J. Agric. Sci. Mansoura Univ., 28 (9):7043 - 7049, 2003

EFFECTIVENESS OF FOLIAR SPRAYING WITH PHOSPHATE SALTS FERTILIZER, SODIUM BICARBONATE AND A FUNGICIDE FOR CONTROLLING POWDERY MILDEW DISEASE OF GRAPEVINE

Mahrous, H. A. H.
Plant Pathology Research Institute, Agricultural Research Center, Giza.

ABSTRACT

Two field trials on 8 years old grapevines, cv. Ruby seedless (highly susceptible cultivar) were conducted at El-Menyia Governorate, Egypt. In these trials, the grapevines were sprayed with two phosphatic salts solutions (25 mM of K_2HPO_4 "pH 9.3") and 40 mM of KH_2PO_4 + KOH "pH 9.3", sodium bicarbonate at 0.5%. Also, an alternate treatment of phosphates with the systemic fungicide (Topas 10% at the rate of 10 cm^3/100 liter water (LW). and commercial systemic fungicide (Topas 10% at the rate of 10 cm^3/100 L.W.) were used. The above mentioned treatments were applied at 14 days intervals during the growing season starting at 10-15 cm shoot length on 15 march till veraison stage (the beginning of ripening) in order to control powdery mildew disease.

The obtained results showed that the disease severity of powdery mildew was best reduced by using any of the used treatments compared with the untreated grapevines. Also, the produced fruit yield from treated vines was significantly higher during the first and the second season if compared with that of the untreated vines.

Keywords: Ruby seedless; foliar spraying; sodium bicarbonate; disease severity; systemic fungicide.

INTRODUCTION

Grapevine (*vitis vinifera* L.) is the leading fruit crop all over the world. In Egypt, grapevine occupies the second rank among fruit crops after citrus. However, the cultivated area was about 141233 feddans with an average production of 1009563 tons (Anonymous 2000).

Under the Egyptian environmental conditions, several diseases attack grapevine, in which powdery and downy mildews and fruit rot diseases are of great economic importance.

Powdery mildew disease is a widely distributed and destructive of vineyards in Egypt. So, it is an important disease of grapevines.

Grapevine cluster and blossom infection with *Uncinula necator* (Schw) Burr before, during or shortly after bloom may result in poor fruit set and quality, and considerable crop loss. (Bulit and Lafon, 1978; Pearson, 1988; Ouge and Berg, 1979).

Disease control is generally achieved by the use of chemical fungicides, including sulfur and sterol bio – synthesis inhibitors. However, fungicide – resistant races of powdery mildew pathogens have been reported on cucumber and grapevines (Schroeder and Provvidenti, 1969; Schepers, 1983; Steva and Clerjeau, 1990; Mc Grath, 1991). Once resistant strains appeared, most of them survived for several years, therefore the risk of re–

enhancing a resistant population with further applications of ineffective fungicides is very high (Dekker, 1987). The need for reducing pesticide levels on food crops, pressures to maintain a healthy environment and often the unavailability of commercially acceptable resistant plants intensify the need for alternative methods for disease control. One of the potential methods of reducing the severity of powdery mildew in an environmentally safe manner is the use of inorganic salts like sodium bicarbonate (Chernyak, 1979; Homma *et al*., 1981; Horst *et al*., 1992 and Ziv and Zitter, 1992) or foliar sprays with potassium silicate (Bowen *et al*., 1992 and Menzies *et al*., 1992) as biocompatible fungicides.

A previous study demonstrated the effectiveness of phosphate salts in inducing local and systemic protection against powdery mildew, in suppressing the disease on cucumber plants (Agapov *et al.*, 1993 and Reuveni *et al.*, 1993) and in controlling powdery mildew on grapevines (Reuveni and Reuveni, 1993)

These findings encouraged to evaluate further the potential use and the efficiency of foliar sprays of two phosphate salt solutions for controlling powdery mildew in vineyards.

MATERIALS AND METHODS

A field trial was conducted in two successive seasons (2000 and 2001) on 8 years old cv. Ruby seedless commercial vineyard in El-Menyia Governorate, Egypt. Vines on this site were moderately vigorous, cordon – trained, super – pruned and planted on a spacing of 3 $\times$ 1.5 m. supported on double T shape.

Methods of fertilization, irrigation, canopy management and other cultural practices for grapevine were as recommended to commercial vineyard in this region.

Six treatments concerning a control (untreated), foliar applications with a systemic fungicide Topas100Ec (Penconazole) at the rate of 10cm^3/100 liter of water, two phosphate salts, 25 mM of K_2 HPO_4 (PH 9.3), 40 mM Solution of KH_2PO_4 + KOH (PH 9.3), sodium bicarbonate at the rate of 0.5% (500 g/100 liter of water), an alternate treatment of phosphates with fungicide, Topas at the rate of 10 cm^3/100L.w. The alternation treatment was sprayed three times with phosphates (40 mM KH_2PO_4+KOH) and four times with Penconazole (Topas 100Ec).

