Assessment of spray application of mono-potassium phosphate as a non-chemical measure to control powdery mildew (*Oidium mangiferae*) in mango inflorescences

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ABSTRACT

MKP (mono-potassium phosphate) has been found to be effective in suppressing powdery mildew in mango inflorescences. Use in combination with surfactants and the effect in relation to the stage of inflorescence development has not been assessed. MKP is a phosphate-potassium salt, and thus represents a non-fungicidal measure to control the disease. In the current study, MKP as a control measure for powdery mildew was evaluated with respect to stage of inflorescence development (commencement of bloom or full-bloom), MKP concentration, and the inclusion of a surfactant (Sanawett). Two trials were carried out. In the first, 2% MKP/Sanawett (20 ml per 100 l water) application was most effective and as effective in controlling the disease as Folicur/Sanawett (20 ml of each per 100 l water) when application was made at the commencement anthesis. Here the inclusion of a surfactant was indicated to increase the efficacy of MKP in controlling powdery mildew. In comparing application at three rates (1, 1.5 or 2% w/v) at two stages of inflorescence development (commencement of anthesis or 80% bloom, second experiment), application at the commencement of anthesis, as opposed during bloom when symptoms were becoming apparent, was superior. Here, 1.5 and 2% MKP application were equally effective in controlling the disease, and as effective in this regard as Folicur spraying. Fruits set and degree of inflorescence colonization were generally negatively correlated. The results clearly show that MKP is an effective control measure of powdery mildew in mango, particularly when applied at 1.5 or 2% with surfactant, and at the commencement of anthesis.

Sanawett: Alkylated phenolethlene oxide condensate 940 g/l.
MKP: KH_2PO_4, a potassium phosphate salt

INTRODUCTION

Powdery mildew in mango, caused by *Oidium mangiferae*, readily colonizes the inflorescences, reducing fruit-set (Schoeman, 1996). The fungus also colonizes developing leaves and young fruits. During initial colonization, small isolated patches of powdery white mycelium appear. These later coalesce, this resulting in general coverage (**Figure 1**). Research results suggest that inflorescences become susceptible from the time of anthesis commencement (Schoeman, 1996). Preventative fungicide spraying, prior to this stage, is generally recommended.

Figure 1. Powdery mildew colonized Kent inflorescences.

Oosthuyse (1998) previously found that mono-potassium phosphate (MKP) was effective in suppressing powdery mildew in mango inflorescences. MKP is a phosphate salt, and thus represents a non-fungicidal measure to control the disease. Control was not as effective as fungicide spraying. However, surfactants were not included in the study, and particular attention was not paid to the effect as it relates to the stage of inflorescence development when powdery mildew colonization is generally observed. Powdery mildew colonization generally becomes noticeable once the inflorescences are in bloom (personal observation). MKP application when colonization commences, as opposed to earlier application, when anthesis commences, may be more effective in controlling the disease if MKP's effect is direct and not prolonged. Fungicide sprays are recommended when the inflorescences commence bloom. Folicur (tebuconazole) is a fungicide used widely by growers in South Africa to control the disease, and is applied prior to the commencement of anthesis.

Ruveni and Ruveni (1995 a, b) also demonstrated powdery mildew suppression in mango inflorescences following MKP application, as well as efficacy of MKP in controlling powdery mildew in wine grapes.

In the current study, MKP as a control measure for powdery mildew in mango inflorescences, was evaluated with respect to the stage of inflorescence development (commencement of bloom or 80% bloom), MKP concentration, and the inclusion of a surfactant.

MATERIALS AND METHODS

Experiment I (Rate of application, inclusion of surfactant)

In early July 2006, 70 high trees were selected in each of two commercial, nine-year-old orchard blocks, a Tommy Atkins and a Kent block, and were marked in accordance with the experiment design. The same procedures were followed in each orchard block. The blocks were on HortResearch SA's research farm Lushof, close to Tzaneen. Ten inflorescence bearing terminal shoots were labeled per tree. Data regarding the extent of mildew colonization and fruits set per inflorescence were collected from these inflorescences. The sprays were carried out on July 17, 2006, when the inflorescences were commencing bloom. The trees were sprayed to run-off during the early morning (before 10 am), when the evaporative demand was reduced. MKP was applied at 1% in the absence of surfactant, or at 0.5, 1, or 2% with surfactant. The surfactant Sanawett was applied at the rate of 20 ml per 100 l. The treatments, Folicur (tebuconizole)/Sanawett, or 1% MKP/Folicur/Sanawett, were also included. Folicur was applied at the commercial rate of 20 ml per 100 l water. In each block there were 10 single-tree replicates of seven treatments (including control) in a Randomized Complete Blocks design.

