

Bicarbonate Solutions Control Powdery Mildew (*Leveillula taurica*) on Sweet Red Pepper and Reduce the Development of Postharvest Fruit Rotting

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Disease severity of powdery mildew (causal agent *Leveillula taurica* (Lév.) Arn.) on pepper (*Capsicum annuum*), defoliation and fruit sunscald rating were significantly reduced ($P=0.05$) by foliar applications of sodium or potassium bicarbonate solutions, compared with water or penconazole (Ophir). Preharvest application of bicarbonate solutions significantly reduced ($P=0.05$) postharvest decay development on sweet red pepper fruits.

KEY WORDS: Disease control; *Leveillula taurica*; powdery mildew; *Capsicum annuum*; sweet pepper; NaHCO_3 ; KHCO_3 .

Powdery mildew caused by *Leveillula taurica* (Lév.) Arn. is a devastating disease of peppers and other crops under greenhouse and field conditions worldwide (10). Leaves infected by *L. taurica* tend to be shed (11), thus subjecting the fruits to sunscald, which originates as whitened areas on the fruit which subsequently turn brown, soften, and collapse. Sunscalded fruits themselves are more susceptible to fungal attack (9). Increasing resistance to fungicides by pathogens has greatly increased pre- and postharvest losses (2,3). Furthermore, the use of pre- and postharvest chemical treatments is increasingly limited due to consumer concerns (12). There is renewed interest in the development of alternative means of controlling fungal development in the field and after harvest.

Bicarbonates, which are widely used in the food industry (8), have also been evaluated for their ability to control plant pathogens. Sodium, potassium and ammonium bicarbonates were found to suppress various fungal diseases on

greenhouse-grown cucumbers (14). Combining bicarbonates with oil controlled powdery mildew caused by *Oidium euonymi-japonicae* (Arcang.) Sacc. (13) or by *Sphaerotheca pannosa* (Wallr.:Fr.) Lév. var. *rosae* Woronichin (7). The goal of the present study was to evaluate the use of bicarbonates in controlling powdery mildew on pepper plants.

Sweet red pepper (*Capsicum annuum* cv. 'Maor') plants were sprayed with 0.5% (w/v) sodium bicarbonate or potassium bicarbonate each mixed with 0.03% (v/v) Tween-20 (Sigma) or 200 mg l^{-1} active ingredient penconazole (Ophir) (1-[(2,4-dichlorophenyl)pentyl]-1H-1,2,4-triazole, Ciba-Geigy, Switzerland). Materials were applied at a rate of 1 l per 10-m row using a hand-held boom sprayer. Control plants were sprayed with water mixed with Tween-20. There were five replicate rows of 20 plants each per treatment. Treatments were initiated when the plants had ten true leaves, one week after the symptoms of natural powdery mildew infection appeared. The

Contribution from the Agricultural Research Organization. No. 1704-E, 1995 series. Received July 10, 1996; received in final form Oct. 28, 1996.

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treatments were applied at five weekly intervals.

Disease severity, defoliation and sunscald were evaluated 40 days after the first application, at harvest. Disease severity was calculated as the percentage of unhealthy leaves from 50 random leaves on each plant. Leaf defoliation was determined by counting the number of leaves found on the ground per five plants and the percentage was evaluated from total leaves counted on these five plants. Sunscald was rated by the percentage of sunscalded fruit found on each plant at the time of harvest.

Twenty red fruits from each row (100 fruits per treatment) were harvested 40 days after the first treatment was given, on the basis of uniform size, color, firmness, and lack of evident defects or diseases. Postharvest decay incidence was evaluated after 14 days of storage at 8°C and an additional 3 days at 20°C.

Trials were performed in 1993 and 1994, with similar results each season. Data from the 1994 season are presented.

Both bicarbonate salts significantly reduced

disease severity, leaf defoliation and sunscald, compared with untreated or penconazole-treated plants (Table 1). No significant differences were observed between sodium and potassium bicarbonate. The percentage of decayed fruit after storage was also significantly lower with potassium bicarbonate than with the two other treatments. The decay-causing fungus isolated from infected fruits was *Alternaria alternata* (Fr.) Keissler.

A postharvest application of bicarbonate salts with emulsifiers protected citrus fruit from decay by various diseases during storage (1,5). In our study, the preharvest application of bicarbonate solutions probably reduced postharvest decay development on the fruit by reducing foliar disease severity and leaf defoliation. Preharvest treatments with bicarbonate salts might also reduce the inoculum level of fungi found on the fruit or plant in the field by suppressing hyphae and spore development on the fruit before harvest (4,6).

TABLE 1. The effect of sodium bicarbonate, potassium bicarbonate and penconazole on disease severity, defoliation rating and sunscalded fruit as evaluated 40 days after first application of solutions, and on postharvest decay of fruit as evaluated after 14 days at 8°C and a further 3 days at 20°C

Treatment	Disease severity ^z (%)	Defoliation ^y (%)	Sunscald ^x (%)	Decay (%)
Control	60 a ^w	60 a	48 a	54 a
Penconazole	32 b	32 b	24 b	24 b
Sodium bicarbonate	12 c	19 c	14 c	30 b
Potassium bicarbonate	10 c	18 c	13 c	15 c

^zPercentage of unhealthy leaves from 50 random leaves on each plant.

^yPercentage of leaves on ground from total leaves per five plants.

^xPercentage of sunscalded fruit on plant at harvest.

^wWithin columns, figures followed by the same letter do not differ significantly according to Duncan's multiple range test at $P=0.05$.

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