All treatments plus triton (B 1956) at the rate of 25 cm^3/100L.W and the foliar sprays were applied 14 days intervals during the growing season starting at 10-12 cm shoot length on 15 March until fruit clusters at veraison stage (the beginning of ripening) and were arranged in a randomized complete block design.

Assessment of Powdery Mildew disease:

For the assessment of powdery mildew, ten clusters of grapevine were randomly selected from each of the four center vines in each plot (120 clucters per treatment) and rated for disease severity. The scale proposed by

Reuveni and Reuveni (1995) was used to determine disease severity of powdery mildew on clusters as follows:
(0)=no powdery mildew colonies were observed on tissue clusters, (1) =1-10%, (2)=11-25%, (3) = 25-50%, (4) = > 50% of the selected clusters infected with powdery mildew. The fungicidal efficiency was calculated according to the following formula (Mahrous, 2001):

$$\% \text{ Efficiency} = \frac{\% \text{ Infection in the control} - \% \text{ infection in the treatment}}{\% \text{ Infection in the control}} \times 100$$

To evaluate the yield, four randomly selected vines from each replicate in each treatment were hand harvested and yield obtained by taking cluster weight per vine. The analysis of variance was performed to analyze the data, and the significance among mean treatments was determined according to Duncan's Multiple Range Test.

RESULTS

Symptoms of powdery mildew on grapevines were initially observed only on berries of untreated control vines. Data presented in table (1) indicate that applications of K_2HPO_4, KH_2PO_4 plus KOH (ph9.3 and Topas, as well as $NaHCO_3$ and alternating sprays of fungicide and phosphate inhibited disease development.

Table (1): Effect of foliar sprays with phosphate salts, sodium bicarbonate and a fungicide on powdery mildew disease severity and yield of grapevine (Season, 2000).

Treatments	Disease severity %	Efficiency %	Yield/vine (kg)	Weight of cluster (g)
Control (Untreated)	32.37[a]		6.67[f]	190.5
K_2HPO_4 (pH 9.3) 25 mML.W. (435.5 g/100LW)	2.95[e]	90.89	13.62[b]	389.14
KH_2PO_4+KOH 40 cm^3/ 100 L.W	3.17[d]	90.21	12.60[c]	360.00
Topas, 200Ec	2.73[e]	91.57	14.89[a]	425.43
Alternation (KH_2PO_4+KOH and Topas	3.37[c]	89.59	12.25[d]	350.00
Sodium bicarbonate (500g/ 100 LW)	5.67[b]	82.48	10.800[e]	308.57

a,b,c Values in the same column with different superscripts differed significantly at P<0.05.

The disease severity of powdery mildew on grapevine clusters was 2.73, 2.95, 3.17, 3.37, 5.67 and 32.37% for Topas, K_2HPO_4, KH_2PO_4 + KOH, KH_2PO_4 + KOH and Topas, sodium bicarbonate and the control, respectively in the first season (2000).

Powdery mildew infection remarkably reduced the weight of (untreated) control clusters if compared with Topas, phosphate salts and Sodium bicarbonate Data presented in Table (1) show that the average weights of clusters harvested from vines treated with Topas, K_2HPO_4, KH_2PO_4 + KOH, alternation treatment with KH_2PO_4 + KOH and Topas, Sodium bicarbonate and from untreated control vines were 14.89, 13.62, 12.60, 12.25, 10.80 and 6.61 kg, respectively in the first season.

Table (2): Effect of foliar sprays with phosphate salts, sodium bicarbonate and a fungicide on powdery mildew disease severity and yield of grapevine (Season 2001).

Treatments	Disease severity	Efficiency %	Yield/vine (kg)	Weight of cluster (g)
Control (Untreated)	40.77[a]		7.37[e]	210.57
K_2HPO_4 (pH 9.3) 25mM (435.5G/100L.W)	3.83[d]	90.58	14.13[b]	403.71
KH_2PO_4 + KOH 40 cm^3/ 100 L.W	4.05[c]	90.04	12.87[c]	367.71
Topas (Penconazole) 10 cm^3/100 L.W.	3.24[e]	92.03	15.33[a]	438.0
Alternation (KH_2PO_4 + KOH and Topas	4.18[c]	89.72	12.67[c]	362.00
Sodium bicarbonate (500g/100 L.W)	6.17[b]	85.88	11.49[d]	328.20

a,b,c Values in the same column with different superscripts differed significantly at P<0.05.

