

# APPENDIX D

## INDUCED RESISTANCE: REVVING UP PLANT DEFENSES

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Abby Seaman, Area Extension Educator, NYS IPM Program

Plants respond to attacks by insects and diseases by mobilizing an array of compounds that inhibit plant diseases, or reduce feeding by insects. Often, plants in which resistance is induced by one pathogen or insect will also be resistant to some other pathogens or insects, but not necessarily the entire spectrum of potential pests. It is also possible that mobilizing resistance to one pathogen could increase susceptibility to another pathogen. Various approaches to inducing resistance in plants are currently being studied as possible pest management tools in the field. This article describes some of the ways that plant resistance can be induced in the absence of pests, rendering plants more resistant to future attacks by insects or pathogens.

### **COMPOSTS**

The application of mature composts to soil or potting mix has been shown to induce a resistance response in above-ground parts in several crops including cucumber and tomato. The exact mechanism by which composts and compost extracts induce resistance is not well understood, and not all composts are able to cause an induced resistance response. One study that looked at 25 different composts for induction of resistance to bacterial spot in radish found that only two of the composts induced strong resistance (Krause et al. 1998). The ability of a compost to induce resistance may depend on the compost being recolonized by specific organisms during the curing phase (Hoitink and Boehm 1999). Induced resistance responses may also be variable from one batch of compost to the next, and the response may be different when different types of soils are amended (Abbasi et al. 2001).

### **ISOLATED PLANT GROWTH PROMOTING RHIZOBACTERIA**

One of the hypothesized mechanisms for the induction of resistance by composts is the presence of certain plant growth promoting rhizobacteria (PGPR). Researchers have isolated a number of species of bacteria that

have plant growth promoting properties and tested them in specific crop/pest situations. They have found that particular species of bacteria work better in particular plant/pest situations.

Zehnder et al. (1997) found that plant growth was enhanced and that striped cucumber beetle feeding and subsequent infection by bacterial wilt were reduced in cucumber plants treated with a mixture of species of PGPRs compared with untreated controls. PGPRs have also been shown to protect cucurbits from anthracnose and angular leafspot (Raupach and Kloepper 2000), and tomatoes from viral diseases (Zehnder et al. 2001).

### **OTHER MICROBIALS**

Microbial products that are sold for biological control of soil-borne root pathogens may also induce resistance to diseases of above ground parts. We suspect that induced resistance is involved because of examples in which the product was applied only to the soil and the effect was seen in the above ground parts of the plants. In trials conducted on an organic farm in western NY during the summers of 2001 and 2002, tomatoes drenched with a suspension of Plant Shield (*Trichoderma harzianum*) at transplanting had reduced levels of early blight at the end of the season compared with the untreated control. In a third season of this trial, during which *Septoria* leafspot was the predominant foliar disease, the Plant Shield drench did not reduce disease significantly compared with the untreated control. In a greenhouse tomato trial, Mycostop (*Streptomyces griseoviridis*) applied as a soil drench provided control of gray mold comparable to foliar fungicide (Bravo) applications (Lamboy et al.). Both Plant Shield and Mycostop are OMRI approved.

### **CHEMICAL INDUCTION**

A number of compounds have been shown to induce resistance in plants when applied to the foliage. Among the compounds demonstrated to have this effect are salicylic acid, potassium phosphate, a water solution of NPK fertilizer, certain plant extracts, and extracts of microbial metabolites. Specific plant/compound combinations seem to be necessary to induce resistance; e.g. a given compound will induce resistance in some plants but not others. Commercial products that act as resistance inducers are currently on the market. One product is called Messenger. The active ingredient of Messenger is a protein called harpin, which occurs on the cell wall of the bacteria that causes fire blight in fruit trees, and is recognized by some plants as a sign of pathogen attack. Harpin application also has the beneficial side effect of increasing plant growth. Another product, Actigard, is a synthetic chemical that induces a resistance response in plants. A third product, Milsana, is an extract from the giant knotweed plant. None of these products is currently OMRI approved.

### **NONPATHOGENS OR WEAK PATHOGENS:**

Weak or nonpathogenic strains of plant pathogens can induce a resistance response if they have surface proteins detected by the plant as those of pathogens. Weak strains of viruses have been used to induce resistance

that helps protect plants from later infection by virulent strains. Cucumber plants inoculated with anthracnose were found to have fewer striped cucumber beetles feeding on them in cage studies (Zehnder et al. 1997).

### INDUCED RESISTANCE ON THE FARM

Although research on induced resistance has been conducted since the mid 1970's, there is still a lot to be learned before it can be used predictably in the field. Organic growers, who regularly add compost or other organic matter to their soil may already be taking advantage of the benefits of induced resistance because of the increased microbial activity that results from additions of organic matter. It's not clear at this point how much additional advantage the use of resistance inducing products would provide to plants growing in a very microbially active soil. Those who are still working to build their soil may get some benefits from the use of microbial or other products that induce resistance. Microbial products have also been found to be effective in a greenhouse situation where sterile potting mixtures are being used. Products sold for biological control of certain pathogens may also have more generalized induced resistance effects. They include products such as Serenade (*Bacillus subtilis*), Plant Shield (*Trichoderma harzianum*), and Soilgard (*Giocladium spp.*), all of which are currently OMRI approved. These products and the chemical resistance inducers listed above will not provide complete control of plant diseases, but may delay or reduce disease development in the field. Keep an eye on this emerging area of research as specific practices and products are developed for field use.

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