1. Title: Growing Snap Beans in Fields with Different Soil Health: Yield, Root Disease, and Soil Health Indicators.

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3. Abstract:

A vegetable crop and pest management systems evaluation site established in 1995 has shown that 4 different management systems practiced over time have resulted in different levels of soil health. In 2006 snap beans were grown in strips in the fields in order to observe if the differences in soil health would translate into yield differences. After one year, results show that while not statistically significant, the management system that was determined to have the healthiest soil also had the highest snap bean yield. Future years of evaluation are required to confirm this observation.

4. Background and Justification:

From 1995-1999 a team of vegetable research and extension staff conducted a sweet corn systems evaluation in four discrete 2-acre fields at the Vegetable Research Farm at NYSAES Geneva (Petzoldt et al 1996, 1997, 1998, 1999, 2000, 2001b). Conventional, IPM Present, IPM Future, and Organic systems were defined and compared on the basis of yield and quality, economics, and environmental impact. Results indicated that while yield and quality, acceptable to all sweet corn markets, could be achieved under all four pest management systems, there were quite different economic and environmental costs associated with each system. In general, the Conventional system was the least expensive economically but the most expensive environmentally, the Organic system had the least environmental impact but was often the most expensive economically (although some of the extra cost may be recouped by receiving a higher price for the product), and the two IPM systems tended to be midrange both environmentally and economically. From 2000 through 2004 the systems comparison focused on cucurbit crops: melons, cucumbers, zucchini, and pumpkins, with similar results (Petzoldt et al 2001a, 2002, 2003, 2005a, 2005b).

From the time of establishment of the systems evaluation site in 1995, annual soil nutrient tests and some soil health tests were conducted on the four fields. Results at that time were similar among the four systems. With the establishment of the Cornell Soil Health Program Work Team (SHPWT) and the elucidation of specific tests as indicators of soil health, more extensive testing and comparison of fields at the site was conducted. It appears that the four management systems have resulted in different levels of soil health among the fields (Petzoldt et al 2005a, 2005b).

5. Objectives:

In 2006 our overall goal was to explore more closely the observed differences among the fields in soil health. Our specific objectives at the site were to:

1) Compare yield and levels of selected pests on snap beans in all 4 systems
2) Measure key soil health indicators according to the Tier I soil health assessment protocols developed by the SHPWT.

3) Maintain the integrity of the systems that had been established in order to maintain the soil health differences

6. Procedures:

In 2006, in order to collect additional information about soil health in the four fields managed under different IPM/ICM systems and to identify whether soil health differences would be translated into yield differences, snap beans cv. 'Hystyle' were planted into 4, 8-row strips in each of the four fields, with the strips randomly distributed across each field. Because of the susceptibility of snap beans to some of the root rot disease organisms (primarily Rhizoctonia, Fusarium, Pythium and Thielaviopsis) common in vegetable production, we wondered if the differences observed in root disease ratings over the years (Figure 1) would translate into yield differences. Table 1 shows the management practices used for each field in 2006.

For each of the 4 strips of beans per field, twelve soil samples were collected and composited into one sample for a total of 16 composited samples (4 per field). The samples were returned to the laboratory where a range of soil health tests were performed according to the procedures of the Cornell Soil Health Program Work Team (http://www.hort.cornell.edu/soilhealth/.htm). Yield was recorded on 8/8 - 8/9/06 using a 1-row Pixall bean harvester on 800 feet of bean row. Root disease ratings were derived according to the method from Abawi ((Abawi et al., 2004) by collecting soil samples from each field and growing beans in the sampled soil in the green house. Bean roots from these plants were then rated on a 1-9 scale where 1 = little or no disease and 9 = a high level of disease. Potato leafhopper (PLH) adults were sampled on 7/27/06 using a sweep net to make 10 sweeps on the third row in from each side of each 8-row strip (80 sweeps/field). PLH nymphs were sampled on 8/3/06 by inspecting 10 randomly selected trifoliate leaves from each of the same rows.

