# Mono Potassium Phosphate (MKP) as part of an Integrated Pest Management Program to Control Powdery Mildew

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## Abstract

PowderyMildew (***Oidium mangifera, Podosphaera leucotricha, Sphaerotheca pannosa, S fuliginea, Uncinula necator*** – and others) affects many crops around the world. Experiments have shown that MKP sprayed alone, as a tank mix or in alternation with fungicides have been successful in the control of powdery mildew in apples, vineyards, peaches, nectarines, greenhouse cucumbers, roses, melons and mangoes. In most cases, the conventional fungicide program may be cut by 50%. The action ofMKP as a biocompatible fungicide appears to be synergistic with that of the fungicide, often improving disease control. The method ofMKP application depends largely on the disease pressure and the crop to be sprayed. The benefits of incorporating MKP into a spray program include good disease control, reduced fungicide applications (cost effective), reduced fungicide residues on food crops, less fungicide resistance pressure, promotion of IPM and enhanced plant nutrition. This paper reviews information available regarding powdery mildew control on numerous crops around the world.

## Introduction

Mono Potassium Phosphate (MKP or $KH_2PO_4$) is a technically pure and concentrated water-soluble fertilizer containing 54% $P_2O_5$ and 34% $K_2O$. MKP is extensively used in hydroponics, fertigation and as foliar applications for plant nutrition of phosphate and potassium. In addition, the phytosanitary benefits of MKP as a biocompatible fungicide against powdery mildew, when applied as a foliar spray, has recently come to the fore. MKP is also used as a buffer additive to tank mixes of chemicals. The buffered pH of 4.5 prevents the rapid alkaline hydrolysis of certain chemical actives in high pH water

(Ankorion, 1996).

Stricter residue controls, a reduction of chemical usage demanded by consumers, tighter economic margins for farmers and resistance build-up of pathogens to fungicides has driven research into alternative methods of pathogen control using integrated pest management programs (IPM). IPM is a combination of crop protection practices, including chemicals, crop resistance, biological control and cultural practices, tomaintain pests and diseases below an economic threshold (Reuveni and Reuveni, 1998).

In South Africa, the **Integrated Production ofWine** is a compulsory points system that has been detailed by the South African Wine and Spirits Board. Points are allocated to producers according to cultural practices followed. These include chemical toxicity of the sprays used and numbers of sprays applied per crop. Marketing benefits are rewarded to producers who comply within the designated norms (Nietvoorbij Bulletin, 1994).



Spray practices that lead to less fungicide being used will score favourably on the points system.

**Phytosanitary effects ofMKP**

Notwithstanding the fact that optimal fertilization is important in IPM (Reuveni and Reuveni, 1998), phosphate salt foliar sprays have been shown to suppress and control various fungi causing powdery mildew such as ***Uncinula necator*** in vineyards (Reuveni and Reuveni, 1995a; Reuveni and Reuveni, 1995b; Reuveni et al., 1997; Latorre et al., 1998), ***Oidium mangifera*** in mangoes (Reuveni and Reuveni, 1995b; Oosthuyse, 1998; Reuveni et al., 1999), ***Podosphaera leucotricha*** in apples (Reuveni, M. et al., 1998), ***Sphaerotheca fuliginae*** in cucumbers (Reuveni et al., 1993; Reuveni et al., 1995; Reuveni et al., 1999), ***Sphaerotheca pannosa*** in nectarines (Reuveni and Reuveni 1995b), ***Erisiphe graminis*** in wheat (Sherchand and Paulsen, 1985), ***Leveillula taurica*** in peppers (Reuveni, R. et al., 1998) and various other crops as mentioned by Reuveni and Reuveni (1998) and Guohua (1998).

The decrease and inhibition of the pathogen appears to be either due to the phosphate alone or a combination of phosphate and potassium (Reuveni et al.,1995; Reuveni and Reuveni,1995b). The phosphate and potassium salts may have direct antifungal properties as microscopic observations showed a direct effect of phosphates on the collapsing and malformation of conidia and mycelia in ***S. fuliginae*** in cucumbers (Reuveni et al., 1995; Reuveni and Reuveni, 1998) and on ***L. taurica*** in peppers (Reuveni, R. et al., 1998). Furthermore, the authors reported that the action of the phosphate and potassium salts might be as a result of systemic induced resistance (SIR) within plants to powdery mildew infection.

In earlier work, Reuveni et al. (1993) showed that spraying the upper surface of the first true leaf of cucumbers 2 hours before inoculation induced SIR against powdery mildew in leaves 2 and 3 lower down. SIR, as noted against ***S. fuliginae*** in cucumbers and against ***Exserohiliumm turcicum*** and ***Puccinia sorghi*** in maize, is rapid and evidence points to the release of an ‘existing active signal’ which activates the defense mechanism throughout the plant (Reuveni and Reuveni, 1998). The resulting improved growth of the cucumbers as reported by Reuveni et al (1993) was probably due to increases in soluble carbohydrates and photosynthesis rates due to SIR against the pathogens.

In vines, where powdery mildew infection drastically reduces berry weight, peroxidase activity within the soluble fraction and the ionically bound fractions of berry skins appears to be a marker for powdery mildew resistance. Although not clearly understood, the increases in peroxidase activity with phosphate salt treatments, also indicates a possible active role of phosphates in the defense mechanism against powdery mildew (Reuveni and Reuveni, 1995a).

