THE EFFECTS OF SEED TREATING TWO SOYBEAN VARIETIES WITH SELECTED FUNGICIDES

and

THE EFFECTS OF SOYBEAN SEED TREATMENT WITH CAPTAN-THIRAM ON ROOT NODULATION AND YIELD

by

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Abstract

Seeds of two soybean varieties, Cutler 71 and Williams, were treated with three fungicides and the results compared with the control with respect to germination, stand counts, disease incidence and yield. The experiments were conducted at two locations in soils where the preceding crop was soybean. Results indicated that emergence was significantly increased with two of the three fungicides used. Except for one fungicide and one seed quality, there were no significant increases in yield.

Introduction

Soybean seed treatment to improve seed germination, stand and yield, and to reduce disease occurrence has been studied extensively. Fungicides used have differed from those used in this research, but the goal has been the same.

Gray and Sinclair (2) found that Benlate completely inhibited the growth *in vitro* of four pathogens studied. They concluded that "these results suggest the compounds remain active for only a relatively short period in the hypocotyl without continual root exposure, and thus offer only limited protection to soybean seedlings against attack of damping-off organism." Athow and Caldwell (1) after a four year test to determine the effect of seed treatment and planting rates on the emergence and yield of soybean in spaced-row and large drill-plot, concluded that "seed treatment may be of value when seed of poor quality is used, or seeding

is at a very low rate. Under standard seeding rates and with the use of reasonably good seed, however, no practical value of seed treatment has been demonstrated." Sherf and Reddy (4), using Arasan and Spergon, obtained 9.6 and 10.8% increase in stand accompanied by 1 and 0.4 bushel/acre more yield respectively over the control. They stated "on soils where bacteria are needed, chemical treatment should not be used." Thapliyal and Sinclair (6) found that Benlate remained active in the hypocotyl tissue of soybeans for a relatively short period and offered only limited protection to seedlings. They concluded that systemic fungicides may be effective for periods too short to increase soybean stands. Tachibana (5) using six planting rates and six soybean varieties with fungicides, Captan and Terraclor Super-X, obtained increased yield though stand was not improved. He concluded that a minimum planting rate for maximum yield was evident for each soybean variety and treatment, including control. Maximum yields for treated seeds were obtained at or below planting rates that were optimum for untreated seeds. No significant benefits of treatment generally occurred at low or high planting rates. Hildebrand and Koch (3), in experiments over a three year period, concluded that "with poor quality, weather damaged seeds as was produced in 1942, and with the cracked-coat fraction (resulting from combine injury) of an otherwise high-quality seed, such as that produced in 1944, treatment with Spergon increased emergence and yield." These were the only instances, however, in which increases in early stands of plants as the result of seed treatment were correlated with significant increases in yield. They also found that when healthy seeds were planted at different rates, emergence of seedlings was closely correlated with rate of planting, but differences in yield were not significant. They also found that

there was a complete lack of correlation between stands of plants, differing numerically by a ratio almost as high as 4:1, and yield. Their conclusion was that the increase in early stand of plants as the result of treatment should not be regarded as necessarily indicating a corresponding increase in yield. Wyllie and Goth (7) stated "the value of soybean seed treatment apparently depends upon several factors: 1) the quality of the seed, 2) weather and soil conditions immediately following planting and while plants are in the seedling stage, and 3) the depth of planting." They also stated "although the majority of the commercial seed lots responded favorably to treatment, many did not respond and large yield reductions occurred in some cases. Why certain seed lots respond to seed treatment and others do not is not known. They concluded that "no evidence of injury caused by thiram to soybean was found in this study, at either the recommended application rate of 2 ounces/bushel or at excessive dosages, nor was evidence found to suggest that seed treatment adversely affected nodulation. Apparently adequate populations of nodule-forming bacteria were present in the soil, since soybeans had been grown on the land in previous years."