Table 1: Management practices for each of the 4 systems fields - 2006

	Conventional	IPM Present	IPM Future	Organic
Cover crop prep	N/A	flail chopped 5/11/06	flail chopped 5/11/06	flail chopped 5/11/06
Tillage	Plow 5/17/06 Disc 5/23/06	Plow 5/15/06 Disc 5/24/06	Plow 5/17/06 Disc 5/25/06	Plow 5/18/06 Disc 5/23/06
Plant Beans	6/16/06	6/16/06	6/16/06	6/17/06
Bean variety/seed treatment	Hystyle/ Captan + Apron	Hystyle/ Captan + Apron	Hystyle/ Captan + Apron	Hystyle/ Captan + Apron
Plant between bean strips	none	buckwheat	soybeans	soybeans
Weed control	Eptam @ 3.5pt/acre + Treflan @ 1.5pt/acre; 6/14/06	Sandea @ 1 oz/acre on 6/16/06	Sandea @ 1 oz/acre on 6/16/06	Stale seedbed – Cultivate with Rabe Werk 6/15/06; Cultivate with Rabe Werk 6/23 with tines over rows raised
Fertility	350 lbs/acre 15-15-15 brdcst preplant, 6/14/06	175 lbs/acre 15-15-15 brdcst preplant; 6/14/06 175 lbs/acre 15-15-15 band @ planting	175 lbs/acre 15-15-15 band @ planting	Broadcast 2000 lbs/acre Fertrell 2-4-2; 6/14/06
Cultivation dates	7/7/06	7/7/06	none	7/7/06
Harvest dates	8/9/06	8/8/06	8/8/06	8/9/06

7. Results:

Tables 2 through 5 show bean yield, root rot ratings, selected soil health data, and potato leafhopper counts for 2006. Figure 1 shows the progression of root rot ratings from 1995 through 2006.

Table 2: Yield of snap beans - 2006

Treatment	Pounds of beans/ 800 row feet
IPM Future	117.01 a
IPM Present	88.08 a
Organic	80.58 a
Conventional	78.23 a

Table 3: Root rot ratings - 2006

Treatment	Root rot rating
IPM Future	2.38
IPM Present	2.88
Organic	2.65
Conventional	4.50

Rated on 1-9 scale where 1 is no disease and 9 is heavily diseased. (Abawi)

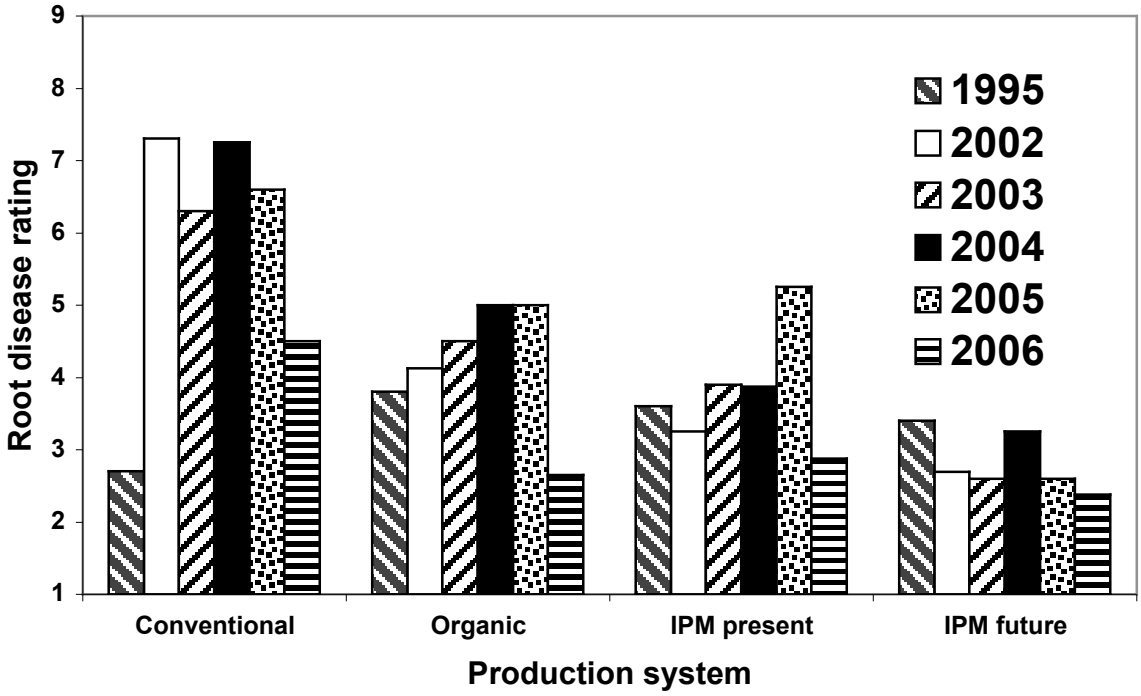
Table 4: Selected Soil Health Data – 2006

