2011 Pennsylvania Vegetable Marketing and Research Program
Pennsylvania Vegetable Growers Association Report
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Title: Extended season management of snap bean root pathogens using combinations of seed, soil and foliar treatments

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Brief project description:

Snap beans are susceptible to a number of common soilborne root pathogens including *Rhizoctonia solani*, *Pythium* spp., and *Fusarium* spp. Often these pathogens occur in association with one another to create complexes. Root rots are generally most severe and cause the greatest damage to beans when cool and wet soil conditions occur from seeding to three weeks after planting and then are followed by hot dry weather. The poorly established root systems are unable to up-take the nutrients and water necessary to sustain the plant and it collapses. Damages and losses are often expressed as poor emergence due to seed decay and pre-emergence damping-off, post-emergence damping-off, as well as root rots later in the season that lead to the development of stunted, unthrifty and less productive plants.

The wide host ranges of these soilborne pathogens and their ability to produce resistant survival structures make the use of crop rotation as a management strategy difficult once they are established in a field. Since resistant snap bean cultivars are currently not available (although they can differ in susceptibility), growers have relied on seed treatments as the most effective way to deliver early season protection. However, these pathogens can still infect the unprotected tap and feeder roots later in the season resulting in reduced yields. The use of in-furrow soil treatments at planting in combination with *Rhizobium* may provide longer season control of soilborne root diseases through stimulation of root growth through root nodulation and nitrogen fixation and longer-term protection of that new root growth. In addition, foliar applications of systemic translocated potassium phosphite may provide additional protection from *Pythium* and other soilborne oomycete pathogens. Identification of the most effective seed, soil and foliar treatment combinations will provide growers with additional tools for managing soilborne pathogens season-long.

Objectives for 2011 include:

1. Identifying soilborne pathogens contributing to reduced yield in grower collaborator fields.
2. Evaluating seed, soil and *Rhizobium* treatments and treatment combinations in fields to identify treatments and treatment combinations that can be incorporated into an integrated pest management program for managing snap bean root pathogens.

Methods and Results:

Objective 1: Identifying soil-borne pathogen contributing to reduced yield in grower collaborator fields.

To identify the soil-borne pathogens contributing to reduced yields in grower collaborator fields, composite soil samples were collected from three problematic fields in Potter Co., PA at the end of June. The composite samples were thoroughly mixed, divided and placed into five replicate clay pots (4-in. diameter) and planted with 8 snap bean seeds cv. 'Hystyle', maintained in a greenhouse at 25°C and watered and fertilized as needed. After 7 weeks, the plants were removed; the roots were washed free of soil, then examined and rated for root disease severity based on the severity of symptoms on the hypocotyls and roots using a scoring of 1 (healthy) to 9 (>75% of the hypocotyls and roots are showing severe symptoms and signs of decay). Based on root symptoms, the fungal pathogens present (*Fusarium* spp. *Rhizoctonia solani*, *Pythium* spp., etc.).

Results:

The greenhouse bioassays indicated the potential for significant problems with soilborne fungal pathogens in one of the three fields sampled based on the average bioassay root health rating of 8.5 (Fig 1A) whereas, the ratings in the other two fields were 4.5 and 5.0 (Fig 1B and C, respectively). Based on root and hypocotyl symptoms on the bioassay plants, the primary pathogen in all three fields was *Fusarium solani* f. sp. *phaseoli*, the causal agent of Fusarium root rot. It is very common in bean growing soils and is often found associated with Rhizoctonia root rot and Pythium root rot. It is most problematic when soils are cool and wet early in the growing season and then followed with hot and drier conditions.

Figure 1. Roots of soil bioassay plants grown in composite soil samples collected from three fields in Potter Co., PA.

Objective 2: **Evaluating seed, soil and *Rhizobium* treatments and treatment combinations in fields to identify treatments and treatment combinations that can be incorporated into an integrated pest management program for managing snap bean root pathogens.**

Trials were conducted in three Potter Co. fields with known histories of severe soilborne pathogen pressure that has been associated with reduced snap bean yields. The field trials were arranged in a split-split plot design with the in-furrow treatment (none, *Rhizobium* spp., azoxystrobin) as the whole plot, foliar application of potassium phosphite and snap bean cultivar (Dart, Caprice, Titan) as the split plots with four replications (Figure 2, Table 1). This arrangement enables all possible treatment combinations to be evaluated in a systematic manner. Unfortunately, the very hot and dry conditions that persisted this season precluded the application of the foliar treatments so only seed and in-furrow treatment combinations were evaluated.

