BRASSICA COVER CROPS AND SEED MEALS AS SOIL BIOFUMIGANTS IN VEGETABLE CROPS

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The web address for project descriptions is http://web.utk.edu/~tkarpine/EnhBiofum.html.

Data now supports the concept that many classes of biological pest management are effective in controlling diseases caused by soilborne pathogens. The volatile compounds released from *Brassica* plants are known to release biocidal compounds that are able to suppress soilborne pathogens when incorporated into the soil. Sustainable control of soilborne phytopathogenic fungi is likely to be achieved through the enhancement of biologically based methods via the integration of multiple techniques. Even sub-lethal doses of biofumigants can act to weaken pathogen propagules making them more susceptible to the actions of the microbial antagonists that can be delivered through compost applications. It is clear that a fundamental attribute of an effective integrated organic system is its ability to decrease pathogen numbers in the soil and establish a soil microecology suppressive to pathogens.

Biofumigation

Biofumigation is the use of volatile plant chemicals for control of soilborne pests. The viability of biofumigation to control pathogens has been investigated for many years. Studies conducted at The University of Tennessee showed that mustard seed meal has extremely high concentrations of isothiocyanates (ITCs). The seed meal is also a fertilizer source of nitrogen and other nutrients. When incorporated into the soil, ITCs act as effective biofumigants, reducing populations of pathogenic fungal species (*Sclerotium*, *Rhizoctonia*, and *Phytium*), nematodes, weeds, and certain insect species. These products have been shown to suppress the pathogens *Botrytis cinerea*, *R. solani*, *F. oxysporum*, *Didymella lycopersici*, and *Cladosporium fulvum*. In these studies, we found that the volatiles from several Brassica species suppressed the growth of the tomato pathogens *P. ultimum*, *R. solani*, and *S. rolfsii*. The biocidal activity of *Brassicas* against fungal pathogens, nematodes, weeds, and insects is frequently attributed to ITCs from Brassica tissues. ITCs are effective, broad-spectrum pesticides, and substantial quantities of them can be produced for field application. Research has shown that Black mustard (*B. nigra* L. W. Koch) and Indian mustard (*B. juncea* L. Czern and Coss.) produce high levels of ITC, and could be utilized in a biofumigation cropping system.

Since 1999 field trials have been conducted at Knoxville Experiment Station. Significant decreases in the incidence of Southern Blight of tomato were recorded, as well as increases in fruit yield, when integrating biofumigation into a sustainable production system. The research yielded important knowledge pertaining to the development of the appropriate production methods utilizing biofumigation as a management technique. Both *Brassica* cover crops and mustard seed meal incorporations have been evaluated. The ability to amend production soils

with the spreadable meal, in conjunction with its high ITC content (3-4 x leaf tissue), give this enhanced biofumigation technique great potential. Problems associated with growing cover crops such as variable stands and weather complications are avoided when using the meal. As a fully organic product, pre-plant mustard meal applications give the grower superior ability to control soilborne pests.

Tomato Production and Blight diseases as a Model System

The use of raised-bed plasticulture methods for fruit and vegetable production is becoming increasingly prevalent within the United States. Advantages include increased crop performance by conserving moisture and nutrients, stabilizing soil temperature, reducing some diseases, reducing or eliminating weeds, and increasing early harvest yields. Often grown without rotation, tomato fields can develop high pathogen inoculum densities. Southern Blight, caused by the phytopathogenic fungus *Sclerotium rolfsii*, represents one of the major disease threats to tomato crops (both organic and conventional) in the southeast United States. Various control methods have traditionally been utilized to lessen the incidence of Southern Blight in commercial vegetable fields, all with no definitive control of the disease. A prevailing hypothesis is that by altering the composition or activities of soil microflora, including the addition of biocontrol agents such as antagonistic microorganisms, that there is a potential for improved control of soilborne diseases.

Introduction

The effects of different combinations and techniques of mustard meal and compost application and chemical fumigants on vegetable production are studied in four field experiments in Tennessee and North Caroline and in three on-farm trials with commercial growers during 2003-2005. Yield and quality of tomato and strawberry plants and their diseases were measured to characterize the effects of enhanced biofumigation on productivity. The web address for the project is http://web.utk.edu/~tkarpine/EnhBiofum.html.

The objectives of the studies were to study the effect of *Brassica* cover crop and mustard meal application in combination with composting on soilborne diseases and tomato yield.

Treatment combinations applied in several locations included: 1) Control (no amendments); 2) Brassica plants (fall incorporation); 3) Brassica plants (spring incorporation) + Basamid at 175 lb./acre; 4) Brassica plants (fall incorporation) + mustard meal at 1000 lb./acre (spring incorporation); 5) Mustard meal at 500 lb./acre; 6) Mustard meal at 1000 lb./acre; 7) Mustard meal at 2000 lb./acre; 8) Compost at 30 tons/acre; and 9) Compost at 30 tons/acre + Mustard meal at 1000 lb./acre.

Impact of Results/Outcomes

The following results of the study are practically and scientifically important and will impact on sustainable agriculture.

1. Combination of mustard meal incorporation with compost increases the yield and quality of tomatoes, but the effect may only be achieved after 1-2 years of the application.
2. Combination of mustard meal application with compost protects tomato plants from Early Blight.
3. Mustard meal application increases the yield of strawberry plants and protects them against Anthracnose. These positive effects may accompanied by an increase in the number of weeds.
4. The application of mustard meal disturbs the bacterial and fungi communities in the soil during the first two weeks after the application. Both, a decrease and an increase in the number of heterotrophic bacteria and fungi may take place. To the end of the growing season the bacterial and fungi population is stabilized and deceased in number.
5. The response of nematode population to mustard meal and compost application depends on soil and weather conditions. Both a decrease and an increase in number of total nematodes, fungal feeders and bacterial feeders may occur. Mustard meal treatment and basamid treatment decrease the number of spiral nematode in soil associated with damage to some crops.

The following technique of mustard meal application is recommended for vegetables production:

1. Compost may be incorporated before the mustard meal application in fall, or in spring. Usual rate is 30 tons per acre. It may also be applied together with the mustard meal.
2. Mustard meal should be incorporated two weeks before the expected date of plating at a rate 1000 - 2000 lb. per acre. Mustard meal should be applied only to beds that will be covered with plastic to prevent lose of the biofumigant.
3. Mustard meal must be tilled in the soil. The beds need to be covered with plastic and irrigated with at least 1 inch of water the same day of application. The irrigation must be repeated in a day at the same rate (1 inch). The irrigation is necessary to trigger reactions of mustard meal with the soil and soil organisms. The heat under the plastic kills pathogens and stimulates reproduction of beneficial microbes and nematoes in the soil.
4. Plants may be planted in two weeks after mustard meal application. This delay is necessary to avoid toxic effect of mustard meal on germinated seeds or roots of seedlings