Reducing Risk Associated with Organic Snap Bean Production in Wisconsin

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Project Summary

The objective of this research was to determine the best management practices to reduce the risk associated with large-scale organic snap bean (***Phaseoulus vulgaris***) production in Wisconsin. The principal limiting factors are 1) root rot disease, 2) seed corn maggot and 3) nitrogen management. Results indicate that the root rot resistant cultivar 'UW3' combined with a seed treatment of Entrust and composted poultry manure would provide the optimal results. A prior year N credit provided higher plant stands than composted poultry manure; however, it did not result in an overall higher yield.

Introduction

Wisconsin currently ranks number one in the production of processing snap beans with 44% of the nation's crop (USDA, 2012). In addition, Wisconsin ranks second, only to California, in the number of organic farms in the state with organic crop sales reaching $16.7 million in 2007 (Blazek, 2010). Production and processing of organic snap beans in Wisconsin offer a significant opportunity for value added economic impact to over 1,400 certified growers and a very significant opportunity for the processing industry. In Wisconsin, organic snap bean production for processing currently meets less than one-third of current demand. In spite of price incentives, it is especially difficult for processors to contract sufficient acres to meet demand due to the high risk and low yields associated with larger-scale organic production. The principal limiting factors are 1) root rot disease, 2) seed corn maggot and 3) nitrogen management.

1) Root Rot

We have developed snap bean cultivars resistant to root rot pathogens. Field-based research trials have consistently demonstrated that 'UW3' has a higher yield, percent emergence and stand compared to the industry standard, root rot susceptible cultivar, 'Hystyle' under root rot and non-root rot conditions for organic production.

2) Seed Corn Maggot

Seed corn maggot (SCM), ***Delia platura***, causes severe plant stand reduction generally resulting in lower yields (Hammond, 1991). Adult seed corn maggot flies are attracted to decomposing organic matter and freshly plowed fields, which becomes a significant problem for organic farmers when trying sustain good N management (Van Wychen Bennett, 2011). SCM larvae feed on newly planted seeds, as well as, the below ground tissue of snap bean seedlings resulting in damage, poor germination and poor plant stands (Delahaut, 2007). Generally, there are four to five generations per year, but it is the first and second that pose the greatest risk to farmers (Bessin, 2003).

In conventional production, snap bean seed is generally treated with a cocktail of insecticides, fungicides and antibiotics to minimize damage to seeds and seedlings due to root and seed rots and SCM. Dow AgroSciences, LLC has identified a spinosad-based, Organic Material Review

Institute (OMRI)-approved insecticide called Entrust, which is effective against SCM damage.

3) Nitrogen Management

Nitrogen management is one of the most difficult and costly practices in organic agriculture. It must be carefully evaluated and managed (Johnson et al., 2012). Organic growers must focus on the interconnection between soil, nutrients, pests, and weeds to be successful.

Objectives Statement

The objective of this research was to integrate technologies, strategies and experience, based on previous and on-going factorial experiments, to determine the optimal genotype, fertilizer type, fertilizer rate, seed treatment and seed source to increase benefits and reduce risk associated with organic snap bean production in Wisconsin. We conducted field trials at two locations in 2011 to evaluate the factorial effects and interactions within the trial and to conduct on-farm validation.

Changes to the Original Proposal

Typically, snap bean seed in the United States is produced in the Pacific Northwest from April through September. Seed would not have been available for our 2011 trials due to the timing of the grant finalization. Instead, we subcontracted with a commercial seed producer (Piga Seeds) in Chile that Pure Line Seeds, Inc. uses for off-season production to produce the organic seed.

Materials and Methods

Trials were conducted at two organic certified sites during the 2011 growing season, Hancock Agricultural Research Station (HARS) in Hancock, WI and Flyte Family Farm (FFF) in Coloma, WI. The experimental design utilized randomized complete blocks with three replicates at both locations. The experiment was a 2^5 factorial with two contrasting levels for each factor (Table 1). Blocks with prior year nitrogen credit were plowed down prior to planting. Composted, pelletized poultry manure was used as the composted poultry manure (CPM) source for the study. The CPM was applied at a rate of 14 lbs/block. It was incorporated into the soil immediately and the trial was planted two weeks later.

Table 1. Outline of 2^5 factorial experimental design used at Flyte Family Farm and Hancock Agricultural Research Station.

Factor	Levels	Comments
Location	Hancock ARS Flyte Family Farm	Flyte Family Farm is a commercial scale, certified organic producer.
Nitrogen source	Composted Poultry Manure (14 lbs/block) Prior year nitrogen credit	Nitrogen credit at Flyte Family Farm from clover. Nitrogen sources at Hancock ARS from cow manure and rye.
Planting time	Early (mid-May) Late (mid-June)	Flights of ovipositing adult seed corn maggots vary over the season.
Cultivar	UW3 Hystyle	UW3 is root rot resistant and Hystyle is susceptible
Seed treatment	Entrust (0.50 mg ai/seed) None (untreated)	Seed was treated only with 0.50 mg ai/seed of Entrust.

