Best orchard practices for the control of mango blossom malformation in South Africa

Preliminary report

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ABSTRACT
Mango blossom malformation (MBM) caused mainly by *Fusarium mangiferae* is a major constraint in mango production worldwide. In South Africa, MBM control practices have yielded variable results. In Israel frequent applications of Prochloraz and cultural practices have had a positive effect on reducing the disease. In this study the effect of applying different products in combination with standard control practices on disease incidence is evaluated. The trial is conducted in a ‘Kent’ orchard with a known history of MBM. The trial began in July 2012, with 11 treatments applied monthly until end of flowering, and commenced again in 2013 at flower initiation. Evaluations and ratings of the number of malformed flowers removed from each data tree were recorded. Flowering was irregular during the early evaluations with the growth regulator, Cultar, which had an effect on early flower induction. A Team also showed increased early flowering. At the final evaluation, Cultar had the highest rating and Carbendazid the lowest. Only three of the treatments, the Brilliant/Bion treatment, Eco 77 and Carbendazid, yielded less malformed flowers than the control. The rest of the treatments had more malformed flowers than the control. Prochloraz did not lower the incidence of the disease as experienced in Israel, which may be due to the lower frequency of applications than those applied in Israel. The effect of Eco 77 is encouraging. The large variation between replicates resulted in no statistical variation between treatments but early flowering induced by Cultar resulted in the highest mean yield despite the highest incidence of malformed flowers. The effects of the different treatments on MBM incidence should be clearer after harvest and the next season’s evaluation.

OBJECTIVES
To determine the efficacy of different products in combination with good orchard practices to control mango blossom malformation.

INTRODUCTION
Mango blossom malformation (MBM) caused mainly by *Fusarium mangiferae* (Britz et al., 2002) is becoming a major constraint in mango production in South Africa as well as other mango producing countries. The importance of mango malformation in South Africa was highlighted by Kotze in 1983 and new projects to control the disease have recently been initiated. In Senegal it is feared that MBM can possibly decimate the mango production within three years (Sylla, 2010).

Many efforts have been made to control the disease, including the use of plant growth regulators, management through de-blossoming, the application of nutrients, pruning of malformed parts, management with insecticides and fungicides, and the use of bio-pesticides (Kumar et al., 2011), all of which yielded variable results. Attempts in South Africa to control the disease with fungicides have also yielded variable results (Diekman et al., 1982; Lonsdale & Kotze, 1993). It is therefore important that studies relating to MBM will not be conducted with a silver bullet approach, but that success will depend on a coordinated effort with studies spanning at least 3 to 5 years (Rijkenberg, 1983). According to Iqbal et al. (2010) and Muhammad et al. (1999), fungicides such as Benlate and Topsin show potential in the control of *F. mangiferae*. In Israel, frequent applications of Prochloraz in combination with cultural practices like de-blossoming, do have a positive effect on lowering the disease incidence (Dr Stanley Freeman, personal communication). In this project the effect of applying different products in combination with standard control practices on disease incidence is evaluated.
MATERIALS AND METHODS
The trial is conducted in a ‘Kent’ orchard at Bavaria Estates, Hoedspruit, with a known history of MBM. A strict physical control program, which includes regular removal of malformed flowers and pruning, is being followed in the orchard. The trial consists of eleven treatments, applied to three-tree-plots, of which the middle tree served as data tree, and replicated 5 times in a randomised block design. Treatments are depicted in Table 1. Season one’s treatments commenced in July 2012 (16/07/2012, 03/08/2012 and 19/10/2012) and continued during the flowering season (season two) from April to October in which five applications were applied (approximately monthly). Cultar was applied once per season. An organic silicate penetrant/adjuvant, Link, was applied in combination with treatments 2, 4, 6, 7, 9 and 10 during the first season.

Evaluations were done by counting the number of malformed flowers removed from each data tree during each commercial de-blossoming by the producer. The first removal of malformed flowers was done on 25/05/2013, followed by removal on 5/08/2013, 2/09/2013 and 26/09/2013. The mean malformed flowers were determined. During each evaluation the number of flowers for each data tree were rated on a scale of 0 to 3; where 0 is regarded as no flowers present at evaluation and 3 is regarded as the maximum flower presence at evaluation interval. The cumulative mean ratings were calculated.

The number of fruit per data tree was determined at harvest and the mean yield per tree per treatment calculated and subjected to statistical analysis (ANOVA and Tukey (HSD) – analysis of the differences between the categories with a confidence interval of 95%).

RESULTS
Flowering was irregular during the early evaluations (Fig.1) with the growth regulator, Cultar, clearly having an effect on early flowering. The A Team experimental fungicide also showed increased early flowering.