Treatment	Aggregate Stability (%)	Organic Matter (%)	Active Carbon (ppm)	Penetrometer readings		
				0-6”	6”-12”	12”-18”
IPM Future	21.15	4.25	552.9	126.7	242.7	298.2
IPM Present	12.01	3.40	411.1	179.2	277.5	295.8
Organic	18.55	4.72	618.7	141.7	254.2	231.7
Conventional	10.81	3.98	578.4	125.0	231.7	285.8

Table 5: Potato leafhopper infestation

Treatment	Adults (#/80 sweeps)	Nymphs (#/80 leaves)
IPM Future	12a	29a
IPM Present	13a	25a
Organic	12a	25a
Conventional	49 b	52 b

Figure 1: Root disease ratings 1995-2006



8. Discussion:

Since this is a progress report with only one year's data from this type of trial at this site, it is difficult to draw conclusions about the relationship between soil health, yield, and pests. Throughout the 2006 growing season photographs show the Conventional field to have the poorest stands and least healthy appearing plants while the IPM Future plants were the most vigorous and had the healthiest appearance. The following paragraphs summarize the data collected so far.

While in 1995, the first year of the comparison, the fields had similar root rot ratings, since 2002, the IPM Future field has consistently had the lowest root rot ratings (or least amount of disease and healthiest roots) in this test. The Organic and IPM Present systems had slightly higher levels of root rot in the test than IPM Future in those years while the Conventional field has consistently had the highest levels of root rot compared to the other 3 fields. The different management systems appear to have had a big impact on root disease in the fields over the years with the Conventional field having consistently high disease ratings.

The IPM Future and Organic fields have higher aggregate stability and organic matter content compared to the IPM Present and Conventional fields – two factors that would indicate that the soils in IPM Future and Organic fields are currently healthier. This data is consistent with the root disease ratings.

The Organic field is showing the highest levels of active carbon (the fraction of soil organic matter that is readily available as a carbon and energy source for the soil microbial community). The Conventional and IPM Future fields are slightly lower in active carbon while the IPM Present field is considerably lower than the other 3 fields.

Soil penetrometer readings for the fields indicate that the IPM Present field is the most compacted while the IPM Future, Conventional and Organic fields are similarly less compacted.

One of the more surprising data sets was the infestation by potato leafhopper adults and nymphs. Although we would likely have expected little difference in an immigrant pest like leafhoppers among the fields, the Conventional field had approximately double the number of adults and nymphs compared to the other three fields. We will continue to monitor this pest in future years to see if this pattern is repeated.

Yield, which can in part reflect the various soil health factors, while not significantly different among the fields this season, was highest in the IPM Future field while the other three fields had similar yields.

The data are yielding more questions than answers in the overall assessment of the soil health resulting from the various management systems. Numerous factors contribute to soil health. Clearly the systems that have been implemented over the past 12 years have had impacts on various factors related to soil health. Currently, the data indicate that the IPM Future and Organic systems may have the overall healthiest soils at the site. However, additional soil health data collected from this trial have not been fully analyzed in conjunction with the data presented here. As that data is in incorporated into the analysis, our conclusions may change.

9. References:

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