Evaluation of Seed Treatment Chemicals, *Bacillus subtilis*, and Seed Adjuvants on Snap Bean Seedling Diseases, Plant Growth, and Estimated Yields at West Tennessee Experiment Station

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Interpretative Summary

Two snap bean varieties (cv. Strike and Hialeah) were used to evaluate the disease-control efficacy of several seed treatment combinations and their effects on plant growth and yield. Delta Coat AD (metalaxyl + chloroneb), alone or in combination with other seed treatment materials, significantly reduced seedling disease losses to soil-borne pathogens and improved plant stands. A killing-frost precluded actual evaluation of treatments on snap bean yield. Yield models, however, predicted that the highest snap bean yield would have occurred with the combination of Delta Coat AD and Subtilex (*Bacillus subtilis*).

Introduction

The major objectives of this study were (1) to determine the effect of snap bean seed treatment chemicals, biologicals, and seed treatment supplements on snap bean seedling diseases, stand, growth, and yield, and (2) to determine whether observed effects are affected by choice of snap bean variety.

Materials and Methods

The experiment was conducted at The University of Tennessee's West Tennessee Experiment Station at Jackson on a Memphis-Calloway silt loam intergrade, 0.5% O.M., pH 6.4 (water), with high soil test levels of available P (46 lb/A) and K (184 lb/A). Available Ca, Mg, Zn, Fe, and Mn were >1280, >64, 5, 17, and 50 lbs/A, respectively. Total soluble salts were 490 ppm. The test was conducted in a field that had been planted annually to snap bean since 1989 with moderate to severe seedling disease losses. A split-plot design was used with two snap bean varieties (cv. Strike and Hialeah) as main plots. Main plot treatments were replicated four times. Subplots consisted of eight different combinations of seed treatment materials and adjuvants. Each subplot consisted of two rows of beans, 20 ft long, planted 30 in. apart.

Seed treatment slurries were created by adding the test materials to distilled water. Treatments were applied 18 Aug to untreated seed at ca. 10 fl oz slurry/100 lb seed, then mixed with the seed for 2 min in a rotating glass cylinder. The test area was cut with a field harrow on 17 Aug, then ammonium nitrate at 45 lb N/A, Treflan E.C. at 0.75 pint/A, and D.Z.N. Ag 500 at 2.0 quart/A were broadcast over the field and incorporated. The test was planted 21 Aug into very warm, dry soil using a John Deere 71 Flexi-planter equipped with cone-seeders, a seeding rate of 5 seeds/ft, and an average planting depth

of 1.9 in. Dual II at 1.5 pint/A was applied as a pre-emergence herbicide on 22 Aug. The test was irrigated twice during the first week after planting with a lateral boom system, once on 22 Aug (ca. 0.6 in. water) and again on 25 Aug (ca. 0.4 in. water). The lateral boom was used four more times during the course of the test (30 Aug and 3, 18, and 22 Sep) for an additional 2 in. water. Capture 2EC at 6 fl oz/A was applied 29 Aug to control a white fly infestation.

Differences in seedling emergence were recorded 28 Aug. Post-emergence damping-off losses were recorded 7 Sep. Representative dead and dying seedlings (>20 per rep) were collected 8 Sep for pathogen identification. Differences in seedling vigor were recorded 8 Sep by measuring to the nearest 0.5 cm the length of the blade of center leaflet of the first trifoliolate leaf on five representative plants per row. Healthy stands were recorded two, four, or six weeks after planting on 7 Sep, 21-22 Sep, and 4 Oct, respectively. The heights of five representative plants per row were recorded 5 Oct. All data were subjected to analysis of variance. Mean separation tests were performed where significant differences were indicated. Arsine transformations were used for analyses of percentage data; results in tables, however, are expressed as untransformed percentages.