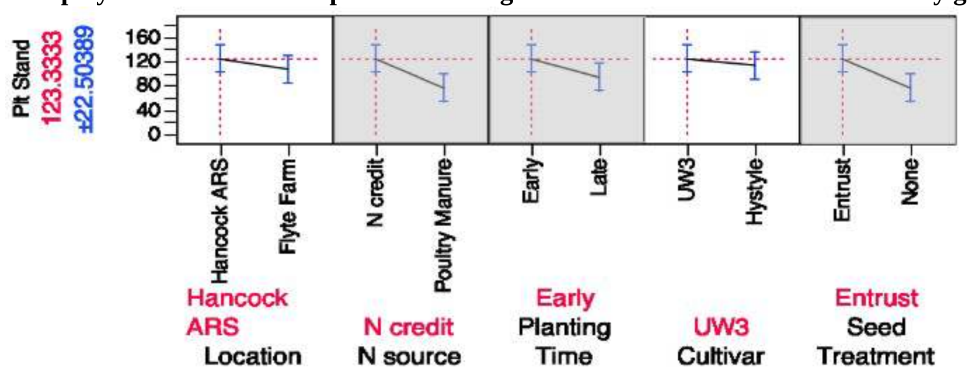
Blocks were 15’ X 21’ with row spacing of 30” and were precision planted with a single row cone planter at a rate of 8 seeds/ft for both early and late trials. Blocks at HARS received a direct application of blood meal at planting to increase seed corn maggot pressure at this location only

(Kuhar et al., 2006). Initial plant stand evaluations were conducted 14 days after germination (Smith, 1996). Evaluation of seed corn maggot damage was conducted by extracting seed hulls from additionally planted rows at HARS to help determine the presence and pressure of seed corn maggot. Mechanized harvesting and auto-grading were used at both locations for both early and late trials (see Figs. 1 and 2 in the photo section).

Results

A 2^5 factorial analysis of variance (ANOVA) for plant stand included all main effects, as well as, all first order and higher order interactions. The significant main effects and interactions from the ANOVA for plant stand are illustrated in Figures 3 and 4.

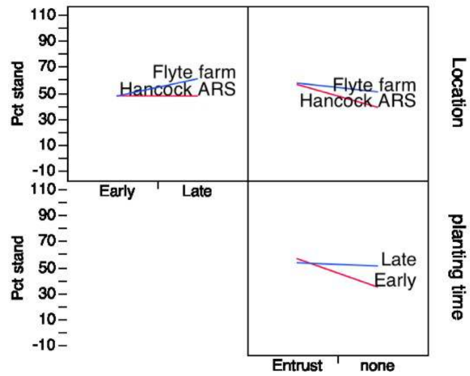
Fig. 3. Graphic display of main effects for plant stand. Significant main effects are illustrated by gray shading.



Nitrogen source, planting time and seed treatment were significant factors affecting plant stand (Fig. 3). Plant stands were lower in field trials that used composted poultry manure (74.7%) compared to fields with a prior year legume as a nitrogen credit (89.3%). Early planting (mid-May) had a lower plant stand (76.8%) compared to later planting (mid-June) (87.2%). This likely corresponded to flights and oviposition of the seed corn maggot. Seed treated with 0.50 mg ai/seed Entrust had significantly higher plant stands (91.6%) compared to the untreated seed (72.3%). There was no significant difference in plant stand between the two cultivars suggesting that plant stands were not affected by root rot at either location in 2011.

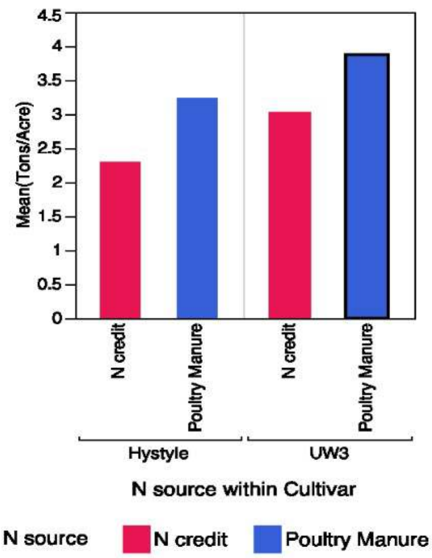
The first order interactions for percent plant stand between locations (Hancock vs. Flyte), planting time (early vs. late) and seed treatment (Entrust vs. untreated) (Fig. 4) all suggest that pressure of seed corn maggot damage was not consistent over locations and planting times (Fig. 5). The significant interactions indicate that Entrust seed pretreatment was only effective in the presence of seed corn maggot.