The field trials were planted on 15 Jun and managed using standard commercial production practices. Each plot consisted of two 20ft rows with a 5ft break between plots within rows and 30 in. between row middles. Plots were planted using a two-row JD-1750 planter fitted with soybean cups and calibrated to deliver 5 seeds/ft at a depth of 1.0-2.5 in. The *Rhizobium* inoculant was applied using a modified fertilizer attachment on the planter. Air temperature, dew point, relative humidity, growing degree-days, and precipitation were monitored from an existing weather station located on the Blass farm. In addition, soil temperatures, at the 2-in. and 20-in. depths, and air temperature were recorded at each field location.

Table 1. Snap bean seed and in-furrow treatments.

Cultivar	Company	Commercial Seed Treatments	
Dart	Harris Moran	Captan 400, Lorsban 50W, Ag-strptomycin, Allegience FL, Cuiser 5FS, Maxim 4FS	
Caprice	Harris Moran	Captan 400, Lorsban 50W, Ag-strptomycin, Allegience FL, Cuiser 5FS	
Titan	Seminis	Captan 400, Lorsban 50W, Ag-strptomycin, Allegience FL, Cuiser 5FS	
In-Furrow Product	**Company**	**Active ingredient**	**Rate**
Soil Implant+	EMD Crop BioScience	*Rhizobium leguninosarum* biovar *phaseoli*	6.5 lb/A
Quadris	Syngenta	Azoxystrobin	0.6 fl oz/ 1000 ft row

Data on emergence was collected from a 10ft section of row on 27 Jun and stand counts as well as yield data (total plant and pod weight) were collected on 18 Aug. Soil samples were collected and assessed for soilborne fungal pathogens as part of Objective 1. In addition, root health and nodulation were rated on 5 plants per plot on 29 Jul. All data was analyzed using an analysis of variance with the GLM procedure of SAS 9.2 (SAS Institute, Cary, NC). In the absence of interactions, the main effects were compared using Fisher's LSD ($P<0.05$).

Results and Discussion:

The growing season was both hot and dry. Total precipitation amounted to 3.53 in. for the three field trials from 15 Jun to 18 Aug. Average daytime temperatures exceeded 85˚F for almost 2 to 3 weeks during the season and maximum daily air temperatures just above the crop canopy reached over 90˚F every day for over 6 weeks (67% of the growing season) with 2 to 3 weeks actually exceeding 100˚F depending on the trial location. At the 2 in. depth, soil temperatures exceeded 80˚F for over half the growing season and only temporarily dropped below 60 ˚F on 11 days within the first two weeks and during last week before harvest.

Both the location of the field trial as well as snap bean cultivar had a significant effect on snap bean emergence evaluated 12 days after planting (Table 2). Snap bean cv. Titan had significantly lower emergence counts compared to cvs. Dart and Caprice. This difference persisted throughout the growing season in all three trials as evidenced by the stand counts taken at the end of the season. The Blass field which was more crusted, had a lower emergence counts that the Sweden Hill field. The in-furrow treatment with either *Rhizobium* spp. or azoxystrobin did not have a significant effect on emergence.

At the end of the season, only the location of the trial had a significant impact on both total plant and pod weight. The Sweden Hill field had significantly higher total plant and pod weights compared to the Snowman and Blass fields. Although the mid-season root health ratings were significantly higher indicating less healthy roots in the Sweden Hill field, the ratings in general across all three fields were relatively low. Root health ratings between 1 and 3 are considered good/healthy, 4 to 6 are moderate and 7 to 9 are bad/severely diseased. The higher yields observed in the Sweden Hill field were likely in part was due to a miscommunication and additional fertilizer was applied both prior to establishing the trial and at-planting at this location. The in-furrow *Rhizobium* spp. and azoxystrobin treatments did not significantly impact either the snap bean root health or snap bean yield in any of the three trials. Not surprisingly, cultivar also did not impact mid-season root health since the commercial seed came pre-treated with a similar mix of fungicides (Table 1). Root health ratings of the field grown snap beans were lower (= less disease) than the greenhouse bioassay snap beans because the dry and warm conditions were less favorable for root disease development. In the greenhouse, regular watering helps to provide conditions that are more favorable for pathogen infection and disease development. Fungal isolations made from representative symptomatic root tissue indicated that *Fusarium* spp. were the primary fungal pathogens on the snap bean roots in the Snowman and Blass fields and the Sweden Hill field also had *Rhizoctonia solani* in addition to *Fusarium* spp. associated with the roots.

