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Title: Evaluation of select seed treatments for the management of soilborne pathogens of snap bean.

Principle Investigators:

Beth K. Gugino, Dept. of Plant Pathology and Environmental Microbiology, The Pennsylvania State University, University Park, PA 16802; (814) 865-7328; bkgugino@psu.edu.

Introduction:

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.

On-farm grower trials are an important tool for evaluating potential management strategies however, the variability in soilborne pathogen pressure and the difficulty in creating a favorable environment for disease development can make it difficult to obtain reliable results especially when a management tool is in the early stages of evaluation. With funding support from PVMRP/PVGA last year, snap beans were double cropped in a 2A research field to begin to establish "disease nursery" where we can inoculate specific pathogens, maintain short rotations and use supplemental overhead irrigation to promote favorable disease conditions for disease development. In 2015 select seed treatments were evaluated for their efficacy on common soilborne pathogens. Additional efficacy data on seed treatments will enable growers to make more informed root rot management decisions at the beginning of the season.

Methods and Results:

Two trials were conducted at the Pennsylvania State University Russell E. Larson Agricultural Research and Extension Center at Rock Springs on a Hagerstown silty clay loam. On 5 May the field was plowed and prepared and 135 lb/A 11-52-0 and 55 lb/A 46-0-0 fertilizer was broadcast and incorporated based on the soil nutrient analysis. The first trial was planted on 7 May (1st planting) and the second trial on 10 June (2nd planting). Each plot consisted of two 12 ft rows with a 5 ft break between plots within rows and 30 in. between row middles. The plots were planted with a two-row JD-1750 planter fitted with soybean cuts and calibrated to deliver 7 seeds/ ft at a depth of 1.5 in. A starter fertilizer (100 lb/A 10-30-10) was also applied at planting in the furrow. The 2nd planting was side-dressed with 30% urea (26 lb/A) on 8 Jul. The left row of the plot was inoculated at planting with a mix of rye grain that had been colonized with

Fusarium solani, *Rhizctonia solani* or *Pythium ultimum*. A 150 ml beaker containing an equal mix of rye grain for each pathogen was added to the soybean cup and dispersed along with the seed into the furrow. Weeds were managed with an application of Medal EC (2.0 pt/A) on 5 May (1st planting) and Medal EC (2.0 pt/) plus Sandea (1.0 oz/A) on 12 Jun (2nd planting). In the absence of rain, supplemental water was delivered using overhead misters from 9 May to 19 May for the 1st planting. No supplemental water was applied to the 2nd planting. The ten treatments (listed above) were arranged in a randomized complete block design with four replications. The snap bean seed cv. Caprice was treated by Harris Moran using standard commercial seed treatment practices.

The seed treatments were additive in design to evaluate the stepwise addition of fungicides to improved management of Fusarium, Rhizoctonia and Pythium soilborne pathogens. The standard seed treatments included Lorsban and Cruiser for insect pests, AS-50 for halo blight and Captan. The additional fungicides evaluated included Allegiance (metalaxyl), Thiram (thiram), Dynasty (azoxystrobin), Maxim (fludioxinil), Apron XL (mefenoxam), Apron MAXX (mefenoxam + fludioxinil) and Vibrance (sedaxane; not registered on snap bean).

Seed emergence was counted for the center 10 ft of each row of each plot on 20 May for the first planting and on 19 Jun, 25 Jun and 3 Jul for the second planting. Unfortunately the first trial was lost due to an early morning frost event on 23 May. For the 2nd planting, 5 plants per row in each plot were dug using a shovel and visually rated for root health on a scale of 1 to 9 on 23 Aug. The plants were pooled across treatments. Rainfall total (in.) for the 1st planting was 1.18 from 5 to 23 May. For the 2nd planting totals were 5.52, 7.19, and 2.43 from 10 to 30 Jun, Jul and 1 to 23 Aug, respectively. Soil temperatures were measured in-field at the 2-in. soil depth using Onset HOBO pendant temperature/light sensors set to record hourly temperature. Average minimum and maximum soil temperatures at the 2-in. depth for the first planting from 16 to 23 May were 58.7 and 71.0°F, respectively. For the second planting, max. and min. soil temperatures during planting through stand establishment from 10 Jun to 15 Jun were 67.2 and 78.1°F, respectively. Data was analyzed using analysis of variance (ANOVA) $P < 0.05$ and means separated using Fisher's Least Significance Difference Test (SAS v. 9.2, Cary, NC).

Figure 1. Snap bean roots 84 days after planting (2nd planting). Untreated control (top) and standard commercial treatment plus Apron MAXX. The larger root system is in part due to the wider plant spacing due to poor emergence and stand establishment.

