Final Project Report to the NYS IPM Program, Agricultural IPM 2000 – 2001

Title: Comparing the Effectiveness of Selected Cover Crops Incorporated as Green Manures without and with a Surface Seal Against Root Pathogens of Beans/Vegetables

Project Leader(s):

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Findings are applicable nationally

Abstract:

Green manures of a number of rotational and cover crops have been shown to effectively suppress the severity of root diseases and improve crop yield. We have recently documented that sudangrass incorporated as a green manure is effective in suppressing the root-knot nematode on vegetable crops. The principal mechanism involved in the observed suppression was shown to be due to the production of gaseous toxic compounds during the decomposition of the green manures in soil. This project was conducted to evaluate the effectiveness of green manures of sudangrass and wheat in suppressing root rot diseases of beans, thus the development an environmentally compatible management strategy for this important disease. Bean and fallow treatments were also included as checks. The replicated trial was established in a 2-acre experimental field, which is heavily infested with root rot pathogens. Sudangrass and wheat were planted on 5 June and incorporated on 9 August at rates of 29.4 and 5.3 T/A, respectively. Half of each of the plot areas were also sealed with a cultipacker-roller. The main results of this project will not be available until the end of the 2002 growing season. However, results of a greenhouse bioassay test showed that beans grown in soils collected from the sealed plots and receiving the green manure of sudangrass exhibited a slightly lower root rot severity. It is hoped that the suppresion of root diseases will increase substantially prior to the next planting season.

Background and justification:

Root rot diseases of beans and vegetables in general are of common occurrence and often cause significant yield losses, although the occurrence of these diseases vary from year to year and among fields within one production area. Root diseases are generally of a complex etiology, as they can be caused by a single pathogen or by various combinations of pathogens. For example, the major pathogens on beans include the pathogenic fungi *Rhizoctonia*, *Fusarium*, *Pythium*, and

Thielaviopsis. The lesion nematode (*Pratylenchus*) is also an important pathogen of beans and many other vegetables. General damage symptoms of root diseases such as beans include poor seedling establishment, damping-off, stunted and uneven growth, premature defoliation, death of severely infected plants; thus reduced yield. Specific and diagnostic symptoms will depend on the pathogen(s) involved.

The involvement of multiple pathogens with diverse biology in causing root rots of beans and other crops has made it difficult to effectively control these diseases with the application of a single and practical management option. Thus, effective management of these diseases is possible only through the use of a combination of compatible and appropriate control options (cultural, biological and/or chemical) utilizing the principals and strategies of IPM (Soil-IPM).

The incidence and damage of root pathogens are generally high when vegetables are grown in short or inappropriate rotations and in poor soils (compacted, low content of organic matter, etc.). It is well known that increasing the levels of organic matter in soil results in improved soil structure, improved drainage, increased nutrient availability, and increased microbial diversity and activity. The addition of fresh organic materials in the form of green manures has been also shown to generally suppress root pathogens, both nematodes and fungi. Thus, soil organic matter and its replenishment has become a major component of soil health management programs, and especially in the strictly organic production systems.

Results of numerous field and greenhouse tests in New York have demonstrated that the incorporation of green manures of grain crops such as ryegrass, wheat, oats, ryegrain, barley, and others have generally reduced root rot severity and increased bean yield. However, cover crops differed significantly in their effects on various root pathogens. In addition, a cover crop of hairy vetch was found to increase the population of the lesion nematode, increase the root rot severity ratings and to lower bean yield. Most recently, we have documented that several crops including wheat, corn, barley, sudangrass and others are non-hosts to the root-knot nematode. However, only sudangrass hybrids and selected white clovers and flax were effective in reducing the population of the root-knot nematode when incorporated as green manures in muck soils. We have recently documented that the mechanism involved in the observed suppression of nematodes by a green manure of sudangrass is due to the production of decomposition toxic products (including hydrogen cyanide) in soil. It was also found that immature nematode eggs are 10 times more sensitive to the toxic compounds than larvae of the same nematode. These toxic products interfered with egg maturation and hatching

The various green manures tested were incorporated by first cutting the foliage and then disking the green tissues. Since these antagonistic green manures were found to produce toxic gaseous compounds, it will be interesting to evaluate them with a soil surface seal in order to keep the effective gases longer in the soil and/or increase their concentration in soil. As mentioned above, nematode life stages are differentially sensitive to hydrogen cyanide and other products released by decomposing sudangrass tissues, and the same may be true with other nematodes and fungal pathogens. Thus, improving the efficacy of these antagonistic crops with a soil surface seal will increase their utility as a biologically based root disease control strategy. This control strategy of root pathogens is applicable to many crops, it is practical and compatible to environmental health issues and to organic production needs.