Unfortunately, the persistent hot temperatures precluded the foliar application of potassium phosphite during the season as originally planned and were not favorable for root disease development. Under these environmental conditions, the use in-furrow application of *Rhizobium* spp. and azoxystrobin did not significantly improve overall root health nor increase total plant weight or yield. Benefits of these treatments may be observed under more favorable disease conditions. In general, snap bean yields in Potter Co., PA were very low this season likely due to the high temperatures. Temperatures above 85˚F during flowering can interfere with pollination and result in blossom drop and pod deformation due to lack of ovule development.

Table 2. The effect of field location, cultivar and in-furrow treatment on snap bean emergence, stand, mid-season root health rating of field grown plants, and total plant and pod weights. No statistical interactions were observed so the main treatment effects (field location, cultivar, in-furrow treatment) were analyzed individually.

Field location effects on ….	**Emergence (10ft row)**	**Stand (10ft row)**	**Mid-season root health rating**	**Total plant wt (lb/10ft row)**	**Total pod wt (lb/10ft row)**
Sweden Hill	58.3 a	60.9	4.9 a	12.46 a	5.58 a
Snowman	56.6 ab	59.2	3.6 b	10.05 b	4.17 b
Blass	54.9 b	56.0	3.3 b	8.57 c	4.17 b
	P=0.0479	NS	*P*<0.0001	*P*<0.0001	*P*<0.0001
Cultivar effects on ….	**Emergence (10ft row)**	**Stand (10ft row)**	**Mid-season root health rating**	**Total plant wt (lb/10ft row)**	**Total pod wt (lb/10ft row)**
Dart	60.6 a	63.2 a	3.8	10.21	4.32
Caprice	60.1 a	61.8 a	4.0	10.58	4.92
Titan	49.0 b	51.9 b	4.0	10.71	4.81
	P<0.0001	*P*<0.0001	NS	NS	NS
In-furrow treatment effects on ….	**Emergence (10ft row)**	**Stand (10ft row)**	**Mid-season root health rating**	**Total plant wt (lb/10ft row)**	**Total pod wt (lb/10ft row)**
None	56.0	59.1	4.1	10.67	4.72
Rhizobium spp.	57.9	58.5	4.0	10.85	5.07
Azoxystrobin	55.9	59.3	3.7	10.00	4.25
	NS	NS	NS	NS	NS

		In-furrow trt (column)			In-furrow trt (column)				
		None	*Rhizobium*	mefenoxam	None	*Rhizobium*	mefenoxam		
Rep 3	No foliar spray	cv 2	cv 3	cv 1	cv 1	cv 3	cv 2	Foliar spray	**Rep 4**
		cv 1	cv 2	cv 3	cv 2	cv 1	cv 3		
		cv 3	cv 1	cv 2	cv 3	cv 2	cv 1		
	Foliar spray	cv 1	cv 2	cv 3	cv 3	cv 1	cv 3	No foliar spray	
		cv 3	cv 1	cv 2	cv 1	cv 3	cv 2		
		cv 2	cv 3	cv 1	cv 2	cv 2	cv 1		
Rep 1	No foliar spray	cv 3	cv 1	cv 3	cv 3	cv 2	cv 1	Foliar spray	**Rep 2**
		cv 2	cv 3	cv 1	cv 1	cv 3	cv 2		
		cv 1	cv 2	cv 2	cv 2	cv 1	cv 3		
	Foliar spray	cv 3	cv 2	cv 2	cv 1	cv 2	cv 3	No foliar spray	
		cv 2	cv 1	cv 3	cv 3	cv 1	cv 2		
		cv 1	cv 3	cv 1	cv 2	cv 3	cv 1		

Figure 2. Field trial layout consisting of 3 in-furrow treatments (none, *Rhizobium*, mefenoxam - columns), 2 foliar spray treatments (none - blue, potassium phosphite - red) and 3 different snap bean cultivars noted by different shades of red and blue (cv 1, cv 2, cv 3) replicated four times. The entire trial is approx. 30 ft wide (12 rows) x 300 ft long.