Fig. 4. Graphic display of significant first order (1°) interactions for percent stand between locations, planting time, and seed treatment.



Analysis of the yield data (Tons/Acre) indicates that Cultivar and N source were the only statistically significant main effects that affected yield (Fig. 6). Entrust did not prove to have a statistical interaction effecting the overall yield. The UW3 cultivar had a yield that was 20% greater than the commercially accepted Hystyle. The prior year N credit resulted in a mean yield of 2.66 Tons/Acre, while composted poultry manure resulted in a 3.55 Tons/Acre yield, or a 25% greater yield.

Fig 6. Graphic display comparing yield (Tons/Acre) for snap bean cultivars Hystyle and UW3 using N credit or composted poultry manure as N source.



Discussion and Conclusions

The prior year nitrogen credit resulted in a higher plant stand as compared to fields dressed with composted chicken manure; however, it did not result in a higher yield. This difference could be due to the variation in rates of volatilization and availability of the N source (Havlin, 2005). Seed treated with Entrust had a higher plant stand (27%) compared to the untreated seed. The positive effects of Entrust are likely due to a reduction in seed damage by seed corn maggot. The prevention of seed corn maggot damage helps to avert significant economic loss for organic growers.

Determining the most effective nitrogen management strategy using a prior year N credit or CPM is less straightforward. We saw an increased plant stand from the prior year N credit; however, this was not directly correlated with a higher yield. Instead we observed a higher yield from the CPM regardless of cultivar. The results suggest that the use of cultivar UW3 combined with 1 ton CPM/acre optimizes yield.

This research identified UW3 as the superior cultivar, Entrust as the ideal seed treatment, both of which are commercially available, and composted poultry manure, which is easily accessible and cost efficient, as the strategies to be used to achieve the best management practices for organic snap bean production. Using these practices, Wisconsin organic producers have the opportunity to successfully produce snap beans on a small or large-scale while achieving yields comparable to conventional producers (4.36 tons/acre) (USDA, 2012). A second year of data collection is planned (summer 2012) to confirm our results.

Outreach

The research results from the 2011 growing season were presented at the biennial meeting for the Bean Improvement Cooperative (BIC) in San Juan, Puerto Rico, October 30 - November 4, 2011. In addition to the presentation, a two-page summary was submitted and will be published in the 2012 BIC Annual Report (Fig. 8). A final report including the results from the 2012 growing season will be submitted to the BIC after the final data analysis is completed. In the future, the final results for both seasons of research could be presented at HARS Field Days during the summer of 2012, the Midwest Food Processors Association (MWFPA) meeting held in Madison, WI November 27-29, 2012 and the Organic Farming Conference sponsored by MOSES in 2013. We will work with the UW-Extension office to have the final research results incorporated into a processors guide.

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Photos and figures

Fig 1. Mechanized harvest of 2011 organic field trials at Hancock Agricultural Research Station.

Fig 2. Auto-grading of 2011 organic field trials at Hancock Agricultural Research Station.

Fig 5. Presence of seed corn maggot damage in field. The seedling on the left emerged unaffected, while the seedling on the right experienced damage from seed corn maggot delaying germination and decreasing vigor.

Fig 7. A picture of graduate student, Courtney Pfad on the left, and the Principle Investigator, James Nienhuis on the right, together in the grading shed after harvesting.

Fig 8. 2012 2-page submission to the Bean Improvement Cooperative.

REDUCING RISK ASSOCIATED WITH ORGANIC SNAP BEAN PRODUCTION IN WISCSONSIN

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INTRODUCTION

In Wisconsin, snap beans (***Phaseolus vulgaris***) are an important processing vegetable crop occupying nearly 80,000 acres of land; less than 2,000 of which are organically managed. Organic snap bean production for processing currently meets less than one-third of the present market demand. Despite price premiums as incentive, it is especially difficult for processors to contract sufficient acres to meet demand due to the high risk and low yields associated with larger-scale organic production. The principal limiting factors effecting organic production in the upper Midwest are: 1) root rot disease (***Pythium ultimum*** and ***Aphanomyces euteiches*** f. sp. ***phaseoli***), 2) nitrogen management, and 3) seed corn maggot (***Delia platura***).

In conventional production, snap bean seed is generally treated with a cocktail of insecticides, fungicides and antibiotics to minimize damage to seeds and seedlings due to root and seed rots and seed corn maggot. Dow AgroSciences, LLC has identified a spinosad-based, Organic Material Review Institute (OMRI)-approved insecticide that is effective against seed corn maggot. We have developed a snap bean cultivar resistant to root rot pathogens.

