Effect of potassium bicarbonate on the control of powdery mildew (*Sphaerotheca mors-uvae*) of gooseberry (*Ribes uva-crispa*)

M. Wenneker[1] and J.Kanne[1]

Abstract

*Powdery mildew (*Sphaerotheca mors-uvae*) severely infects young shoots, stems and fruits of gooseberry (*Ribes uva-crispa*). Environmental friendly and biological control measures are being sought throughout the world. Especially in organic gooseberry growing effective control measures are needed, because powdery mildew infections may result in a total loss of the crop. In a field trial the effect of potassium bicarbonate (Armicarb) on powdery mildew of gooseberry was evaluated. Four treatments; i.e. two preventive strategies and two curative strategies, were applied. Plants were sprayed until runoff. The percent of infected berries, shoots and disease severity were assessed. Very high disease incidences were observed in the untreated control. All potassium bicarbonate treatments significantly reduced the powdery mildew severity in leaves and fruits compared to the untreated controls. The preventive strategies were very successful. However, the number of spray applications was high.*

Keywords: alternative fungicides, Armicarb, biological control, small fruits, efficacy

Introduction

American gooseberry mildew (*Sphaerotheca mors-uvae*) attacks gooseberry and black currants causing serious infections, leading to reductions in yield unless adequate (fungicide) protection is given. The fungus appears as a white powdery growth on the young leaves, stem surfaces and berries. Powdery mildew infections may result in a significant reduction in marketable fruits. Fungicides to control mildew are generally applied routinely from early season until end of the shoot growing period. In organic currant growing the number of adequate control methods is very limited. Sulphur as a fungicide against powdery mildew in e.g. gooseberry or table grape growing is not recommendable due to possible bleaching of berries and scorching of tender shoots.

Various bicarbonate salts are suggested as a good option to control powdery mildew. Efficacy of bicarbonate against powdery mildew has been proven in various crops, including grape powdery mildew (*Uncinula necator*), Sawant & Sawant, 2008; cucumber, Homma *et al*., 1981, Zit & Zitter, 1992; rose powdery mildew (*Spaerotheca pannosa*), Horst *et al*., 1992; apple powdery mildew (*Podosphaera leucotricha*), Beresford *et al*., 1996. Bicarbonate salts are considered as good alternative control options, because they have fungicidal properties with a very low mammalian and environmental toxicity profile (Jamar *et al*., 2007). They are also common food additives. Efficacy of bicarbonates can be improved when bicarbonates are used in combination with horticultural oils (Horst *et al*., 1992). Formulated potassium bicarbonate (Armicarb) was more effective in the control of apple scab (*Venturia inequalis*) than bicarbonate alone (Jamar *et al*., 2007).

The objective of this study was to reduce powdery mildew incidences on gooseberry fruits and shoots with potassium bicarbonate (as Armicarb) spray applications.

[1] Marcel Wenneker, Applied Plant Research – section fruit, Wageningen University and Research Centre, P.O. Box 200, 6670 AE, Zetten, The Netherlands, marcel.wenneker@wur.nl

Material and Methods

The experiment was carried out in 2009 in a commercial gooseberry plantation at Udenhout, the Netherlands. The plantation was of gooseberry plants (cultivar Invicta), with a height of 90 cm. The experiment was done in a randomized block design with four replicates. Each replicate consisted of 5 plants. Observations were made on the central 3 plants. Spray applications were carried out with a knapsack sprayer (type Solo) and 1mm hollow cone nozzle. All sprayings were applied until run off.

The experiment consisted of the following treatments:

1) Non-treated control.
2) Armicarb (a.i. potassium bicarbonate 85%) – preventive scheme – dosage 0.50% (5 g/l); weekly spray application. First application 2nd of April 2009.
3) Armicarb (a.i. potassium bicarbonate 85%) – preventive scheme – dosage 0.25% (2.5 g/l); weekly spray application. First application 2nd of April 2009.
4) Armicarb (a.i. potassium bicarbonate 85%) – curative/preventive scheme – dosage 0.50% (5 g/l); this treatment was imposed when the first powdery mildew incidence was observed. First application 16th of April 2009; followed by a weekly spray application scheme.
5) Armicarb (a.i. potassium bicarbonate 85%) – curative scheme – dosage 0.50% (5.0 g/l). Spray application was carried out when mildew was visible, next spraying was carried out when new incidences were visible. First application 16th of April 2009; second application on 11th of May; followed by a weekly spray application scheme, due to the high disease pressure.