The purpose of this study was to examine the effects of fungicide seed treatment on germination, stand count, disease incidence, and yield of soybean, and to look for signs of chemical toxicity under Kansas conditions.

Methods and Materials

Two varieties of registered soybean seed grown in Kansas were used. The seeds of each variety were machine separated into three categories on a weight basis by a combination of variable supportive air

pressure and rate of fall down an inclined plane. The heaviest seeds were the largest and most uniform, and had the highest germination percentage. The next group was smaller and had a lower germination percentage. The lightest group, which gave the lowest percentage germination, had small discolored seeds. Germination percentages were arrived at by two methods. Fifty seeds from each category were planted ½ inch deep in soil, in a greenhouse with the temperature set at 75°F. Emergence was determined at eight days and varied with variety and category. Germination percentages calculated for high, medium, and low categories of the variety Cutler 71 were: 90%, 80%, and 65%, respectively. Percentages for the same categories of the variety Williams were: 82%, 78%, and 60%, respectively. Fifty seeds from each grade were sent to the state seed testing laboratory at Topeka, Kansas for another test. Germination figures for Cutler 71 were: high 85%, medium 80%, and low 54%. The figures for Williams variety were: high 78%, medium 75%, and low 52%.

Three fungicides were used and the results compared to a control. The fungicides used were Benlate, (benomyl), [methyl 1-(butylcarbamoyl) 2-benzimidazole-carbamate] 50% active, at 1 oz/bu; P.C.N.B. (pentachloronitrobenzene), 75% active, at 0.75 oz/bu; and Captan-N [(trichloromethyl) thio] -4-cyclohexene-1:2-dicarboximide 43% plus Thiram (tetramethylthiuram disulfide), 43% active, at 2.5 oz/bu.

Williams soybeans were planted at the Ashland Agronomy Farm south of Manhattan on May 17, at the rate of 62 lb/acre with a hand planter, in a Muir silt loam soil. Emergence percentage was determined at three to four weeks after planting by counting the number of plants that emerged. Plant height was measured six weeks after planting and again a week

before harvest. Random measurements were taken in the treated and control plots.

Cutler 71 soybeans were planted May 23 at the Corn Belt Experimental Farm near Powhattan at the rate of 63 lb/acre, in Grundy silt clay loam soil. Emergence percentage was determined as at Ashland. Plant height was measured seven weeks after planting and at harvest time. The two fields used had recent histories of continuous soybeans.

Results

Significant increases in emergence of Cutler 71 soybean were obtained at Powhattan with Captan-Thiram and with Benlate treatments, but not with P.C.N.B., when all levels of seed quality were pooled and compared with the control (Table 1). P.C.N.B. treatment tended to decrease emergence, though not significantly. However, P.C.N.B. treatment of the low germinating seeds increased yield by 12.81% (Table 2).

There was some indication of emergence and yield reduction, although none differed significantly from the control. The treatment mean of the emergence experiment at Powhattan showed emergence with both Captan-Thiram and Benlate were significantly higher than with the control, but this was not reflected in yield.

Results at Ashland showed significant increases in emergence of Williams soybeans with Benlate and Captan-Thiram over the control, but not with P.C.N.B. (Table 3). Increases occurred mostly with "low" and "medium" germinating seeds. But again there were no significant differences in yield due to fungicide treatment when compared with the control (Table 4). There were decreases in yield with both Benlate and Captan-Thiram used on "low germinating seed. However, these decreases

were not significant.

The treatment mean of Benlate and Captan-Thiram differed significantly from the control in emergence, but no such differences were observed in yields (Table 4). There was little difference in the plant heights. The average height of the treated plants at Ashland after six weeks was 32 inches, the control averaged 30 inches. At Powhattan, seeds were planted one week later than the Ashland seeds. At harvest the plants averaged 38 inches for the treated, and 37 inches for the control at Ashland. The plants at Powhattan averaged 36 inches at harvest for the treated and 36 inches for the control.