Fusarium root rot caused by *Fusarium solani* and Pythium root rot caused by *Pythium ultimum* are favored by soil temperatures below 68°F while Rhizoctonia root rot caused by *Rhizoctonia solani* is favored by soil temperatures between 59 and 64°F. Soil temperatures during emergence of the 1st planting were more favorable for disease development and the percent emergence of the untreated control was only 31% at 15 days after planting (DAP) compared to 56% for the standard treatment of Ag-Strep + Captan + Lorsban and Cruiser. At this point in the growing season (15 DAP), the application of additional seed treatments to the standard treatment did not further improve emergence. Soil temperatures during the duration of the 2nd planting were warmer and less favorable for damping-off and seedling diseases caused by Rhizoctonia, Fusarium and Pythium. Nine days after planting emergence in the untreated control was already at 85.5% almost three times more than the in the 1st planting at 15 DAP. Towards the end of the season, root health ratings were good across all treatments (< 3.0 on a 1 to 9 scale) and were numerically the highest (worst) in the untreated control. It is unclear why the standard seed treatment plus Apron MAXX had the lowest emergence and emergence and stand counts in the two trials, respectively. Plans are underway to repeat this trial in spring 2016 and will specifically focus on two early May planting dates when soilborne pathogen pressure will be most severe due to favorable soil temperatures.

Table 1. First planting emergence count (total 20 ft row) on 20 May 2015. There were no significant differences between the inoculated and uninoculated rows in each plot so the data from each 10 ft row was pooled together for a total of 20ft planted (140 seeds total).

Seed treatment		**Emergence count (20 ft row)**		**% Emergence**
2	AS-50 + Captan + Lorsban + Cruiser (STD)	78.5	a	56.0
8	STD + Vibrance	74.7	a	53.3
4	STD + Allegiance + Thiram	72.7	a	51.9
3	STD + Allegiance.....	70.5	a	50.3
9	STD + Apron XL	69.2	ab	49.4
5	STD + Allegiance + Thiram + Dynasy	67.7	abc	48.3
6	STD + Allegiance + Thiram + Dynasty + Maxim.....	52.2	abc	37.3
7	STD + Allegiance + Thiram + Dynasty + Maxim + Vibrance.....	42.2	bc	30.1
1	Untreated Control.....	42.2	bc	30.1
10	STD + Apron MAXX.....	40.5	c	28.9
	Fisher's LSD	P = 0.0293		

Table 2. Second planting emergence counts (total 20 ft row) on 19 Jun and 3 Jul 2015. There were no significant differences between the inoculated and uninoculated rows in each plot so the data from each 10 ft row was pooled together for a total of 20ft planted (140 seeds total).

Seed treatment		Emergence 19 June			Final stand 3 July		
		Count		%	Count		%
2	AS-50 + Captan + Lorsban + Cruiser (STD)	118.2	a	84.4	126.0	a	90.0
1	Untreated Control	119.7	a	85.5	125.2	ab	89.4
9	STD + Apron XL	118.7	a	84.8	124.5	ab	88.9
3	STD + Allegiance	115.7	a	82.6	122.7	ab	87.6
4	STD + Allegiance + Thiram	118.2	a	84.4	121.7	ab	86.9
8	STD + Vibrance	113.7	a	81.2	121.5	ab	86.8
5	STD + Allegiance + Thiram + Dynasty	100.2	ab	71.6	120.0	ab	85.7
6	STD + Allegiance + Thiram + Dynasty + Maxim	90.7	bc	64.5	114.0	abc	81.4
7	STD + Allegiance + Thiram + Dynasty + Maxim + Vibrance	77.5	c	55.3	112.2	abc	80.1
10	STD + Apron MAXX	76.2	c	54.4	101.0	c	72.1
	Fisher's LSD	P = 0.0002			P = 0.0189		

Table 3. Second planting snap bean root health ratings (1 = healthy to 9 = >75% of the hypocotyl and root system showing symptoms) evaluated 84 days after planting on 23 Aug. Five plants were harvested per rep for a total of 20 plants being evaluated per treatments.

Seed treatment [a]		Root health rating (1 to 9)
1	Untreated Control	2.82
6	STD + Allegiance + Thiram + Dynasty + Maxim	2.38
9	STD + Apron XL	2.37
7	STD + Allegiance + Thiram + Dynasty + Maxim + Vibrance	2.36
4	STD + Allegiance + Thiram	2.33
5	STD + Allegiance + Thiram + Dynasty	2.30
8	STD + Vibrance	2.28
2	AS-50 + Captan + Lorsban + Cruiser (STD)	2.18
3	STD + Allegiance	2.18
10	STD + Apron MAXX	2.15

[a] Allegiance (metalaxyl) and Apron XL (mefenoxam) are labeled for managing Pythium; Apron MAXX (mefenoxam + fludioxinil) for Pythium, Fusarium and Rhizoctonia; Thiram (thiram) for Fusarium; Dynasty (azoxystrobin) for Rhizoctonia; Maxim (fludioxinil) for Fusarium and Rhizoctonia; AS-50 (streptomycin) for halo blight and Captan (captan) for Fusarium. Vibrance (sedaxane; not registered on snap bean) for Rhizoctonia. All seed was treated with Lorsban and Cruiser to manage insect pests.