For treatment 2 as well as for treatment 3 in total 11 and 14 spray applications were applied until fruit and shoot disease assessments, respectively. So, equal numbers of applications were applied for these treatments. For treatment 4 in total 9 and 12 spray applications were applied until fruit and shoot disease assessments, respectively. For treatment 5 in total 6 and 9 spray applications were applied until fruit and shoot disease assessments, respectively. After the assessments the spray applications were continued weekly until the second week of July 2009.

Disease assessment

For the disease assessments on berries (17th of June 2009), plants were divided in two segments; i.e. from 0 – 60 cm above the ground and 60 – 90 cm. Berry infections were assessed by evaluating 40 berries per segment (= 80 berries per plant). The disease incidence per treatment was calculated from the overall count (as a percentage of diseased berries). Disease incidence on shoots was assessed on 6th of July 2009. Shoot infections were assessed by scoring the number of infected and healthy shoots per plant, and following as a rating (0 – 4, where 0 = no infection and 4 = very severe infection). The rating was used to calculate a severity index (Si). The Si = [(number of shoots in scale 0 x 0)+(number of shoots in scale 1 x 2)+(number of shoots in scale 2 x 3)+(number of shoots in scale 3 x 4)+(number of shoots in scale 4 x 50)]/total number of shoots.The mean disease incidence of all plants for each replicate was used for statistical analysis. All data were subjected to analysis of regression using GenStat Release 9.2 statistical package (Lawes Agricultural Trust, Rothamsted Research, UK). Effect of treatments was determined with ANOVA at a 0.05 probability level. Significant F-tests ($P< 0.05$) were followed by a Least Significant Difference (LSD)-test for pair wise comparison of treatment means using LSD0.05 values.

Results

In the unsprayed control plots very high disease incidences were observed; on average more than 90% of the berries were infected with powdery mildew (figure 1). The weekly (preventive) spray applications with potassium carbonate reduced the disease incidences on fruits significantly. On average approximately 10% of the fruits were affected by powdery mildew. In the lower segment of the plants higher disease incidences were observed compared to the higher segment (figure 2). There were no statistical significant differences between the 0.50% and 0.25% Armicarb dosages. The curative treatment (T5) was less successful. This treatment resulted in more than 30% affected fruits.

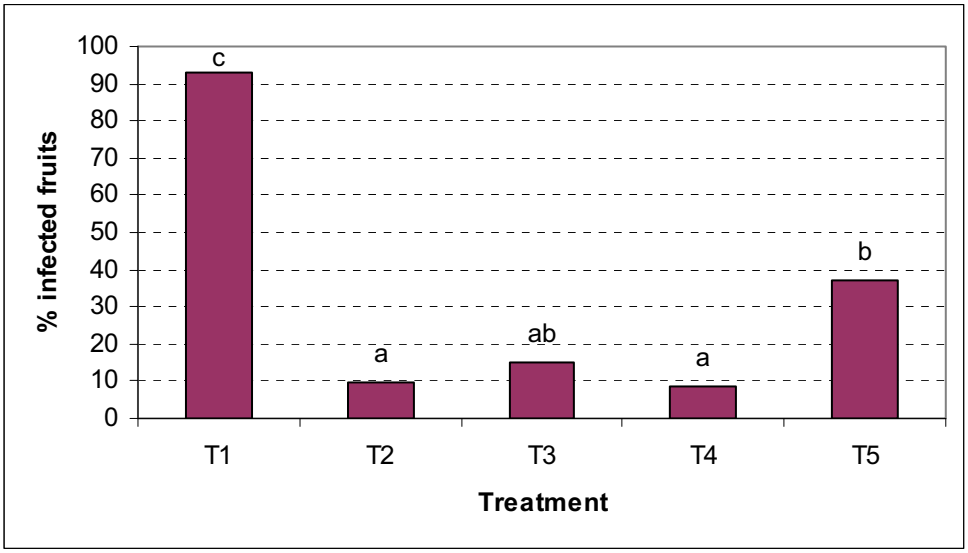

Figure 1: Percentage of infected fruits per treatment.