THIS BOOK CONTAINS NUMEROUS PAGES WITH DIAGRAMS THAT ARE CROOKED COMPARED TO THE REST OF THE INFORMATION ON THE PAGE.

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TABLE 1. Average emergence of "Cutler 71" soybean seedlings per row as affected by seed quality and fungicide treatment. Corn Belt Experimental Field, Powhattan, Ks, 1974.

Fungicide	Seed quality[a]			Treatment means	Percent variation from control		
	High	Medium	Low		High	Medium	Low
Control	117.67[b]	113.83	89.58	107.03			
Benlate	130.33	107.75	97.25	111.78*	10.76**	-5.34[c]	8.56
Captan-Thiram	123.92	133.42	100.17	119.17*	5.31	17.21**	11.82**
P.C.N.B.	125.00	106.50	85.42	105.46	6.23	-6.44	-4.64
Means	124.23	115.37	93.10				

[a]Percent germination under laboratory conditions: High = 85%, Medium = 80%, Low = 54% as determined by the Kansas State Seed Laboratory at Topeka.

[b]Average number of plants per row of three replications of 4 rows each; 210 seeds per row.

[c]Negative numbers suggest reduction from treatment.

*Differs significantly from control mean, P = 0.05.

**Differs significantly from control mean of the same quality, P = 0.01.

TABLE 2. Soybean yield in bu/A as affected by seed quality and fungicide treatment. Corn Belt Experimental Field, Powhattan, Ks, 1974.

Fungicide	Seed quality			Treatment means	Percent variation from control		
	High	Medium	Low		High	Medium	Low
Control	30.26	28.27	28.41[a]	28.98			
Benlate	29.76	29.98	25.98[a]	28.57	-1.65	6.05	-8.55
Captan-Thiram	28.07	28.97	28.47	28.50	-7.24	2.48	0.21
P.C.N.B.	28.81	28.59	32.05	29.82	-4.79	1.13	12.81*
Means	29.23	28.95	28.73				

[a]Mean based on least square average of two replications due to lightning damage which destroyed the third replication. The others are based on three replications.

*Differs significantly from control mean of the same quality, P = 0.05.

TABLE 3. Average emergence of Williams soybean seedlings per row as affected by seed quality and fungicide. Ashland Agronomy Farm, Manhattan, Ks, 1974.

Fungicide	Seed quality[a]			Treatment means	Percent variation from control		
	High	Medium	Low		High	Medium	Low
Control	138.33[b]	123.83	88.41	116.86			
Benlate	146.00	140.91	104.16	130.36*	5.54	13.79**	17.81**
Captan-Thiram	146.66	131.33	104.58	127.52*	6.02	6.06	18.29**
P.C.N.B.	134.00	131.91	96.33	120.74	-3.13[c]	6.53	8.96
Means	141.25	132.00	98.37				

[a]Percent germination under laboratory conditions: High = 78%, Medium = 75%, Low = 52% as determined by the Kansas State Seed Laboratory at Topeka.

[b]Average number of plants per row of three replications of 4 rows each; 210 seeds planted per row.

[c]Negative numbers suggest reduction from treatment.

*Differs significantly from control mean, P = 0.01.

**Differs significantly from control mean of the same quality, P = 0.01.

TABLE 4. Soybean yield in bu/A as affected by seed quality and fungicide treatment. Ashland Agronomy Farm, Manhattan, Ks, 1974.

Fungicide	Seed quality[a]			Treatment means	Percent variation from control		
	High	Medium	Low		High	Medium	Low
Control	29.53	30.25	30.80	30.20			
Benlate	31.66	30.17	29.59	30.48	7.21	-0.26	-3.93
Captan-Thiram	29.89	32.49[a]	30.30[a]	30.90	1.22	7.40	-1.62
P.C.N.B.	27.31	30.25	31.18	29.58	-7.51	0.00	1.23
Means	29.60	30.79	30.47				

[a]Mean based on least square average of two replications due to compaction of the soil which interfered with the third replication. The others are based on three replications.