Results and Discussion

The test received 0.06 in. rainfall during the first week after planting. Rainfall events for the remainder of the test totaled 3.3 in. during Sep and 0.9 in. during Oct. The mean daily soil temperature at the two-inch depth during the first 10 days after planting (recorded at the NOAA weather station located 290 yd SSW of the test site) for bare soil, undisturbed, unirrigated was 86E F; the range was 71 - 103EF. These conditions plus the supplemental irrigations created an environment conducive for seedling diseases caused by *Rhizoctonia solani* (Rhizoctonia damping-off and stem rot) and by *Macrophomina phaseolina* (ashy stem blight). Of 89 dead and dying seedlings collected 8 Sep, it appeared that 46% of the seedling losses were due to Rhizoctonia damping-off and stem rot and 21% were due to ashy stem blight. Symptoms of both diseases were noted on an additional 15% of the collected seedlings.

Snap bean emergence began 27 Aug. Significant differences in the rate of seedling emergence due to both variety and seed treatment were observed (Table 1). These differences in emergence were poorly correlated with subsequent observations of seedling damping-off losses, healthy stand, and seedling vigor measurements ($P = 0.71$, $P = 0.43$, and $P = 0.22$, respectively). There were significant differences in the effects of seed treatment on post-emergence damping-off (Table 1) and healthy stands two, four, and six weeks after planting (Table 2). Delta Coat AD, Delta Coat AD + Subtilex, Delta Coat AD + Polymer CFC, Delta Coat AD + Polymer CFC + BeanSignal, and Delta Coat AD + Kodiak Concentrate significantly reduced damping-off losses compared to the untreated control. These same five treatments also led to increases in healthy stand two, four, and six weeks after planting compared to the untreated control. The Delta Coat AD +

BeanSignal combination also significantly increased stands compared to the control two weeks after planting but not four or six weeks after planting. The Delta Coat AD + Subtilex combination consistently led to the highest stands.

The open flowers were observed on 5 - 20% of the plants in each row on 26 Sep. Plants were in full bloom 1 Oct. and continued flowering heavily for the next week. Pod length in the best rows exceeded 2 in. by 5 Oct. Unusually early frosts 7 - 11 Oct. coupled with record breaking low temperatures killed many smaller plants and also killed the upper b's of remaining plants. The surviving plants produced a few pods in the lower a of the plants, but these were too low for mechanical harvest.

As a substitute for actual row yields, several yield models were developed for both 'Hialeah' and 'Strike' snap beans based on data collected from a similar snap bean seed treatment study conducted in the spring of 2000 in the same field. These models used a combination of early season and late season plant stands and growth measurements to reliably predict mean treatment yields (r^2 $0.90). These models predicted some notable (P = 0.10) differences in snap bean yields due to seed treatment (Table 3). Three treatments, Delta Coat AD, Delta Coat AD + Subtilex, and Delta Coat AD + Polymer CFC + BeanSignal, were predicted to have notably higher yields than the untreated control. Highest predicted yields were with the Delta Coat AD + Subtilex seed treatment combination.

Table 1.Snap Bean Seed Treatment Test, West Tennessee Experiment Station, Jackson, TN, Fall 2000: Effects of variety and seed treatment on rate seedling emergence, total emergence, and post-emergence damping-off [1].

Seed treatment materials and rate per 100 lb seed	Rate seedling emergence 8/28 (%)		Total seedling emergence (estimated)[2] %	Dam off ((p 9 (
VARIETY				
1) Hialeah	56	b	82	9
2) Strike	63	a	87	8
SEED TREATMENT				

1) water 10.0 fl oz	67	a	80	12	a
2) Captan 4000 2.5 fl oz + Apron XL 0.32 fl oz + AgriStrep 500 0.89 oz	63	ab	84	11	ab
3) Delta Coat AD 7.0 fl oz	64	ab	87	7	c
4) Delta Coat AD 7.0 fl oz + Subtilex 0.25 oz	63	abc	86	6	c
5) Delta Coat AD 7.0 fl oz + BeanSignal 1.0 fl oz	56	bcd	83	9	abc
6) Delta Coat AD 7.0 fl oz + Polymer CFC 0.5 fl oz	49	d	83	6	c
7) Delta Coat AD 7.0 fl oz +Polymer CFC 0.5 fl oz + BeanSignal 1.0 fl oz	63	ab	86	6	c
8) Delta Coat AD 7.0 fl oz + Kodiak Concentrate 0.25 oz	52	cd	86	8	bc

[1] Values are the means of either four replications (for variety) or eight replications (for seed treatment). Means in the same column for the same factor (variety or seed treatment) followed by the same letter do not differ significantly by Fisher's (protected) LSD (P = 0.05).

