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Controlling fungal diseases of vegetables with biocides

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Abstract- Plant diseases continue to play a major limiting role in agricultural production, particularly in intensively managed crops. Fungal diseases of vegetables are one of the economic problems and cause greater losses of yield. Pre- and postharvest chemical treatments traditionally have been used against plant pathogenic fungi. Concerns about food safety, environmental quality and pesticide resistance have dictated the need for alternative pest management techniques. There is renewed interest in the development of alternative means of controlling fungal development in the field and after harvest. There are a limited number of published reports on the effects of biocides on control of fungal diseases. Some detergents have been found to be highly antifungal against some plant pathogenic fungi, such as powdery mildew (*Sphaerotheca fuliginea*) on cucumber. Recently, the efficacy of nonionic surfactants in the control of root rot on cucumber and pepper was reported. Selected organic and inorganic salts are active antimicrobial agents and their antifungal activity has been demonstrated on several plant-pathogens systems. Potassium bicarbonate has been shown to control both growth and development of soil-borne pathogen *Sclerotinia sclerotiorum*. Bicarbonates were used in controlling powdery mildew (*Leveillula taurica*) on pepper. Potassium or sodium bicarbonate salts controlled infection by powdery mildew (*Sphaerotheca fuliginea*) on squash. Inorganic fertilizer salts were found to reduce powdery mildew (*Erysiphe orontii*) on tomato. Bicarbonate salts provided control of gummy stem blight (*Didymella bryoniae*) and Alternaria leaf blight (*Alternaria cucumerina*) on muskmelon. Potassium or sodium bicarbonate was tested to study their effect on early blight disease (*Alternaria solani*) of potato. Postharvest application of salts reduced the severity silver scurf (*Helminthosporium solani*) and dry rot (*Fusarium* spp.) on potato, cavity spot (*Pythium sulcatum*) and black root rot (*Chalara elegans*) on carrots. This paper reviews the literature of fungal disease suppression by applications of biocides as alternatives to fungicides.

Key words: Biocide, fungal disease, vegetable

I. Introduction

Vegetable crops are grown worldwide as a source of nutrients and fiber in the human diet. Fungal plant pathogens can cause devastation in these crops under appropriate environmental conditions. Fungal diseases in vegetables strike quickly and then ruin a whole crop. In most growing areas, synthetic fungicides are needed to control fungal pathogens. Raised resistance to fungicides by pathogens has increased pre and postharvest chemical

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treatments which augment consumer concerns.) There is renewed interest in the development of alternative means of controlling fungal development in the field and after harvest. The main aim of this paper is to review the literature of fungal disease suppression by applications of biocides as alternatives to fungicides.

II. Controlling fungal diseases of vegetables with biocides

Several fungi may cause disease in vegetable plants, transmitting the disease through the soil or foliar. Chemical fungicides traditionally have been used against plant pathogenic fungi. Concerns about food safety, environmental quality and pesticide resistance have dictated the need for alternative pest management techniques. Biocidal products, such as some detergents, salts and surfactants have been found to be highly antifungal against some plant pathogenic fungi.

Preharvest application of biocides

- **Use for controlling foliar plant diseases**

Chemical fungicides often fail to control foliar diseases, mainly because the pathogen develops resistance. Problems with management of powdery mildew are usually due to fungicide resistance or phytotoxicity. New materials are needed for management of powdery mildew to reduce dependence on the products presently available.

Detergents are considered biorational compounds and are in the same category as bicarbonate salts, neemoil, horticultural oils, and antitranspirants (1). Some detergents have been found to be highly antifungal against some plant pathogenic fungi, such as powdery mildew on cucumber (2).

Biochemical changes associated with salt application possibly induced systemic resistance (3). Foliar application of 1% solution of mono-potassium phosphat effectively protected the foliage against powdery mildew (*Sphaerotheca fuliginea*) on cucumber (Fig. 1) (4,5).

Fig. 1. The suppressive effect of foliar application of MKP against powdery mildew on cucumber plants

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Disease severity of powdery mildew (*Leveillula taurica*) on pepper, defoliation and fruit sunscald rating were significantly reduced by foliar applications of sodium or potassium bicarbonate solution (6). Inorganic fertilizer salts were found to reduce powdery mildew (*Erysiphe orontii*) on tomato (7). Bicarbonate salts, applied by spraying, provided good control of gummy stem blight (*Didymella bryoniae*) and Alternaria leaf blight (*Alternaria cucumerina*) in greenhouse-grown muskmelon (8). Potassium-sodium bicarbonate was tested to study their effect on early blight disease caused by *Alternaria solani* of potato plants (9).