**Efficacy ofMKP as a Bio-compatible Fungicide**

Figure 1 shows that phosphate sprays alone (sprayed fortnightly from 10cm shoot length - 7 sprays) were effective in controlling powderymildew when compared to a control and

3

systemic fungicides alone (Reuveni and Reuveni, 1995a). However, at the last rating, the fungicide treatment proved more beneficial than the simple phosphate compounds. The authors conclude that the two weekly intervals between phosphate sprays were too long at this stage.

A 50% reduction of the fungicide used by alternating myclobutinal with a phosphate salt gives better control than the phosphate salt alone in nectarines (Reuveni and Reuveni, 1995b – data not shown). Figure 2 (Reuveni and Reuveni, 1995b) shows that alternate phosphate and myclobutinal treatments (three sprays each) were as effective in controlling powdery mildew in nectarines as the myclobutinal treatment alone.

0

0.5

1

1.5

2

2.5

3

3.5

**Disease severity 0- 4**

1 2 3

**Rating time**

**Figure 1: The Efficacy of Phosphate Salt Sprays on Powdery Mildew In Vines**

Control KH2PO4 K2HPO4

Dorado Penconazole Benomyl

a

b b b b b

a

b b b b b

a

b

c

d

0

0.5

1

1.5

2

2.5

**Disease severity**

**0- 4**

Control Alt. Myclob.

**Treatment**

**Figure 2: Alternation of Phosphates with**

**Fungicide in the Control of Powdery Mildew**

leaves

fruits

a

a

b b b b

4

The application of systemic fungicides only created by omitting the MKP out of the fungicide/MKP alternation treatment, in both mangoes and apples, resulted in poorer disease control than the MKP treatment alone or the alternation treatment. This indicates the significant role of the phosphate salt in disease control enabling reduced fungicide applications by as much as 50% (Reuveni, M. et al., 1998; Reuveni et al., 1999).

Oosthuyse (1998) found very good control of ***O. mangifera*** in both Kent and Tommy Atkins mangoes using tank mixes of 0.5% MKP and ¼ strength commercial fungicides when compared to the control,MKP alone or Bayfidan alone (figure 3).

**Figure 3: Proportion of Inflorescences Showing Powdery Mildew Colonization in Tommy Atkins (sig. 5%). From Oosthuyse (1998).**

**Percentage of infected inflorescences**

**Tankmix Treatment**

The degree or severity of colonization was also effectively controlled in both varieties using the same treatments (Oosthuyse, 1998 – data not shown).

Reuveni et al. (1999) confirmed that tank mix treatments with 1% MKP and commercial rates of a sterol inhibitor or 1% MKP with commercial rates of strobilurin Kresoxymmethyl (strobi) were the most effective in controlling ***O. mangiferae*** (>95% control).

The same research shows that a tank mix of 1% MKP with the same fungicides at half strength produced as good control as normal commercial fungicide practices in mangoes.

A probable synergy or additive effect between the fungicide and the phosphate salt needs to be explored in more detail (Reuveni et al., 1999). Yield increases were greater in all treatments against the control as a result of less powdery mildew infection of the flowers.

In apples, trials against powderymildew show that reducing fungicides by 50%, either by alternating 1% MKP with systemic fungicides or by tank mixes of 1% MKP with fungicides at half strength, were as effective as commercial systemic fungicide practices

Unsprayed Punch/MKP Folecur/MKP Wsulf/MKP

MKP Benlate/MKP Omega/MKP Bayfidan

35

25

15

5

a

b

b b b b b b

5

(Reuveni,M. et al., 1998). In work done by Wilcox (1997) on apples, no russeting or phytotoxicity was noted with the 6 full cover sprays of the MKP (0.9%) and Captan tank mix (Ankorion – personal communication). Other benefits ofMKP sprayed during the early development of the apple fruit are reduced incidence of senescent breakdown, core flush and superficial scald during storage (Yogaratnam and Sharples, 1982).

Effective results against powdery mildew in vines using 1% MKP in alternation with systemic fungicides or by using MKP at 0.5 and 1% as a tank mix with fungicides, at full and at half strength, have also been reported by Latorre et al. (1998). The authors noted that the last application in the pink stage (7-11ºBix) caused the berries to lose their natural appearance probably due to a partial loss of surface waxes. This would deem the late application unsuitable for table grapes. The maturity of the berries was, however, unaffected by late applications (Latorre et al., 1998). According to Reuveni and Reuveni (1995a) juice quality of wine grapes, as measured by pH, ºBrix and total acids, were similar for all treatments although the cluster weight was significantly greater where powdery mildew control was effective.

The decision to use either a MKP and fungicide tank mix or to use MKP in alternation with fungicides is based on the severity of the infection period and the length of the crop susceptibility. Usually, tank mix treatments are recommended when the period of crop susceptibility is short-lived and critical, such as the flowering time in mango. Alternation treatments are usually preferred when a plant or crop is susceptible to a relatively low infection pressure over a long period of time, for example in apples, vines, roses and cucumbers (Ankorion – personal communication). In many experiments, the application of the adjuvant Tween 20 improved results by aiding the retention of phosphate ions on the leaf surface and by aiding stomatal penetration (Reuveni and Reuveni, 1998).

**Conclusion**

MKP used as a tank mix or in alternation with a conventional powdery mildew fungicide shows efficacy as good as and sometimes better than conventional commercial fungicides alone.

Where consumers are demanding less fungicide usage, where integrated pest management (IPM) is sought after, where pathogen resistance to chemicals is increasing and where economic pressures force growers to reduce input costs, the use ofMKP as a nutrient and as a biocompatible fungicide makes economic, marketing and phytosanitary sense.

MKP has recently been registered as a fungicide in the USA (Ankorion – personal communication. Mineag SQM Africa (Pty) Ltd is currently undertaking trials for registration in South Africa.



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