[2] Estimated total seedling emergence is based on the sum of post-emergence damping-off losses and healthy stand two weeks after planting.

Table 2.Snap Bean Seed Treatment Test, West Tennessee Experiment Station, Jackson, TN, Fall 2000: Effects of variety and seed treatment on healthy plant stands ca. two, four, and six weeks after planting [1].

	Healthy stand	Healthy stand	He st

Seed treatment materials and rate per 100 lb seed	9/07 (%)		9/21-22 (%)		10/04 (%)	
VARIETY						
1) Hialeah	74	b	68		65	
2) Strike	79	a	71		68	
SEED TREATMENT						
1) water 10.0 fl oz	68	d	62	c	58	d
2) Captan 4000 2.5 fl oz + Apron XL 0.32 fl oz + AgriStrep 500 0.89 oz	73	cd	64	c	63	cd
3) Delta Coat AD 7.0 fl oz	79	ab	72	ab	70	ab
4) Delta Coat AD 7.0 fl oz + Subtilex 0.25 oz	81	a	76	a	73	a
5) Delta Coat AD 7.0 fl oz + BeanSignal 1.0 fl oz	74	bc	67	bc	64	bcd
6) Delta Coat AD 7.0 fl oz + Polymer CFC 0.5 fl oz	77	abc	70	ab	67	abc
7) Delta Coat AD 7.0 fl oz + Polymer CFC 0.5 fl oz + BeanSignal 1.0 fl oz	80	a	74	a	72	a
8) Delta Coat AD 7.0 fl oz + Kodiak Concentrate 0.25 oz	78	abc	72	ab	69	ab

[1] Values are the means of either four replications (for variety) or eight replications (for seed treatment). Means in the same column for the same factor (variety or seed treatment) followed by the same letter do not differ significantly by Fisher's (protected) LSD (P = 0.05).

Table 3.Snap Bean Seed Treatment Test, West Tennessee Experiment Station, Jackson, TN, Fall 2000: Effects of variety and seed treatment on plant growth and estimated snap

bean

yield [1].

Seed treatment materials and rate per 100 lb seed	Length first trifoliolate leaf 9/08 (in.)		Mean plant height 10/05 (in.)		Estim yie (lb
VARIETY					
1) Hialeah	1.7	a	10.5	a	4154
2) Strike	1.2	b	9.7	b	3724
SEED TREATMENT					
1) water 10.0 fl oz	1.4		9.7		3519
2) Captan 4000 2.5 fl oz + Apron XL 0.32 fl oz + AgriStrep 500 0.89 oz	1.4		9.6		3569
3) Delta Coat AD 7.0 fl oz	1.5		10.2		4188
4) Delta Coat AD 7.0 fl oz + Subtilex 0.25 oz	1.6		10.4		4507
5) Delta Coat AD 7.0 fl oz + BeanSignal 1.0 fl oz	1.4		10.0		3629
6) Delta Coat AD 7.0 fl oz + Polymer CFC 0.5 fl oz	1.4		10.1		3715
7) Delta Coat AD 7.0 fl oz + Polymer CFC 0.5 fl oz + BeanSignal 1.0 fl oz	1.5		10.3		4364
8) Delta Coat AD 7.0 fl oz + Kodiak Concentrate 0.25 oz	1.5		10.4		4019

[1] Values are the means of either four replications (for variety) or eight replications (for seed treatment). Means in the same column for the same factor (variety or seed treatment) followed by the same letter do not differ significantly by Fisher's (protected) LSD (P = 0.05).

[2] Yields are based upon the means of two different yield models which in earlier tests were shown to be highly predictive of mean treatment yields (r^2 >0.90). Means in the same column for the same factor (variety or seed treatment) followed by the same letter do not differ at the P = 0.10 level.

This research represents one season's data and does not constitute recommendations. After sufficient data is collected over the appropriate number of seasons, final recommendations will be made through research and extension publications.