Data regarding the extent of mildew colonization was collected just after full-bloom when small fruitlets could be seen on the flower axils (August 1 and 2, 2006). In each inflorescence, the extent of powdery mildew inflorescence colonization was rated as follows. A rating of "0" was given if mildew was absent, a rating of "1" if isolated symptoms were apparent, a rating of "2" if approximately 1/3 of the inflorescence tissue was visibly affected, a rating "3" if approximately 2/3 of the inflorescence tissue was visibly affected, and a rating of "4" if the inflorescences showed general colonization. The number of healthy set fruits per inflorescence was counted on August 7 and 8, 2006.

The data (tree averages) were subjected to Analysis of Variance. Mean separation was based on the 5% least significant difference (LSD) criterion.

Experiment II (Stage of inflorescence development)

On July 6, 2006, 10 adjacent trees were used in each of three bearing orchard blocks; a Kent, Keitt and Tommy Atkins block. The blocks were on HortResearch SA's research farm at Lushof, Tzaneen. In each tree-set, the same procedures were followed. Eighty two inflorescences bearing terminal shoots were subsequently labeled (July 12, 2006). Care was taken to ensure that the stage of inflorescence development was very similar in each shoot. All were extending, and were between 8 and 15 cm in length. When bloom was commencing (July 20, 2006) or when the inflorescences showed approximately 80% bloom (July 27 and 28, 2006), MKP was spray applied at the rates of 1, 1.5 or 2% (w/v). Inflorescences sprayed with Folicur at 20 ml per 100 l water when bloom was commencing, served as controls. In all the treatments, the surfactant Sanawett was used and applied at the rate of 20 ml per 100 l water. The inflorescences were sprayed thoroughly with a knapsack sprayer. Spraying was carried out prior to 10 am in the morning when the evaporative demand was reduced. There were 12 replicates of seven treatments in a Randomized Complete Blocks design.

On August 3 and 4, 2006, the extent to which powdery mildew had colonized each inflorescence was estimated in terms of a percentage. At this stage small fruitlets could be seen in the flower axils. The number of healthy fruits on each inflorescence was counted on August 9 and 10, 2006. Counts were done just prior to the period of fruit drop. Inflorescence blight was not evident at the time of counting.

The data were subjected to analysis of variance. Mean separation was based on the 5% least significant difference (LSD) criterion.

RESULTS

Experiment I

In considering the averages (**Table 1**), 2% MKP/Sanawett was apparently most effective in controlling powdery mildew in both the Tommy Atkins and Kent inflorescences, and as effective in this regard as the sprays containing Folicur. 1% application was not indicted to be inferior regarding control, however. In Tommy Atkins, 0.5% MKP/Sanawett was more effective in reducing colonization than 1% MKP, indicating increased efficacy as a result of the inclusion of the surfactant. The inclusion of Folicur with 1% MKP/Sanawett did not result in better control than 1% MKP/Sanawett. Number of fruits set per inflorescence bore no clear relationship with degree of colonization. In Tommy Atkins, greatest set was associated with reduced colonization. However in Kent, a relationship with fruit set was not apparent. It is noted, however, that blight, another inflorescence disease (*Botryodiplodia theobromae*), affected numbers of inflorescences and portions of the inflorescences during the period after full-boom and before fruit counts were made. This disease reduces fruit set, causing fruitlet desiccation.

The results clearly suggest that 1% or 2% MKP when applied with a surfactant is as effective as the commercial Folicur application in controlling powdery mildew.

Table 1. Powdery mildew severity (rating) and number of fruits set per inflorescence in Tommy Atkins and Kent. Means separated by differing letters differ according to the 5% LSD criterion.

