4 programmes, applied to 20tree blocks and replicated twice in a randomised block design. Before each fungicide application, 50 leaves and fruit were inspected for phytotoxicity on data trees. Test materials, dosages and volumes sprayed are depicted in **Table 1**. The concentrations of fungicides (g / 100 ℓ) applied with the ESS were much higher than for the conventional Cima application. However, the volumes applied by ESS were much lower at 180 ℓ per hectare compared to 1200ℓ applied with Cima spraying equipment. This resulted in the same amounts of active ingredient for fungicide applied per hectare for programme 3 (ESS, 100) and 4 (Cima, conventional). When Dimildex (a.i. copper oxychloride, 850 g/kg) were applied at 300 g per 100 litre water with conventional Cima spraying equipment at 1200 litre per hectare, an amount of 3.6 kg Dimildex were applied per hectare, therefore 3.06 kg copper oxychloride. In the trial if referred to ESS at 50 percent of active ingredient per hectare, it implies that 50 percent of the active ingredient applied by conventional Cima spraying equipment was applied with the ESS. The same calculations were used for systemic fungicides applied in the trial.

Efficacy of spray programs were evaluated at harvest by picking 60 fruits per treatment from each block of data trees, thus 120 fruits in total per treatment. Fruits from each treatment were divided into two sub samples. One sample was washed in a 200 ppm chlorine solution, followed by hot water dip treatment (50°C for 5 minutes) and wax. The second sample was washed in a 200 ppm chlorine solution, followed by hot water dip treatment (50°C for 5 minutes), 30 sec prochloraz dip treatment (180 mℓ / 100 ℓ) and wax.

Table 1. Test material compared at Bavaria Estates, Hoedspruit as a semi-commercial pre-harvest applications.

Treatment number	Fungicide programme	Programme description	Dosage per 100 ℓ	Dosage per hectare	Active ingredient applied per hectare	Volume sprayed per ha
1	Punch C or Tilt or Dimildex	ESS, 50	50 mℓ 66.7 mℓ 1000 g	90 mℓ 120 mℓ 1800 g	11.25 g 30 g 1530 g	**180 ℓ**
2	Punch C or Tilt or Dimildex	ESS, 80	80 mℓ 106.7 mℓ 1600 g	144 mℓ 192 mℓ 2880 g	18 g 48 g 2448 g	**180 ℓ**
3	Punch C or Tilt or Dimildex	ESS, 100	100 mℓ 133 mℓ 2000 g	180 mℓ 240 mℓ 3600 g	22.5 g 60 g 3060 g	**180 ℓ**
4	Punch C or Tilt or Dimildex	Cima, conventional	15 mℓ 20 mℓ 300 g	180 mℓ 240 mℓ 3600 g	22.5 g 60 g 3060 g	**1200 ℓ**

* ESS = Electrostatic Spraying System. ESS 50, 80 and 100 the percentage stipulated amount of active ingredient as applied with the conventional Cima application.

Results

No prochloraz post-harvest treatment

This evaluation, where fruit was not treated with prochloraz, is normally included to evaluate the effect of pre-harvest orchard applications on post-harvest expression of diseases.

Anthracnose

The best results were obtained with programme 2 (ESS, 80) with 20 percent fruit with anthracnose lesions (**Table 1**). This was significantly better than fruit from programme 1 (ESS, 50) with 43 percent fruit with lesions. The next best programme regarding control of anthracnose was programme 3 (ESS, 100) with 33 percent, followed by programme 4 (Cima, conventional) with 37 percent fruit with lesions.

After 14 days of incubation at room temperatures there was no statistical difference between treatments. However, trends do show that programme 2 and 3 gave better control than programme 4 (Cima, conventional) and programme 1 (ESS, 50).

Soft brown rot / Stem-end rot

Very low percentage of stem-end rot was observed during the trial, therefore fruits with stem-end rot lesions were classified as soft brown rot. Evaluation of fruits 7 days after removal from cold storage showed that programme 2 (ESS, 80) had 17 percent fruit with soft brown rot symptoms (**Table 2**). This was significantly less than all other treatments evaluated for these parameter. Programme 3 (ESS, 80) gave better control of soft brown rot than programme 4 (Cima, conventional) and programme 1 (ESS, 50) although not statistically different.

After 14 days of incubation fruit from programme 2 (ESS, 80) still had significantly less soft brown rot compared to the other programmes.

Table 2. Percentage fruit infected with anthracnose and soft brown rot when evaluated at 7 and 14 days after removal from cold storage, with no post-harvest prochloraz treatment.

