ROOT HEALTH MANAGEMENT FOR VEGETABLE CROPS IN THE MIDWEST

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The Upper Midwest is an important region for production of green peas, snap beans, and sweet corn for the processing industry. Land suitable for growing vegetable crops near processing plants has been used intensively over the years, resulting in some cases in heavy infestations of soilborne pathogens.

One of the most challenging root diseases to manage is Aphanomyces root rot of peas. There are no chemical pesticides available for controlling this disease, nor are there pea varieties resistant to *Aphanomyces*. Crop rotation to non-legumes delays the build-up of *Aphanomyces*, but once soil is heavily infested, crop rotation is impractical because oospores of the fungus can survive in soil for more than 10 years without a pea crop. One of the most effective and widely used control strategies is indexing fields to determine the risk of planting peas the following year. Soil samples are collected from fields in the fall and the potential for disease is determined by a greenhouse test. Soils identified as having a high inoculum potential are considered high risk and are not planted to peas that year. This illustrates another strategy of disease management - don't fight 'em or eliminate 'em; avoid 'em!

Green manures incorporated into soil can also reduce the potential for disease. For example, sulphur-containing compounds released during the breakdown of glucosinolates in crucifer tissues may kill *Aphanomyces*. Intercropping two or more plant species together can also result in disease suppression. Oats intercropped with peas seems to reduce the severity of Aphanomyces root rot of peas. The suppressive effect may result from oat root exudates that cause the motile spores of this fungus to stop swimming, thereby preventing them from infecting peas roots. Unfortunately, this practice, while pertinent for forage-pea production, is not practical for green peas grown for processing. Loosening the soil with a chisel plow prevents soil from becoming compacted, allowing better soil drainage and creating soil conditions less favorable for infection of pea roots by the motile spores that require water-fill pores of a minimum size to move through soil.

Two strains of seed- and root-colonizing bacteria have been found that protect peas, snap beans and sweet corn against infection by the soilborne pathogens *Pythium*, *Rhizoctonia*, and *Aphanomyces*. Field studies show that treatment of pea seeds with either *Pseudomonas fluorescens* PRA25 or *Burkholderia cepacia* AMMD increases plant stands, reduces disease severity, and increases yield compared to plants

grown from seeds not treated with bacteria. On average, yields of peas grown from seeds treated with the biocontrol agents is 24% (*B. cepacia* AMMD) and 16% (*P. fluorescens* PRA25) greater than yields of peas grown from seeds without the bacteria. The biocontrol bacteria are effective on several pea cultivars, and may be combined with the seed-applied fungicides captan and metalaxyl, used for control of *Pythium*.

The development of suitable formulations and application strategies is one of the biggest stumbling blocks to commercial development of microbial biocontrol agents. Formulations must be effective, compatible with agricultural practices, and economically feasible. Currently, formulations of biocontrol agents include peat-based inoculum, frozen concentrates, liquid concentrates, and freeze-dried powders which can be added to seeds, soil, or transplants.

Vegetable, fruit and specialty crops are especially good commodities for application of biocontrol strategies because of their high value, the efficacy of biocontrol agents against diseases not controlled otherwise by conventional means, and because of increased societal pressure to reduce the use of pesticides on fresh produce. Many new biocontrol products are already registered for use on food crops. In fact, of the 40 new pesticides registered by the U.S. Environmental Protection Agency in 1995, fully half were biologicals, many of these microbial biocontrol agents.