- **Use for controlling soilborne plant diseases**

Soilborne fungal pathogens play a major role in the development of root-rot disease complexes on many important field and horticultural crops that often result in the death of plants and important yield losses. Management of soil borne diseases is very difficult because these fungi survive for long time as mycelium in organic matter under different conditions. In most growing areas, synthetic fungicides are needed to control soilborne pathogens. New integrated pest management (IPM) strategies are needed with the ultimate goal of the management of soilborne pathogens with little or no synthetic fungicides used within a growing season. One way to achieve this goal may be the use of effective natural substances that have minimal adverse effects on the environment and health (10).

Surfactants are widely used to enhance the efficacy of various pesticides, but a significant improvement in disease control can only be achieved when a suitable surfactant is selected for a specific fungicide-pathogen-crop interaction (10). Recently, the efficacy of nonionic surfactants in the control of root rot of cucumber caused by *Pythium aphanidermatum* and root rot of peppers caused by *Phytophthora capsici* was reported (Fig. 2) (11).

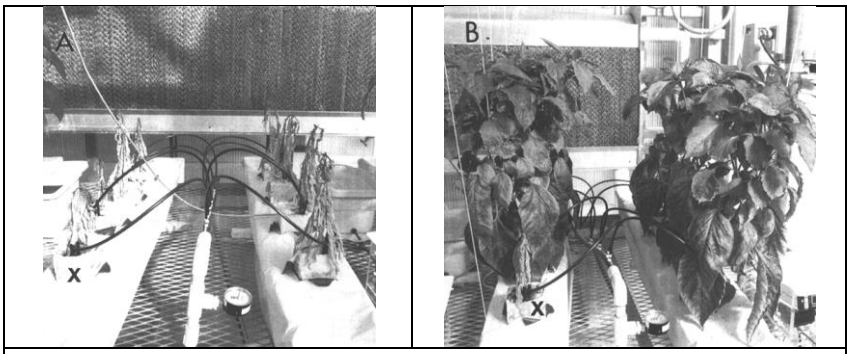

Fig. 2. Mortality of seedling pepper plants after hypocotyl-inoculation of a single plant (X) on one side of a two-sided recirculating hydroponic unit in the (A) absence or (B) presence of a nonionic surfactant in the nutrient

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solution.

Selected organic and inorganic salts are active antimicrobial agents and their antifungal activity has been demonstrated on several plant-pathogens systems. Potassium bicarbonate has been shown to control both growth and development of soil-borne pathogen *Sclerotinia sclerotiorum* (12).

Postharvest application of biocides

Nowadays, chemical fungicides are the most common strategy used to control postharvest diseases on vegetables. Salts constitute an interesting alternative to synthetic chemical fungicides for utiliza- tion as postharvest chemicals considering that they generally display a broad spectrum of antimicrobial activity, low mammalian toxicity, biocompatibility, and relatively low cost. In the search for alternatives to synthetic fungicides to control postharvest disease, sulfur-containing salts were evaluated for their effects on the mycelial growth of various fungal pathogens and their ability to control carrot cavity spot (*Pythium sulcatum*) and potato dry rot (*Fusarium sambicunum*) (13,14,15). Post-harvest application of ammonium bicarbonate, sodium bicarbonate, potassium carbonate, calcium propionate and potassium sorbate reduced black root rot on carrots caused by *Chalara elegans* (16). Antifungal activity of salts (ammonium phosphate) was investigated against potato dry rot (*Fusarium* spp.) (14,17). Sodium carbonate applied on potato tubers as post-harvest treatments were shown to markedly reduce the severity of silver scurf (*Helminthosporium solani*) (13).

III. Conclusions

Chemical fungicides traditionally have been used against plant pathogenic fungi. Frequency usage of the synthetic fungicides leaded to the development resistant population of the fungi, increase production costs, and environmental and human health hazards. Biocidal products, such as some detergents, salts and surfactants have been found to be alternatives to synthetic chemical fungicides. They have shown increasing evidence of efficacy in controlling to be highly antifungal against some plant pathogenic fungi. This paper reviews the literature of fungal disease suppression by applications of biocides as alternatives to fungicides.

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