MATERIALS AND METHODS

The objective of this research is to integrate technologies, strategies and experience to determine the optimal genotype, fertilizer type, fertilizer rate, seed treatment and seed source to increase benefits and reduce risk associated with organic snap bean production in Wisconsin. The best management practices are validated with certified-organic, commercial grower cooperators. The experiment was a 2^5 factorial with two contrasting levels for each factor, with 3 reps per location.

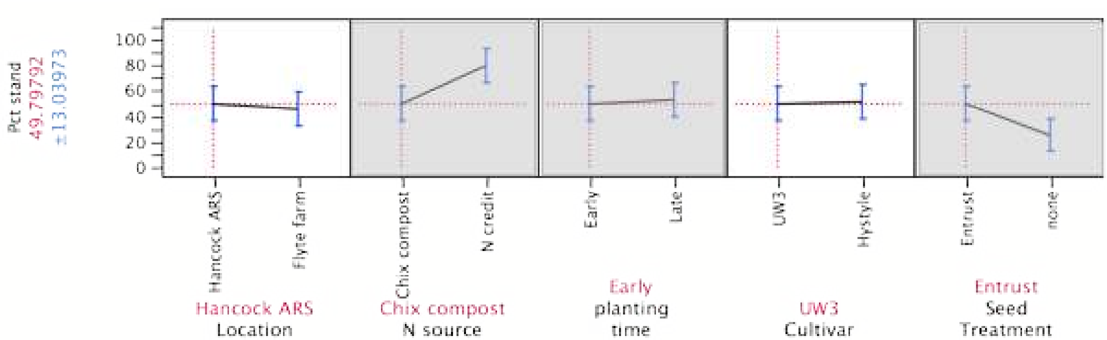
Table 1. Outline of 2^5 factorial experimental design

Factor	Levels	Comments
Location	Hancock ARS	Flyte Family Farm is a commercial scale, certified organic producer
	Flyte Family Farm	
Nitrogen source	Chicken Guano	Nitrogen credit at Flyte Family Farm from clover. Nitrogen sources at Hancock ARS from cow manure.
	Prior year nitrogen credit	
Planting time	Early (mid-May)	Flights of ovipositing adult seed corn maggots vary over the season
	Late (mid-June)	
Cultivar	UW3	UW3 is root rot resistant and Hystyle is susceptible
	Hystyle	
Seed treatment	Entrust (0.50 mg ai/seed)	Seed was treated only with Entrust.
	None (naked)	

RESULTS AND DISCUSSION

The ANOVA for plant stand included all main effects, as well as, all first order and higher order interactions. The significant main effects and interactions from the ANOVA for plant stand are illustrated in Figures 1 and 2 below.

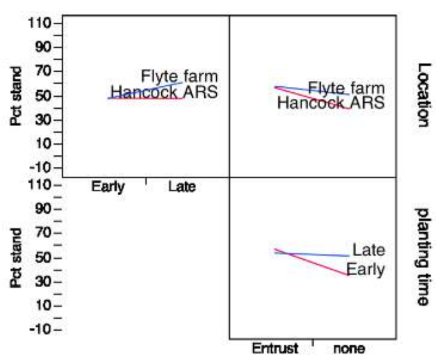
Fig. 1. Graphic display of main effects. Significant main effects are illustrated by gray shading.



Significant Main Effects

• Nitrogen source - Plant stands were lower in composted chicken guano (74.7%) compared to fields with a prior year legume as a nitrogen credit (89.3%).
• Planting time – Early planting (mid-May) had a lower plant stand (76.8%) compared to later planting (mid-June) (87.2%). This likely corresponded to flights and oviposition of the seed corn maggot.
• Entrust – Seed treated with 0.50 mg ai/seed Entrust had significantly higher plant stands (91.6%) compared to non-treated, naked seeds (72.3%).
• There was no significant difference in plant stand between the two cultivars suggesting that plant stands were not affected by root rot at either location.

Fig. 2. Graphic display of first order (1°) interactions.



The first order interactions for percent plant stand among locations (Hancock vs. Flyte), planting time (early vs. late) and seed treatment (Entrust vs. naked) (Fig. 2) all suggest that pressure of seed corn maggot was not consistent over locations and planting times. Entrust seed treatment was only effective if seed corn maggots were present.

CONCLUSIONS

The prior year nitrogen credit resulted in a higher plant stand and yield as compared to fields dressed with composted chicken guano. This difference could be due to the variation in rates of volatilization of the N source. Seed treated with Entrust had a higher plant stand (27%) compared to naked seed. The positive effects of Entrust are likely due to a deduction in seed damage by seed corn maggot.

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