Treatment number	Fungicide programme	Programme description	Percentage decayed fruit			
			Anthracnose		Soft brown rot	
			7day	14day	7day	14day
1	Punch C or Tilt or Dimildex	ESS, 50	43 b	70 a	53 b	88 b
2	Punch C or Tilt or Dimildex	ESS, 80	20 a	53 a	17 a	52 a
3	Punch C or Tilt or Dimildex	ESS, 100	33 ab	53 a	38 b	78 b
4	Punch C or Tilt or Dimildex	Cima, conventional	37 ab	62 a	47 b	87 b

Values in the same column followed by the same alphabetical letter do not differ according to Fishers' protected t-test at the 5 % level of significance.

Prochloraz post-harvest treatment

This evaluation is normally included to give an indication of the effect of pre-harvest programmes in combination with post-harvest prochloraz treatments, on decay development.

Anthracnose

In general the percentage anthracnose on fruit from all programmes was decreased by the post-harvest prochloraz dip treatment. Evaluation of fruit 7 days after removal from cold storage showed no statistical differences between programmes **(Table 3)**.

After 14 days incubation programme 2 (ESS, 80) had significantly less fruit with anthracnose lesions than fruit from programme 1 (ESS, 50). Trends showed that programme 2 (ESS, 80) was more effective than programme 3 and 4 regarding the control of anthracnose.

Soft brown rot

Results showed that the application of post-harvest prochloraz dip treatment did not have a significant effect on the expression of soft brown rot. It is a well known phenomenon that prochloraz is not very effective to control soft brown rot and stem-end rot development and sometimes even enhance expression of this disease by inhibiting competitive anthracnose disease development. In general results showed that pre-harvest programmes 2, 3 and 4 were superior to programme 1.

Table 3. Percentage fruit infected with anthracnose and soft brown rot when evaluated at 7 and 14 days after removal from cold storage, with post-harvest prochloraz treatment.

Treatment number	Fungicide programme	Programme description	Percentage decayed fruit			
			Anthracnose		Soft brown rot	
			7day	14day	7day	14day
1	Punch C or Tilt or Dimildex	ESS, 50	28 a	55 b	35 a	88 b
2	Punch C or Tilt or Dimildex	ESS, 80	15 a	25 a	23 a	63 ab
3	Punch C or Tilt or Dimildex	ESS, 100	18 a	37 ab	22 a	53 a
4	Punch C or Tilt or Dimildex	Cima, conventional	20 a	37 ab	33 a	55 ab

Values in the same column followed by the same alphabetical letter do not differ according to Fishers' protected t-test at the 5 % level of significance.

Discussion and Conclusion

The efficacy of contact fungicides can be adversely affected by poor coverage and excess runoff. The ESS enables the application of fungicides with virtually no run-off and exceptional coverage. In this trial the best demonstration of efficacy of pre-harvest fungicide applications was obtained where no post-harvest prochloraz was applied since post-harvest treatments seems to mask the effect of pre-harvest applications.

If similar amounts of active ingredients were applied with two different types of spraying equipment (ESS vs. Cima = programme 3 vs. programme 4) then anthracnose and soft brown rot control was approximately 9 percent better with the ESS when no post-harvest prochloraz treatment was applied. The effect was improved further to 9 percent for anthracnose and 35 percent for soft brown rot if the fungicide concentration was reduced with 20 percent. (Programme 2 vs. programme 4). When fungicide concentrations were reduced with 50 percent efficacy were reduced (programme 1 vs. programme 1) and anthracnose increased with 8 percent and the percentage soft brown rot stayed the same. Therefore we can conclude that fungicide application in a mango pre-harvest disease control programme can be applied at 80 percent of the conventional concentration with the ESS. The reason why the application at 100 percent (programme 4) was mostly inferior to the 80 percent (programme 3) can possibly be due to a negative effect of increased fungicide concentration in limited amounts of water or a negative effect on distribution. This implies that there is an optimum concentration somewhere between 50 and 100 percent that must still be determined.

Results of this trial showed positive results in the first year of evaluation. Future work on optimising dosages and possibly the additions of adjuvants to facilitate mixing under these high concentrations ratios (g / 100 l) are of extremely important. Possible dosages that should be tested are 50, 60, 70, 80, 90 and 100 percent of the current registered dosage sprayed per hectare by conventional Cima spraying equipment. The effect on Maximum Residue Levels (MRL) of ESS applied fungicides is also important for registration purposes and should be enclosed in future research.

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