![Figure 1. Mean number of malformed flowers of the different treatments after two evaluations as well as the mean cumulative flower rating.](image1)

![Figure 2. Mean number of malformed flowers of the different treatments after four evaluations as well as the mean cumulative flower rating.](image2)

<table>
<thead>
<tr>
<th>Treatment No.</th>
<th>Treatment</th>
<th>Active Method</th>
<th>Method</th>
<th>Application (g or ml/100 L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Control</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>Brilliant + Bion 50WG + Foliar complex</td>
<td>Ammonium phosphonate + Acibenzolar-S-methyl Soil Foliar</td>
<td>240 + 12.5 + 67</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Cultar</td>
<td>Paclobutrazol (year 1) Soil Foliar</td>
<td>16 ml/500 ml/tree 8 ml/500 ml/tree</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Folicur 250EW + Link</td>
<td>Tebuconazole Soil Foliar</td>
<td>20 + 50</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Eco 77</td>
<td>Trichoderma harzianum B77 Foliar</td>
<td>37.5</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>A Team + Link</td>
<td>Experimental fungicide mixture Soil Foliar</td>
<td>7.5 + 50</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Prosario 250EC + Link</td>
<td>Prothioconazole + Tebuconazole Soil Foliar</td>
<td>7.5 + 50</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Comcat + Anngro + Zumsil</td>
<td>Plant extract + carrier + monosilic acid Foliar</td>
<td>9.7 + 3 + 25</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Carbendazid + Link</td>
<td>Carbendazim Soil Foliar</td>
<td>50 + 50</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Chronos + Link</td>
<td>Prochloraz Soil Foliar</td>
<td>25 + 50</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Breakdown All</td>
<td>Eliments Soil Foliar</td>
<td>27</td>
<td></td>
</tr>
</tbody>
</table>
After the second evaluation, the Brilliant/Bion treatment had the least malformed flowers removed, followed by the Folicur, Eco 77 and Carbendazid. The rest of the treatments had more malformed flowers than the untreated control. It must, however, be noted that the untreated control also had the lowest mean yield per tree of all the treatments (Fig. 1).

After the fourth evaluation, the mean cumulative flower rating did level out considerably with Cultar remaining the highest rating and Carbendazid the lowest (Fig. 2). Only three of the treatments, the Brilliant/Bion treatment (42% less than the control), Eco 77 (30% less than the control) and Carbendazid (11% less than the control) yielded less malformed flowers than the control. The rest of the treatments had more malformed flowers than the control, with the Cultar treatment having 46% more malformed flowers.

The mean yield per treatment is depicted in Table 2. No statistical differences were found between the treatments as a result of variation between replicates. The Cultar treatment, however, yielded the highest mean number of fruit per tree (29.8) and the control treatment, with an average of 8 fruits, the lowest. Of the treated plots, the Brilliant/Bion/Foliar Complex yielded the lowest mean number of fruit (13) per tree. The rest yielded between 16 and 20 fruit per tree.

**CONCLUSION**

The results of this study indicate that the combination treatments of Brilliant and Bion lowered the incidence of MBM by more than 40%. However, of the treatments, it is also the treatment with the lowest mean yield per tree of the treated plots. Eco 77 was the only other product that lowered the presence of malformed flowers. Most of the other treatments increased the disease incidence. Cultar increased the early onset of flowering and also had the highest mean flowering rating. This treatment also had the highest incidence of MBM but also the highest yield. In recent years, the season with the highest yield also had the highest incidence of MBM on Bavaria Estates (Dr. Johan du Preez, personal communication).

At early evaluations, A Team also showed an increase in flowering, probably as a result of the azyoxystrobin in the formulation. Besides the fungicidal effect of strobilurins, the fungicide group also has an influence on plant physiology. Prochloraz did not have the desired effect on lowering the incidence of the disease as experienced in Israel. However, the frequency of applications was much less than those applied in Israel. Besides spray periods, the infection periods and therefore the timing of applications may also differ between winter rainfall production areas like Israel and the South African Lowveld. The effect of Eco 77 is encouraging and confirms the observation by a Clanwilliam based producer that found another *Trichoderma* based product to have a limiting effect on MBM (Bernie van den Hever, personal communication).

Although these are preliminary results and the real impact will only be noted during the coming flowering season, the following findings are important:

- Chemical flower manipulation to promote early flowering seems to increase both the incidence of MBM and yield. The balance between the cost of removing malformed flowers and increase in yield will determine the use of this method of control.
- Products that lower the incidence of MBM as a result of induced resistance do not necessarily increase yield, as the case with the Bion/Brilliant treatment. The Comcat/Anngro/Zumsil treatment did not lower MBM incidence but also had lower yield than most treatments. The effect of systemic resistance inducing substances needs further evaluation.
- The lowering of MBM incidence in Eco 77 treated plots is encouraging as the incidence was lower than that of any of the conventional chemical treatments.
- In this trial, conventional chemicals thus far did not control MBM as well as expected. The effect may differ after the next season’s evaluation.

From these preliminary results it is suggested that the integrated control of MBM should include:

- Continuous removal of malformed flowers – at least three to four times per season.
- Implementation of measures (chemical and other) to promote the onset of early flowering.
- Chemical sanitation of trees with sprays of a disinfectant like Sporekill to lower the inoculum (not included in this trial) followed by an application with
• Evaluation of the inclusion of Bion/Brilliant in the above programme.
• Further evaluation of chemicals - type and timing – for the control of the disease.
• Including weather prediction during flowering for the timing of Sporekill and Eco 77 application.

REFERENCES