In the second season (2001), it is clear from the data in Table (2) that all treatments were in the same trend of the data obtained in the first season (Table 1).

The disease severity percentage of powdery mildew reached to 3.24, 3.83, 4.05, 4.18, 6.17 and 40.77% for K_2HPO_4, KH_2PO_4 + KOH, Topas, alternation treatment (KH_2PO_4 + KOH and Topas), sodium bicarbonate and the control, respectively.

During both seasons, the severity of powdery mildew disease was reduced significantly due to the effect of sprayed substances compared with the control.

The average weights of clusters harvested from vines treated with Topas 200EC, K_2HPO_4, KH_2PO_4 + KOH, alternation treatment (KH_2PO_4 + KOH and Topas), sodium bicarbonate and from untreated control vines were 15.33, 14.13, 12.87, 12.67, 11.49 and 7.37 kg/vine, respectively.

In general, the yield was increased in all treatments and accompanied with disease reduction.

DISCUSSION

This study demonstrated that simple compounds, such as K_2HPO_4 and KH_2PO_4 have a potential for controlling powdery mildew disease of grapevines. Evidently bi-weekly foliar applications of phosphates inhibited disease development on berries of grape vines and were active on this crop for controlling the causal organism. This confirms the previous findings on capability of phosphates in controlling powdery mildew of grapevines. (Reuveni and Reuveni, 1993) overall, foliar sprays of systemic fungicide was more effective than salt solutions in controlling powdery mildew.

Other inorganic salts which have biocompatible fungicidal potential include $NaHCO_3$, $KHCO_3$ and silicate salts. Sodium bicarbonate has been reported to control powdery mildew disease on various crops (Homma *at al*., 1981, Horst *et al*., 1992; Ziv and Zitter, 1992). A collapse of hyphal walls and shrinkage of conidia and conidiopores as a result of Potassium bicarbonate application has been observed (Homma *et al*., 1981). In addition, an inhibitory influence on conidial formation and germination of *Sphaerotheca fuliginia* has been reported (Homma *et al*., 1981). This might be explaining the inhibitory properties of phosphate salts used in this study and in suppression on *S.pannosa* var. *rosae* on roses (Reuveni *et al.*, 1994b). Application of silicon in combination with potassium and phosphates reduced the number of powdery mildew colonies on cucurbits and grape leaves (Bowen *et al*., 1992 and Menzies *et al.*, 1992). The obtained results by using foliar spray with phosphate salts in controlling the powdery mildew fungus has been clearly determined and are in the line with the previous reports. Phosphate salts might be ideal biocompatible fungicides due to their efficiency in suppressing and controlling powdery mildew on cucumber (Agapov and Reuveni, 1993 and Reuveni *et al.,* 1993). The rapid absorption of phosphate by the plant tissues and their extreme mobility within tissues, as well as their low cost, low animal toxicity, comparative environmental safety and their nutrient value, make them ideal foliar fertilizers which can be used for disease control. The usage of alternate phosphates with application of conventional fungicides for powdery mildew control would be more cost–effective than the use of fungicides alone, and reduce the development of fungicidal resistance during the season.

REFERENCES

Agapov, V.; M. Reuveni and R. Reuveni (1993). Eradication of cucumber powdery mildew by phosphate and potassium salts. Abstracts of Papers.6th Int. Cong. Plant Pathol. (Montreal, Canada). P214

Anonymous (2000). Annual report of Agric. statistical Dept. Egyptian Min. of Agric. A.R.E. (in Arabic).

Bowen, P.; J. Menzies; D. Ehret; L. Samuels and A.D.M. Glass (1992). Soluble silicon sprays inhibit powdery mildew development on grape leaves. J. Am. Soc. Hort. Sci., 117: 906 - 912

Bulit, J. and R. Lafon (1978). Powdery mildew of the vine. In The Powdery Mildew (Ed. by D.M. Spencer), pp. 525–548. Academic Press. New York

Chernyak- Ml .(1979) Against powdery mildew of peach, Zashchita–Rastenii., 3: 55.1.

Dekker, J. (1987). Build- up and persistence of fungicide resistance. In Rational Pesticide Use. (Ed. by E. J. Brend and E.K. Atkin) pp 153-168. Cambridge University Press. Cambridge. U.K.

Homma, Y.; Y. Arimoto and T. Misato (1981). Studies on the control of plant diseases by sodium bicarbonate formulation. 2. Effect of sodium bicarbonate on each growth stage of cucumber powdery mildew fungus (*Sphaerotheca fuliginea)* in its life cycle. J. Pestic. Sci., 6: 201-209.

