

BIOAG PROJECT PROGRESS REPORT

TITLE: Evaluating Soils Receiving Multiple Green Manures for Suppression of *Verticillium dahliae*

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KEY WORDS: green manures, mustard, *Verticillium wilt*, potatoes, soil

ABSTRACT: Farmers are using mustard green manures on over 20,000 acres each year in the Columbia Basin, mainly before potatoes. Although this practice has the potential to replace the use of the fumigant metam sodium for control of *Verticillium dahliae*, only a small number of farmers are doing so. They lack any way of estimating the effect of the green manures on their soil's ability to suppress this or other soilborne pathogens. This project will evaluate the soil changes that have resulted from multiple mustard green manure crops (up to eight over the past 16 years) on one farmer's fields where metam sodium has been successfully eliminated. We will evaluate the soil's suppression ability and attempt to correlate it with other soil measurements with the goals of giving farmers a way to rate the suppression ability of their own soils following green manures and giving researchers direction in determining the mechanism behind the suppression.

PROJECT DESCRIPTION: We propose to evaluate the soil changes that have resulted from multiple mustard green manure crops on the Gies farm. We will evaluate the soil's suppressive ability and attempt to correlate it with other soil measurements with the goals of giving farmers a practical way to rate the suppression ability of their own soils following green manures. This will give farmers more confidence in replacing fumigation with green manures when warranted and also give researchers direction in determining the mechanism behind the suppression in hope of further improving the effectiveness of the practice.

OUTPUTS

- Work Completed:
Soils work

We compared soil measurements from four fields receiving long-term green manures and four fields not receiving green manures. The results (shown below) indicate several biological measurements that may be useful in determining

the state of Basin soils receiving green manures. The combined assessment given by the Cornell soil health rating might also be something to investigate further. What is still lacking is a measurement of the soil physical properties that reflects any changes brought on by the green manure amendments. Previous research indicates that infiltration and soil slake tests hold promise, but these were not included in this testing as they are not very adaptable to commercial lab testing.

We have yet to receive results of measurements being made on these soils by Dr. Linda Kinkel at the University of Minnesota. She is measuring various properties of soil suppressive activity by *streptomyces*.

	Measurement	Green manured soils	Non-green manured soils	Prob>F	
Physical	Aggregate stability (%)	29.6	26.3	0.6195	NS at the 0.05 level
	Available water capacity (m/m)	0.081	0.099	0.2051	NS at the 0.05 level
	Sand (%)	69.2	73.3	0.1930	NS at the 0.05 level
	Silt (%)	25.7	23.3	0.4373	NS at the 0.05 level
	Clay (%)	5.1	3.4	0.0004	***
Biological	Soil organic matter (%)	1.2	0.9	0.0014	**
	Active carbon (ppm)	235.0	135.2	0.0040	**
	Potentially mineralizable N (ugN/g dw soil/week)	21.9	13.0	0.3613	NS at the 0.05 level
	N mineralization, 7 day (mg N/g soil)	70.5	31.1	0.2698	NS at the 0.05 level
	N mineralization, 23 day (mg N/g soil)	94.0	82.0	0.7930	NS at the 0.05 level
	Snap bean root health rating (1-9, 1=best)	3.5	4.9	0.0100	**
	Fluorescein diacetate (ug FDA/g OD soil)	15.7	7.2	0.0008	***
Chemical	Glucosidase (ug p-nitrophenol/g soil/hour)	636.7	282.2	0.0009	***
	pH in water-soil paste	6.2	5.7	0.0397	*
	pH in CaCl ₂	5.6	5.0	0.0392	*
	Exchangeable acidity	1.8	5.2	0.0079	**
	P (Morgan, ppm)	9.5	14.7	0.2096	NS at the 0.05 level
	K (Morgan, ppm)	233.3	121.4	0.0013	**
	Mg (Morgan, ppm)	212.3	199.4	0.4597	NS at the 0.05 level
	Mn (Morgan, ppm)	13.4	16.9	0.1887	NS at the 0.05 level
	Fe (Morgan, ppm)	7.0	13.1	0.0098	**
	Zn (Morgan, ppm)	2.2	2.8	0.3093	NS at the 0.05 level
	Ca (Morgan, ppm)	2238	1769	0.0128	*
Al (Morgan, ppm)	51.4	60.5	0.0566	NS at the 0.05 level	
	Cornell soil health rating	68.7	59.9	0.0016	**

From this work we have selected the following measurement to use in further research:

- Sand, silt and clay, mainly for site characterization

- Organic matter, active carbon, potentially mineralizable N, root health rating, FDA, glucosidase, pH
- Possibly keep a modified version of the Cornell soil health rating

Greenhouse work

We have conducted both proposed tests to evaluate the soils' ability to suppress *V. dahliae*. The first test in which the eight soils mentioned above were evaluated for fungal disease levels showed that 3 of 4 the fields not receiving green manures had no colony forming units (cfu) of *Verticillium* whereas the fields receiving green manures all had *Vert.* cfu above the level recognized as the threshold for disease expression. This indicates that the green manures do not reduce the inoculum levels of the soil, at least not as much as the fumigation in the other soils. Green manured soils generally showed lower levels of *Fusarium* levels than non-amended soils.

In the disease-free plant assay, plants in the amended soil showed significantly more necrosis than un-amended soil at both 105 and 126 days after planting. The same was true for *V. dahliae* sclerotia stem height, which was not measurable in the un-amended (fumigated) soils but ranged from 4.6-9.8 cm in the amended soils. However, these differences did not result in significant differences in yield, but rather the highest yield was in a green manured soil. Yield did not correlate with infection by *V. dahliae* nor early necrosis. This indicates that while the green manured soils may not suppress *V. dahliae*, some other mechanism makes up for the higher infection and allows the infected potato plants to maintain yields. Possible explanations are that the amended soils produce more vigorous plants that can overcome infection by *V. dahliae*, or that nutrient differences resulting from the green manure amendments (increased mineralization of the added organic matter) occurred.

We were not able to correlate soil parameters with disease suppression since the expected suppression did

not occur. We will have to rethink this strategy of reducing risk to growers using green manures.

- Publications, Handouts, Other Text & Web Products: None
- Outreach & Education Activities: None

IMPACTS

- Short-Term: knowledge gained of the nature of the effects of green manures on Verticillium wilt in potatoes and of the measurable changes in the soil after long-term use of green manures.
- Intermediate-Term: none
- Long-Term: none

ADDITIONAL FUNDING APPLIED FOR / SECURED

- \$16,688 secured from the Washington Potato Commission
- \$248,720 secured from the WSDA, specialty crop block grants

GRADUATE STUDENTS FUNDED

none

RECOMMENDATIONS FOR FUTURE RESEARCH

We are continuing this line of research, both in the field and greenhouse, and with both plant and soil measurements.