Objectives:

To compare and demonstrate the effectiveness of green manures of wheat, and sudangrass without and with a surface seal against root pathogens and their damage to beans, as a vegetable model system.

Procedures:

The experiment was established in a 2-acre experimental field at the Vegetable Research Farm, NYSAES, which is heavily infested with root rot pathogens. The field was divided into 16 equal sections. Snap beans cv. "Hystyle" was planted in four sections of this trial on 16 May, whereas wheat and sudangrass cv. "Trudan 8" were planted in four sections each on 5 June. The remaining 4 sections were maintained as a fallow (check). All practices of land preparation, planting and maintenance were done according to commercial recommendations. The bean plots were harvested on 23 and 24 July. On 9 August, the cover crops were cut and then incorporated into the soil. Immediately after incorporation, each individual plot was split into two equal sub-plots, and one of the plots was then sealed by a cultipacker-roller. On 21 September, a composite soil sample was collected from each split-plot and bioassyed in the greenhouse. The soil of each sample (2-3 liters) was mixed thoroughly, placed in clay pots (4-inch in diameter) and planted with 7 bean seeds. After 5 to 6 weeks, the test was terminated, roots washed, and total plant weights were recorded. The roots were evaluated for root rot severity on a scale of 1 (normal-healthy roots) to 9 (severe discoloration, reduced size and with considerable decay).

Results and discussion:

In 2001, the proposed trial was set-up in the experimental root rot field. The incorporated rates of the green manures of wheat and sudangrass was 5.3 and 29.4 T/A, respectively. Results of the greenhouse bnioassay test , conducted with soil samples collected 6 weeks after the green manures incorporation, showed that root rot severity was still high in all the plots (Table 1). However, beans grown in the plots that were planted to sudangrass and were immediately sealed after the incorporation of sudangrass exhibited the lower root rot severity ratings (Table 1). Further reduction in the root rot severity ratings might be utilized over time and before the next planting season.

The main results of this project will not be utilized until the end of the 2002 growing season. In May 2002, all the plots will be prepared, planted to beans and maintained to normal harvest time according to the guidelines for commercial production. Emergence and stand count will be recorded at 2 and 5 weeks after planting, respectively. Root rot severity and nematodes in roots and soil will be determined at the full-bloom stage. Nematodes in roots and soil will be extracted by the shaker and pie-pan techniques, respectively and counted under 40-60X magnification. At harvest, total and pod weight will be recorded. In addition, soil samples from all the plots will also be collected before planting and bioassayed in the greenhouse. The appropriate statistical analyses will be performed on the various data collected to compare the efficacy of the green manures included and the influence of the soil seal in controlling root pathogens and damage to beans.

References: (selected)

Abawi, G. S., and T. L. Widmer. 2000. Impact of soil health management practices on soilborne pathogens, nematodes and root diseases of vegetable crops. Applied Soil Ecology 15: 37-47.

Viaene, N. M., and G. S. Abawi. 1998. Management of *Meloidogyne hapla* on lettuce in organic soil with sudangrass as a cover crop. Plant Disease 82: 945-952.

Widmer, T. L., and G. S. Abawi. 2000. Mechanism of suppression of *Meloidogyne hapla* and its damage by a green manure of sudan grass. Plant Disease 84: 562-568.

Table 1: Effect of incorporating green manures with and without a surface seal on bean growth and root rot severity. Greenhouse bioassay, 2001.

Treatment	Emerge[a]	Stand[a]	TOTAL WT. (g/pot)	ROOT ROT Severity(1-9)[b]
SEALED:				
Fallow	6.4	5.3	15.8	7.8
Snap Beans	6.1	4.8	13.7	8.3
Sudangrass	6.5	5.2	16.0	7.1
Wheat	6.1	4.6	12.4	8.1
LSD .05	0.72	0.95	2.65	0.57
Average	**6.3**	**5.0**	**14.5**	**7.8**
NOT SEALED:				
Fallow	6.0	5.1	15.2	8.1
Snap Beans	6.1	5.2	14.7	7.8
Sudangrass	6.3	4.6	13.5	7.9
Wheat	6.3	5.0	13.8	8.1
LSD .05	0.76	1.13	2.96	0.62
Average	**6.2**	**5.0**	**14.3**	**8.0**

[a] number of plants per pot of 7 seeds planted.
[b] recorded 6 weeks after planting on a scale of 1 (healthy) to 9 (>75% of root and lower stem tissues afected with severe discoloration.