Horst, R.K.; S.O. Kawamoto and L.L. Porter (1992). Effect of sodium bicarbonate and oils on the control of powdery mildew and black spot of roses. Plant Dis., 76: 247-251.

Mahrous, H.A.H. (2001). Biological control of grapevine powdery mildew by *Ampelomyces quiqualis.* Congr. Proc. 11th Congress of the Mediterranean Phytopathological Union, Evora, Portugal, 17-20 September.

McGrath, M.T. (1991). Reduced effectiveness of traidimefon of controlling cucurbit powdery mildew associated with fungicide resistance in *Sphaerotheca fuliginea. Phytopathology 81.* 1191 (Abstr.).

Menzies, J.; P. Bowen; D. Ehret and A.D.M. Glass (1992). Foliar applications of potassium silicate reduce severity of powdery mildew on cucumber, muskmelon. and zucchini squash. J. Am. Soc. Hort. Sci., 117:902 - 905.

Ouge, C.S. and H.W. Berg (1979). Powdery mildew sensory effect on wine. Am. J. Enol. Vitic., 30: 321

Pearson, R.C. (1988). Powdery mildew . In Compendium Diseases (Ed . by R.C. Pearson and A.C. Goheen) American Phytopathological Society. St. Paul. MN

Reuveni, M. and R. Reuveni (1993). Efficacy of phosphates in controlling powdrry mildew fungus on field-grown abstracts of papers 6 th. Int. cong. Plant pathol., Canada, p. 214

Reuveni, M. and R. Reuveni (1995). Foliar sprays of phosphates in controlling powdery mildews in field-grown nectarine, mango trees and grapevines . Crop Protection , 14:311-314

Reuveni, M.; V. Agapov and R. Reuveni (1993). In systemic resistance to powdery mildew and growth cucumber by phosphates. Biol. Agric. Hort., 9: 305-315

Reuveni, R.; M. Reuveni; V. Agapov and Raviv.(1994) Effects of foliar sprays of phosphates on roses powdery (*Sphaerotheca pannosa*). J. Phytopathol ., 142: 333-337

Schepers. H.T.A.A. (1983). Decreased sensitivity of *Funliginea* to fungicides which inhibit ergo sterol biosynthesis . Pl. Pathol., 89: 185-187.

Schroeder, W.T. and R. Prowidenti (1969). Resistance in Powdery mildew of cucurbits. Plant Dis. Rep., 53:27

Snedcor, G.W. (1956). Statistical Methods. 5th Ed Ames, Iowa, The Iowa State Univ. Press.

Steva, H. and M. Cherjeau (1990). Cross resistance biosynthesis inhibitor fungicides in strains Uncinula isolated in France and Portugal. Meded. Fac.L. Rijksuniv. Cent., 55: 983-988

Ziv, O. and T. A. Zitter (1992). Effects of bicarbonates and Film-forming polymers on cucurbit foliar diseases. Plant Dis., 76: 513-517

مدى فاعلية الرش الورقي بأملاح الفوسفات وبيكربونات الصوديوم والمبيد الفطري في مقاومة مرض البياض الدقيقي على العنب

حسين عبد القوي حسين محروس

معهد بحوث أمراض النباتات – مركز البحوث الزراعية – الجيزة.

أجريت تجربتين في الحقل على شجيرات عنب عمرها 8 سنوات صنف روبي سيدلس (صنف شديد الحساسية للإصابة) في محافظة المنيا – مصر. في هاتين التجربتين تم رش شجيرات العنب بمحلولين من أملاح الفوسفات بتركيز 25 ملليمول من ثنائي فوسفات البوتاسيوم ، 40 ملليمول من أحادى فوسفات البوتاسيوم مضافاً إليه أكسيد بوتاسيوم ، بيكربونات صوديوم بتركيز 5% ، معاملة بالتبادل بين أملاح الفوسفات والمبيد الفطري (توباس 10%) وأيضاً استخدام المبيد الفطري الجهازي توباس 10% بمعدل 10 سم^3/100 لتر ماء والمعاملات المذكورة بعاليه تم استخدامها كل 14 يوم خلال موسم النمو ابتداء من طول النمو الخضري من 10-15 سم في 15 مارس حتى مرحلة بداية النضج لمقاومة مرض البياض الدقيقي.

أظهرت النتائج المتحصل عليها أن شدة إصابة شجيرات العنب بالبياض الدقيقي قلت بدرجة كبيرة باستخدام أي من المعاملات المستخدمة إذا ما قورنت بشجيرات العنب غير المعاملة .

أيضاً أدت إلى زيادة معنوية في محصول الثمار المنتج من الشجيرات المعاملة بدرجة كبيرة في كل من الموسم الأول والثاني مقارنة بمحصول شجيرات العنب غير المعاملة.