Discussion and Conclusion

Seed treatment increased emergence significantly over the control. Seeds of low and medium germination seemed to give the greatest response. Benlate and Captan-Thiram performed best at Ashland and Powhattan. P.C.N.B. yields were generally lower at both locations. However, a significant increase in yield was obtained over the control with "low" quality seeds treated with P.C.N.B. This sole significant increase in yield over the control by P.C.N.B. cannot be explained statistically. This increase could have been caused by some environmental or soil condition. A probable reason why differences in emergence in this experiment did not necessarily result in difference in yield, is that soybeans have a tremendous ability to compensate for variation in plant population. Plant population from 60 lb of seed/acre will yield as much as plant population from 30 lb of seed/acre (1).

The correlation figures showed a positive correlation between emergence and yield of the control plot at Ashland. Similar results were observed with "low" Captan-Thiram and "high" Benlate at Powhattan. Negative correlation was obtained with the other treatments.

To conclude, seed treatment did not consistantly give increases in germination, nor did an increase in emergence in a given plot give a corresponding increase in yield.

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THE EFFECTS OF SOYBEAN SEED TREATMENT WITH CAPTAN-THIRAM ON ROOT NODULATION AND YIELD

Abstract

Seeds of the soybean variety Williams were treated with the fungicide Captan-Thiram, and inoculated with the bacterium Rhizobium species one day before planting. The number of nodules on the roots of the untreated was greater than the number on the roots of the treated. Yield from the untreated plants was greater than yield from the treated, but not significantly.

Introduction

The effects of chemical seed treatment in combination with seed inoculation on root nodule formation, seed germination and yield have been extensively studied. The chemical protectants and inoculum used have varied with researchers, but results obtained have been similar.

Brinkerhoff et al (1) concluded that Arasan tended to reduce or in some instances nearly eliminated nodulation in non-infested soil when soybeans were grown from treated, inoculated seeds. However, they could obtain no evidence that the addition of nodule inoculum to the seed decreased the protective value of the seed treatment chemicals. Kernkamp et al (3) state "if growers wish to treat the seed, it appears reasonably safe to use the chemical seed treatment in combination with Rhizobium species providing they plant the soybeans in soil that has an adequate population of Rhizobium. If soybeans are planted in ground that has never produced the crop, it appears that the best practice is to use the inoculant and dispense with seed treatment". Nugent et al (4) conclude

that Arasan plus Nitragin increased the average acre yield approximately one bushel over Nitragin alone; however, the yield differences between the treatments were not significant. Ruhloff and Burton (5) found that under some soil conditions it may be more profitable to treat the seed with chemicals, under others it may be more beneficial to inoculate the seed. They observed that when chemically coated seed are inoculated and planted immediately in moist soil, sufficient numbers of the Rhizobium may survive and bring about effective result, but under unfavorable planting conditions the opposite may be true. Wyllie and Goth (6) in an experiment using Thiram as a seed protectant stated that they could find "no evidence of injury caused to soybean, at either the recommended application rate of 2 oz/bu or at excessive dosages, nor was evidence found to suggest that seed treatment adversely affected nodulation. Apparently adequate population of nodule-forming bacteria were present in the soil, since soybean had been grown on the land in previous years." Kernkamp (2) in an experiment conducted in Minnesota, with the fungicide Spergon and the inoculum Nitragin, found that Spergon used in combination with Nitragin, in partially sterilized soil, did not significantly influence nodulation in soybeans. Nodulation was significantly increased, however, when Nitragin was applied without Spergon as compared to any combination of Nitragin with Spergon.

Methods and Materials

Seed of the soybean variety Williams was treated with the fungicide Captan-N /(trichloromethyl) thio/-4-cyclohexene-1:2-dicarboximide 43% active, plus Thiram (tetramethylthiuram disulfide) 43% active, and inoculated with the bacterium Rhizobium species one day before planting.