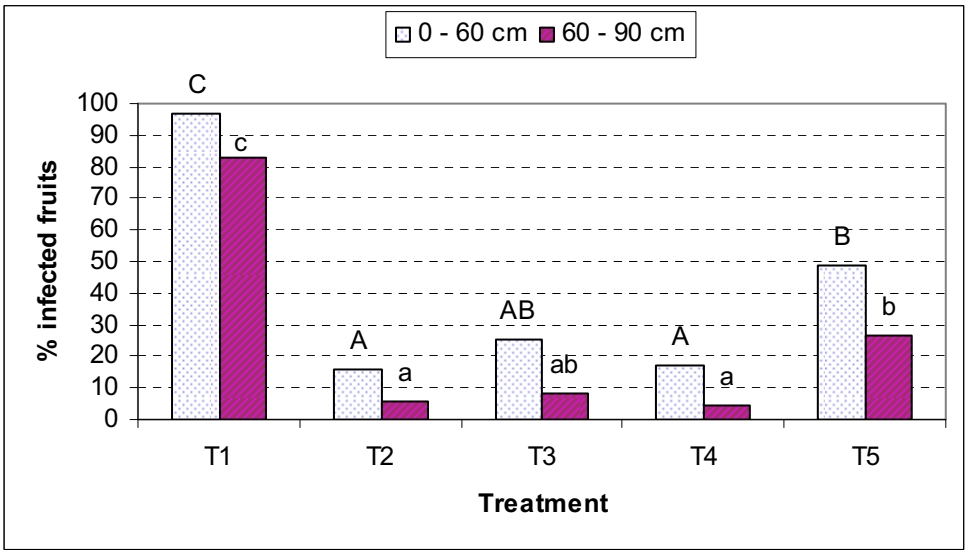

Figure 2: Percentage of infected fruits per segment per treatment. Plants were divided into two segments; 0 – 60 cm and 60 – 90 cm.

In the unsprayed control plots high incidences of powdery mildew infections on shoots were observed (nearly 90% infected shoots). In all potassium bicarbonate treatments disease incidences were strongly reduced compared to no significant differences were found between the potassium bicarbonate treatments regarding the severity index (data not shown).

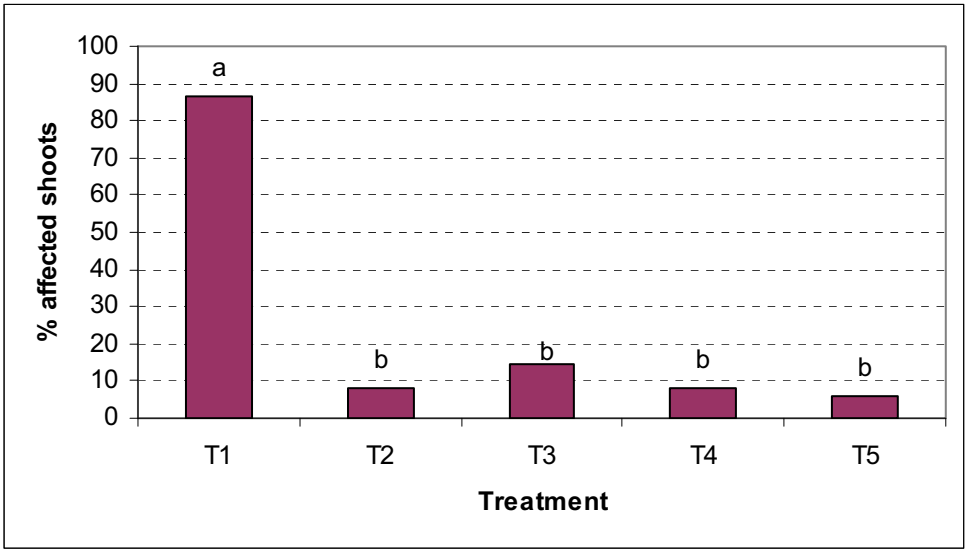

Figure 3: Percentage of affected shoots per treatment.

There were no signs of phytotoxicity due to the potassium carbonate applications observed in any of the treatments.

