FUTURE ALTERNATIVES TO SYNTHETIC FUNGICIDES FOR THE CONTROL OF POSTHARVEST DISEASES

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INTRODUCTION

Biological control practices have had a difficult time making it from the laboratory to the field. Having been developed and tested in controlled environments in the laboratory or greenhouse, most biological agents do not perform well when subjected to the "uncontrolled" environment of the field. Recent success with biological control in the postharvest milieu has been attributed to better environmental control (Wilson and Wisniewski, 1989). Post harvest conditions also make it easier to apply biocontrol agents effectively as commodities are being processed. The higher value of harvested commodities makes it economically feasible to utilize biological methods which would be cost prohibitive in the field. New technologies and concepts will be explored in this paper which may lead to a new generation of control practices and reduce our dependency on synthetic fungicides.

A CHANGING SOCIOECONOMIC CLIMATE

Recent development of biological control methods for the control of postharvest diseases has been generated by emerging socioeconomic concerns over the use of synthetic chemicals. Public demands to reduce pesticides in our food chain should lead to increase support for research to find alternatives. A number of profound changes in Western society point to greater support for biocontrol research and greater acceptance of biological control practices.

The public has made a strong link between food quality and health. This has led to considerable public pressure to withdraw synthetic chemicals from our food chain that may be carcinogenic. The National Academy of Sciences placed fungicides under special scrutiny when it studied the regulation of pesticides applied to our food (National Research Council, 1987). Their report indicates that fungicides constitute 60% of the oncogenic risk among all the pesticides used on food including insecticides. The NAS report states, "For certain crops in certain regions, the loss of all oncogenic compounds - particularly fungicides - would cause severe short-term adjustments in pest control practices because of the lack of economically viable alternatives". Thus, a new market niche has been created for biological control procedures for plant diseases.
As an indication of the possible future impact of public concerns over this issue, Technical Insights, Inc. (1991) in their 25 Predictions for the New Century state that, "The Agricultural Chemical Industry as we know it today will begin to disappear. Biological products will become cost competitive with chemicals due to new environmental-impact taxes". Environmental concerns are rapidly limiting our use of synthetic pesticides. If Technical Insights' prediction holds true, where are the alternative methods going to come from to control plant diseases?

POSTHARVEST BIOLOGICAL CONTROL WITH ANTAGONISTS - A SPECIAL CASE

The closer pesticides are applied to harvest, the most apt consumers are to encounter residues. Pesticides, particularly fungicides which are applied to fruits and vegetables after harvest leave even greater residues. Because of concerns over these residues major fungicides such as benomyl have been withdrawn for postharvest use and effective alternatives are lacking. Biological control with antagonistic microorganisms would be an attractive alternative to synthetic fungicides for the control of postharvest diseases if they were available.

We are fortunate that in the postharvest area, where the withdrawal of fungicides may cause the most acute problems, biological control may hold the greatest promise. Rapid commercial development of biological control methods against postharvest diseases can be expected because the "gap" between laboratory research and application in postharvest environments is not as great as that found in field applications. Also, the higher value of harvested commodities allows the use of more elaborate control methods which may not be economically feasible in the field. The concentrated target area for the application of biocontrol agents found in harvested commodities is advantageous. It is easier to overpower pathogens with antagonists in the postharvest environment than in the field because of the concentrated biomass to be protected and the controlled environmental conditions during storage.

The application of antagonistic microorganisms to food that is to be consumed presents special problems. Public reaction to the application of "living fungicides" to food has yet to be determined. Also, some proposed antagonists produce antibiotics as their main mode of action (Gueldner et al., 1988). The potential exists that exposure of human and animal pathogens to such antibiotics may cause resistance to potentially effective therapeutic compounds. Possible pathogenicity and allergenicity to man and other animals because of antagonists must be considered. Some organisms proposed as antagonists against pathogens of harvested commodities have relatives which are pathogenic or allergenic to man. Antagonists can also cause disease in the tissue they are used to protect. Bacillus subtilis (Hazen, 1989) and Pseudomonas cepacia (Deverall, personal communication) when used to control postharvest diseases have also been pathogenic to their host under certain circumstances. In selecting potential antagonists as biological control agents on food, attention should be given to these potential problems. However, since ancient times microorganisms have been used to pickle and ferment foods in order to preserve them (Gilliland, 1985). Among the wide array of antagonists available we should be able to select and develop ones which are effective and safe.

PLANT-DERIVED FUNGICIDES

Several effective insecticides, derived from plants, are produced commercially. No plant-derived fungicides have been developed commercially. Entomologists intensified their development of natural insecticides following restrictions on the use of compounds such as DDT. From this effort has come