An independent farmer's field that had not had soybeans grown on it for at least 12 years, and located west of Manhattan was selected for planting. The seeds were planted on May 23rd.

In August twenty plants were carefully dug up from both treated and untreated rows. The size and number of nodules on the roots was graded on a 1 to 5 scale (1 =smallest total mass; 5 = highest). Yield was determined at harvest.

Result, Discussion and Conclusion

More nodules were present on the roots of the untreated than on the roots of the treated plants. The mean of the untreated was 2.7 and the treated 1.5. The difference between the means was significant at the 0.01 level (Table 1). The majority of the nodules from both the treated and untreated plants were located on the upper most part of the tap and lateral roots. Yield from the untreated plots averaged 20.8 bu/A and the treated plots averaged 18.8 bu/A, an increase of 10.6% of the untreated over the treated. However, the increase was not significant, possibly because the sample size taken was too small to detect small differences.

A positive correlation of 0.41 was obtained between the numbers of nodules present on the untreated roots and the yield obtained, compared to a negative correlation of -0.3 obtained for the treated. However, these correlation figures are not significant.

In concluding, it would seem that although fungicide seed treatment reduced the number of nodules on the roots, no significant differences in yield could be demonstrated due to this reduction in nodule number. A more extensive test with a larger sample size might show significant differences.

TABLE 1. Root nodulation and yield results from treating the soybean seed variety Williams with Captan-Thiram, Manhattan, Ks, 1974.

Avg. amt. of nodules on roots		Avg. yield in bushels/acre		Percent increase in yield of untreated over treated	Correlation between nodules present and yield	
Untreated	Treated	Untreated	Treated		Untreated	Treated
3.1[a]	1.6	20.4	15.6	10.6	0.4[b]	-0.3[c]
3.5	1.4	17.7	19.5			
2.3	1.7	22.4	20.0			
2.4	1.4	22.3	20.2			
2.5	___	21.0	___			
means:						
2.7*	1.5*	20.8	18.8			

[a]Average number of nodules present out of twenty sample readings taken. Scale used to determine number of nodules on roots: 1 (lowest) - 5 (highest).

[b]Computed figure based on above 5 untreated figures.

[c]Computed figure based on above 4 treated figures.

*Significant at the P = 0.01 level.

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The soybean varieties Cutler 71 and Williams were treated with the fungicides Benlate, Captan-Thiram, and P.C.N.B. and results obtained were compared with respect to germination, disease incidence and yield to results obtained from the control.

The seeds were machine separated into three categories on a weight basis. Fifty seeds from each variety were sent off to the State Seed Testing Laboratory at Topeka to determine germination percentage. Another test was also carried out under greenhouse conditions. The seeds were chemically treated; Benlate 1 oz/bu., Captan-Thiram 2.5 oz/bu., P.C.N.B. .75 oz/bu. The variety Williams was planted at Ashland and Cutler 71 at Powhattan.

Results showed that significant increases in emergence were obtained with the treated over the untreated in most cases. Yield increase was not significant except with "low" quality seed treated with P.C.N.B. at Powhattan.

The conclusion reached is that seed treatment increased germination, but only in a few cases did it increase yield.

In the nodulation experiment, the variety Williams was treated with the fungicide Captan-Thiram and inoculated with the bacteria Rhizobium species one day before planting. Results of the treated were compared to results from the untreated to determine amount of nodules present and yield produced. The seeds were planted in soil where soybeans had not grown for at least 12 years.

Results obtained showed that the amount of nodules present on the roots of the untreated were greater in numbers than those present on the roots of the treated. Yields from the untreated plots averaged 20.8 bu/A, the treated plots averaged 18.9 bu/A, an increase of 10.6% of the

untreated over the treated. This increase, however, was not significant.

The conclusion reached is that while seed treatment reduced the size and numbers of nodules, yield reduction was not significantly reduced.