Final Project Report to the NYS IPM Program, Agricultural IPM 2002 – 2003

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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Abstract:

The incorporation of green manures of grain crops including wheat and sudangrass have been shown to reduce root rot diseases and their damage to beans and other vegetables. In addition, it was recently demonstrated that the incorporation of green manures of sudangrass suppresses the root-knot nematode and its damage to vegetables. The mechanism of nematode suppression was determined to be due to the production of toxic metabilites, including the hydrogen cyanide gas produced during decomposition of sudangrass tissues. Thus, this 2-year project was conducted to evaluate the efficacy of green manures of sudangrass and wheat with and without a surface seal against root rot pathogens and their damage to beans. The test was conducted in a research field with a history of continuous bean production and heavy infestation with root rot pathogens. Results obtained did not show a benefit from the incorporation of green manures of sudangrass or wheat as compared to the check treatments in reducing root rot severity or increasing yield. Also, sealing the soil immediately after the incorporation of the green manures did not result in better yield or reduced root rot severity. Additional cycle(s) of green manures application might be required before reduction in root rot severity and an increase in bean yield is realized in such heavy-textured soil and with high pathogen infestation.

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 during 2001 in a 2-acre field at the Vegetable Research Farm, NYSAES, which is heavily infested with root rot pathogens. The field was divided into 16 equal sections. On 16 May, four sections were planted to snap beans cv. “Hystyle”, 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. On 9 August, the cover crops were cut and then incorporated into the soil. Immediately after incorporation, each individual plot was split into two sub-plots, and one of the sub-plots was then sealed by a cultipacker-roller. On June 20, 2002 all the plots were plowed, fertilized (15-15-15, NPK at 200 lbs./A) and treated with herbicides (Treflan and Eptam). The snap bean cv. 'Hystyle' was planted on June 21, receiving 100 lbs of the same fertilizer in a band. The plot area was then sprayed with the herbicide Dual. At planting, a composite soil sample was collected from each split-plot and bioassyed in the greenhouse for root rot severity. The soil of each sample (2-3 liters) was mixed thoroughly, placed in clay pots (4-in dia.) and planted with 7 bean seeds. After 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). Emergence and stand counts of the field plots were recorded on July 7 and August 12 (harvest), respectively. Thirty roots from each plot were collected on August 1 and rated for root rot severity. At harvest, total and pod weights were recorded.

Results and discussion:

Sudangrass and wheat were planted on May 16, 2001 and were incorporated as green manures on 9 August at the rates of 5.3 and 29.4 T/A, respectively. Results of the greenhouse bioassay test on soil samples collected at bean planting in 2002 are presented in Table 1. As the data suggested, there were no differences in emergence, stand count, total growth weight and root rot severity ratings among all the treatments. Similarly, the number of emerged seedlings, number of plants at harvest, and pod yield of beans planted in the various green manure treatments with and without a surface seal did not differ (Table 2). In addition, roots of beans growing in the various treatments did not exhibit differences in the root rot severity ratings. Number of plant-parasitic and free-living nematodes in the plot area were rather low and again did not show differences among the treatments (Table 3). These results were in contrast to previous results from several experiments documenting the beneficial effects of grain crops as cover or rotational crops in increasing bean yield and reducing root rot severity. In addition, sudangrass has been well demonstrated to suppress the root-knot nematode and its damage to vegetable crops. The latter was shown to be due to the production of toxic metabolites, including hydrogen cyanide, during decomposition of sudangrass tissues in soil. Thus the possible effects of sudangrass incorporation against other soilborne pathogens, such as those causing bean root rots. The test root rot site used in this study has been in continous production of common beans for over 10 years and is heavily infested with several root rot pathogens. Thus, a longer transition and the planting of several cycles of cover crops/green manures might be needed in order to observe a beneficial effect and to appreciably increase the organic matter content of such a site.

References: (selected)

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Table 1: Effect of previous crops and their incorporation as green manures, with and without a surface seal, on bean growth and root rot severity. NYSAES greenhouse bioassay, 2002.

Treatment	Emerge[a]	Stand[a]	Total Wt (g/pot)	Root Rot Severity(1-9)[b]
SEALED:				
Fallow	6.5	6.1	28.3	7.4
Snap Beans	6.4	5.9	24.7	7.8
Sudangrass	6.4	5.8	27.0	6.9
Wheat	6.4	6.1	29.9	6.2
LSD .05	0.48	0.74	5.89	0.92
Average	**6.4**	**6.0**	**27.5**	**7.1**
NOT SEALED:				
Fallow	6.7	6.6	29.8	7.0
Snap Beans	6.4	5.7	26.6	7.5
Sudangrass	6.5	6.0	28.4	6.4
Wheat	6.4	5.4	25.4	6.9
LSD .05	0.57	1.02	7.38	1.08
Average	**6.5**	**5.9**	**27.6**	**7.0**

[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 affected with severe discoloration.

Table 2: Effect of incorporating green manures the previous fall with and without a surface seal on emergence, stand and yield of snap beans grown in a field with a history of severe root rot. NYSAES Research Farm, 2002.

	Plants per 10 ft row [a]		
Treatment	**Emergence**	**Stand**	**Pod Yield (T/A)** [b]
SEALED:			
Fallow	62	61	3.01
Snap Beans	62	61	2.32
Sudangrass	63	62	2.45
Wheat	66	66	2.88
LSD .05	3.6	4.4	1.12
Average	**63.1**	**62.7**	**2.66**
NOT SEALED:			
Fallow	63	63	2.43
Snap Beans	64	64	2.90
Sudangrass	64	65	2.71
Wheat	62	61	2.13
LSD .05	4.0	4.7	0.91
Average	**63.1**	**63.2**	**2.54**

[a] of 8.7 seeds per foot planted w/vacuum seeder.
[b] extrapolated from 4 reps each of 4-10 ft sections per treatment.

Table 3. Effect of incorporating green manures the previous fall with and without a surface seal, on nematode populations and root rot severity of snap beans. NYSAES Research Farm, 2002.

	PIE PAN [a]			Root Rot
Treatment	**Lesion**	**J2 NRKN**	**Saphrophytic**	**Rating (1-9)** [b]
SEALED:				
Fallow	0	0	545	5.8
Snap Beans	0	10	315	6.0
Sudangrass	0	5	495	6.1
Wheat	5	5	695	5.8
LSD .05	ns	ns	ns	0.52
Average	**1.3**	**5**	**513**	**5.9**
NOT SEALED:				
Fallow	0	0	465	6.1
Snap Beans	0	15	565	5.8
Sudangrass	0	0	405	5.9
Wheat	0	0	370	6.2
LSD .05	ns	14.8	ns	0.61
Average	**0**	**4**	**451**	**6.0**

[a] expressed as nema per 100 cc soil.
[b] sampled mid-late season on a scale of 1 (healthy) to 9 (>75% of root and lower stem tissues affected with severe discoloration.