Discussion

The results presented in this paper show the ability of potassium bicarbonate (as Armicarb) to control powdery mildew in gooseberry. In the experiments weekly preventive sprays gave very good results in controlling disease incidences on berries. However, timing of the first applications appears to be crucial. If the spray applications start when powdery mildew becomes visible on shoots it is difficult to control berry infections.

In this trial we successfully controlled powdery mildew on shoots in 3-year old vigorous growing plants, with a high disease pressure. Even when sprayings were started relatively late in the spraying season, good results were obtained.

Indicative quality evaluations of harvested gooseberries showed that treatments with potassium carbonate caused no adverse effects. In apple phytotoxicity was observed on leaves treated with 2% sodium bicarbonate (Ilhan *et al*., 2006), and in grapes and sweet cherries slight phytotoxicity on stems (Karabulut *et al*., 2003, 2005). In our trial 0.50% and 0.25% Armicarb (a.i. 85% potassium bicarbonate) was sprayed, with no significant differences between the dosages. Apparently, a low dose can be very effective when applied in a weekly interval.

Potassium bicarbonate acts as a contact fungicide and is not likely to be systemic or curative (Jamar *et al*., 2007). The use of a non-ionic surfactant improves the efficacy of potassium bicarbonate; probably because of a better coverage (Sawant & Sawant, 2008). Armicarb is a formulated product with a surfactant system that increases its coverage ability. A long lasting action of potassium bicarbonate can not be expected as these salts are quickly converted into an ineffective compound and they will be washed off by even a small amount of precipitation. Therefore, frequent spray applications are necessary and the use of infection risk periods determined by a warning system could be useful. Future research will focus on reducing the number of applications, e.g. warning models based on rose powdery mildew (*Sphaerotheca pannosa*).

In conclusion, our results indicate that applications of potassium bicarbonate (as Armicarb) are effective in reducing the incidence and severity of American powdery mildew in gooseberry. Early spray applications are necessary to protect berries against powdery mildew infections. the control treatment. There were no significant differences between the potassium bicarbonate treatments (figure 3). Also,

Acknowledgements

This work was funded by the Dutch Ministry of Agriculture, Nature and Food Quality. We thank Mrs. G. Brouwer, Mr. H. Oltheten and Mr. P-F de Jong for their valuable discussions during this experiment, Mr. J. Withagen for the statistical analysis, and Mrs. J. Vermeer for allowing using her plantation.

References

Beresford, R.M., Wearing, C.H., Marshall, R.R., Shaw, P.W., Spink, M. & Wood, P.N. (1996). Slaked lime, baking soda and mineral oil for black spot and powdery mildew control in apples. *Proc. 49th N.Z. Plant Protection Conf. 1996*: 106 – 113.

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

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

Ilhan, K., Arslan, U. & Karabulut, O.A. (2006). The effect of sodium bicarbonate alone or in combination with a reduced dose of tebuconazole on the control of apple scab. *Crop Protection* **25**: 963 – 967.

Jamar, L., Lefrancq, B. & Lateur, M. (2007). Control of apple scab (*Venturia inequalis*) with bicarbonate salts under controlled environment. *Journal of Plant Diseases and Protection* **114** (5): 221 – 227.

Karabulut, O.A., Smilanick, J.L., Mlikota Gabler, F., Mansour, M. & Droby., S. (2003). Near-harvest applications of *Metschnikowia fructicola*, ethanol, and sodium bicarbonate to control postharvest diseases of grape in central California. *Plant Disease* **87**: 1384 – 1389.

Karabulut, O.A., Arslan, U., Ilhan, K. & Kuruoglu, G. (2005). Integrated control of postharvest disease of sweet cherry with yeast antagonists and sodium bicarbonate applications within a hydrocooler. *Postharvest Biol. Technol.* **37**: 135 – 41.

Sawant, S.S.D. & Sawant, I.S. (2008). Use of potassium bi-carbonates for the control of powdery mildew in table grapes. Proc. IS on Grape Production and Processing. *Acta Hort*. **785** (ISHS 2008): 285 – 291.

Ziv, O. & Zitter, T.A. (1992). Effects of bicarbonates and film-forming polymers on cucurbit foliar diseases. *Plant Disease* **76**: 513 – 517.