Treatment	Tommy Atkins		Kent	
	Mildew severity	Fruits set	Mildew severity	Fruits set
Untreated control	0.68a	7.18abc	1.39d	2.20a
1% MKP	0.56a	5.48a	1.20cd	2.44a
0.5% MKP/Sanawett	0.29b	5,85a	1.13bc	2.58a
1% MKP/Sanawett	0.31b	8,24de	0.99abc	2.92a
2% MKP/Sanawett	0.11b	6.13ab	0.82a	2.02a
Folicur/Sanawett	0.29b	10.20e	0.87a	2.49a
1% MKP/Folicur/Sanawett	0.21b	7.87bc	0.92ab	3.20a
P treat <	0.001	0.001	0.001	0.57

Experiment II

Bloom spraying was carried out when signs of powdery mildew colonization were apparent. In all of the varieties, MKP application at the commencement of anthesis was generally more effective in controlling powdery mildew than bloom application (**Table 2**). MKP applied at 1.5 or 2% at the start of flowering was highly effective, and as effective as Folicur applied at the same stage in controlling the disease. Application at 1.5 or 2% resulted in best control when considering bloom application only. 1% MKP application was consistently inferior to 1.5 or 2% application. Number of fruits set was generally a reflection of the degree of mildew colonization, the least affected inflorescences showing the greatest set. Number of fruits set following 1.5 or 2% application at the commencement of anthesis was not inferior to that following Folicur application at the same stage of inflorescence development.

DISCUSSION AND CONCLUSION

The results indicate the recommendation of 1.5 or 2% MKP application including a surfactant at the time of commencement of

Table 2. Powdery mildew colonization (%) and number of fruits set per inflorescence in Tommy Atkins, Kent and Keitt inflorescences. Means separated by differing letters differ according to the 5% LSD criterion.

	Tommy Atkins		Kent		Keitt	
Treatment	**% colonization**	**Fruits set**	**% colonization**	**Fruits set**	**% colonization**	**Fruits set**
Control (Folicur)	2.5a	7.9bc	0a	7.3c	0a	11.5c
Anthesis						
MKP 1%	17.5bc	7.6bc	10.0a	6.4bc	9.2bc	10.4bc
MKP 1.5%	10.0ab	8.7c	2.5ab	7.2c	5.0ab	11.02c
MKP 2%	4.2a	8.9c	5.0ab	6.7bc	4.2ab	10.5bc
Bloom						
MKP 1%	33.3d	5.2a	32.5d	4.3a	23.3d	7.5a
MKP 1.5%	16,7bc	6.7b	11.7bc	4.6a	13.3c	7.7a
MKP 2%	20.0c	7.0b	21.7cdc	5.9b	10.0bc	9.2ab
P treat <	0.01	0.01	0.01	0.01	0.01	0.01

anthesis to control powdery mildew in mango inflorescences. Application during bloom was also effective in suppressing the disease as indicated by differences in colonization extent relating to the concentration of MKP applied.

The mode of action of MKP inflorescence application in controlling powdery mildew has not been clarified. Efficacy prior to the appearance of powdery mildew symptoms indicates induced resistance. Alternatively, adherence of the salt on inflorescence tissue may prevent spores coming into contact with the inflorescence tissue from germinating. Ruveni and Ruveni (1995b) suggested the resulting formation of phosphonate within the tissue conferring resistance. It was also stated that whether phosphate alone, and/or phosphate and potassium are involved directly or through the plant tissue in suppressing or inhibiting the pathogen, is unclear.

In their study, Ruveni and Ruveni (1995b) concluded that the rapid absorption of phosphates by plant tissues and their mobility within tissues, as well as their low cost, low animal toxicity, comparative environmental safety and nutrient value, make them ideal foliar fertilizers that may have the added benefit of controlling disease.

In view of inflorescence blight also affecting mango inflorescences and there being no evidence for MKP suppressing or inhibiting this disease, it might be suggested that MKP be included as a mid-spray in mango inflorescence disease programmes. The results clearly indicate that MKP is an effective control measure of powdery mildew in mango.

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