Maryland Soybean Board Grant Report: Final Report (2017-2018)

Evaluation of soybean fungicide seed treatments

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Background and Justification

Soybean fungicide seed treatments are touted as important, value-added products to successful soybean production by seed and chemical companies. Additionally, some growers choose to utilize fungicide seed treatments even when fungal soilborne disease potential is low. Reasons for this include perceived plant health benefits and insurance against potential disease. However, there is no unbiased University research in Maryland, Delaware, or the mid-Atlantic region, to support or refute this claim. Research in other areas of the US show that fungicide seed treatments may have a positive effect on protecting soybeans from soilborne diseases, improve stands, increase yields, and may increase profitability compared to untreated controls in highly infested fields[1-4]. The question still remains if these seed treatments are effective or economical in low-pressure disease situations. During this multi-year project, we measured the effect of fungicide seed treatments on soybean emergence, stand, fungal disease, test weight and yield to determine if fungicide seed treatments are worth the extra cost under typical production scenarios in Maryland and Delaware.

Objectives

1. Determine the yield impact (if any) of fungicide seed treatments on soybean yield under standard management practices for various locations in Maryland and Delaware.
2. Determine the effects of fungicide seed treatments on soybean emergence and stands under standard management practices for the various locations.
3. Determine if there are any economic benefits of fungicide seed treatments based on a yield response (if any) and the cost of the seed treatment (economic return).

Methods

- Commercial soybean variety SS 4514N R2 was chosen for the trials because of its good yield stability across the region and resistance to soybean cyst nematode. Seed was treated by Southern States in Bridgeville, DE with commercial rates of: Acceleron (metalaxyl + fluxapryoxad + pyraclostrobin), Trilex (trifloxystrobin) and ILeVO (fluopyram). Untreated seed was included as a control. Southern States discontinued their soybean seed line in 2018; therefore, a comparable variety (DG S43RY95) was selected and treated by a Channel Seed rep in Pylesville, MD for the 2018 trials.

- Treated and untreated seed was direct seeded into no-till soybean residue on 4 site locations in 2017 (Western Maryland Research & Education Center (WMREC), Keedysville, MD; Central Maryland Research & Education Center (CMREC), Beltsville, MD; Wye Research & Education

Center (Wye), Queenstown, MD; and Carvel Research & Education Center (UDREC), Georgetown, DE). The Delaware location was dropped in 2018 due to weather, field conditions, and space constraints. We chose to plant into soybean residue as a "worse case" management scenario. Planting into soybean residue will maximize our chances observing disease, which has potential to be managed by the seed treatments. Plots were sown on 15 inch rows, 10 feet wide by 30 feet long, arranged in a spatially-balanced complete block design[5] to minimize field variation. Each treatment was replicated five times per location to maximize statistical power. Control treatments were untreated soybean seed. Planting dates for the various locations are shown in Table 1.

- Fertility and crop management (weeds and insects) were managed in accordance with Extension guidelines. Foliar fungicides were not utilized.
- Weather data was collected throughout the growing season via weather stations located on the research farms and used to monitor and evaluate growing conditions and disease potential.
- Emergence and stand counts were conducted 14 days after planting by counting the number of fully emerged and delayed emerged plants per foot of row.
- Because of the lack of root and stem diseases, disease ratings were omitted.
- Plots were harvested with a small plot combine at maturity. Harvest dates are shown in Table 1.
- Data were transformed to fit a normal distribution and analyzed using a mixed model. Treatment effects were separated statistically using Fisher's LSD.
- Yield data was used in conjunction with the cost of the seed treatments, crop budgets for growing no-till soybeans in Maryland, and market price of soybean to determine if there was any economic benefit to using soybean fungicide seed treatments.

Table 1. Plant and harvest dates.

	2017		**2018**	
Location	**Planted**	**Harvested**	**Planted**	**Harvested**
UDREC	May 17, 2017	October 19, 2017	N/A	N/A
WMREC	May 31, 2017	October 25, 2017	June 8, 2018	October 26, 2018
WYE	June 6, 2017	October 23, 2017	June 14, 2018	November 23, 2018
CMREC	July 3, 2017*	November 21, 2017	June 28, 2018	November 23, 2018

*delayed due to wet weather and equipment failure.

Results and Discussion

Table 2 shows a significant treatment effect (P=0.0203) on relative emergence (calculated as a percent compared to the mean emergence for untreated control for the trial location) but no significant treatment effect (P=0.3023) on yield or test weight (P=1.000) in 2017.

Table 2. Mix model ANOVA results for all sites replicated in Delaware and Maryland, 2017 & 2018.

	Relative Emergence		Yield		Test Wt.	
Source	**F Ratio**	**Prob > F**	**F Ratio**	**Prob > F**	**F Ratio**	**Prob > F**
Treatment (2017)	3.4761	0.0203	1.2385	0.3023	0.2944	1.000
Treatment (2018)	0.6226	0.6039	0.4975	0.6858	0.7562	0.5243

Figure 1 shows treatment separation for relative emergence for 2017 & 2018. The seed treatments in 2017, Acceleron and Trilex had the greatest emergence with a relative emergence of 108% and 105%, respectively. ILeVO had the poorest emergence at 95.7% relative emergence across all locations. Fluopyram, the active ingredient in ILeVO, is known to stunt plants and potentially decrease germination under some conditions.

There was no treatment effect observed on emergence in 2018. This may be accounted for by the overall later planting dates in 2018, due to weather, allowing for soil temperatures to increase, thus accelerating germination.

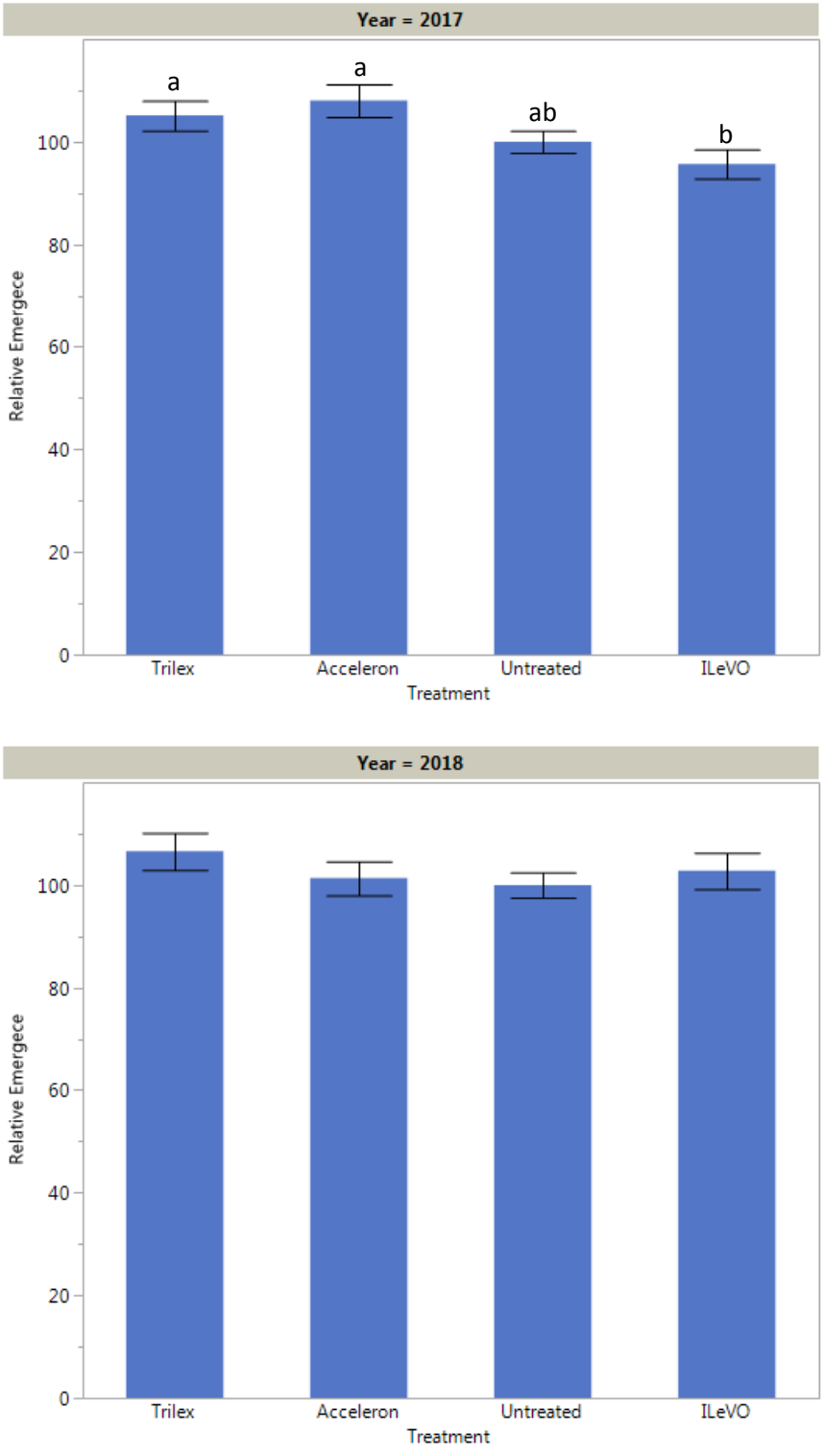


Figure 1. Relative emergence vs. treatment for all tested locations, 2017 & 2018. Each error bar is constructed using 1 standard error from the mean. Treatments connected with the same letter are not significantly different from each other (α=0.05). Treatment effect not significant in 2018.

Figure 2 shows treatment effect on average yield across all locations in 2017 & 2018. There were no significant differences in yield between treatments.

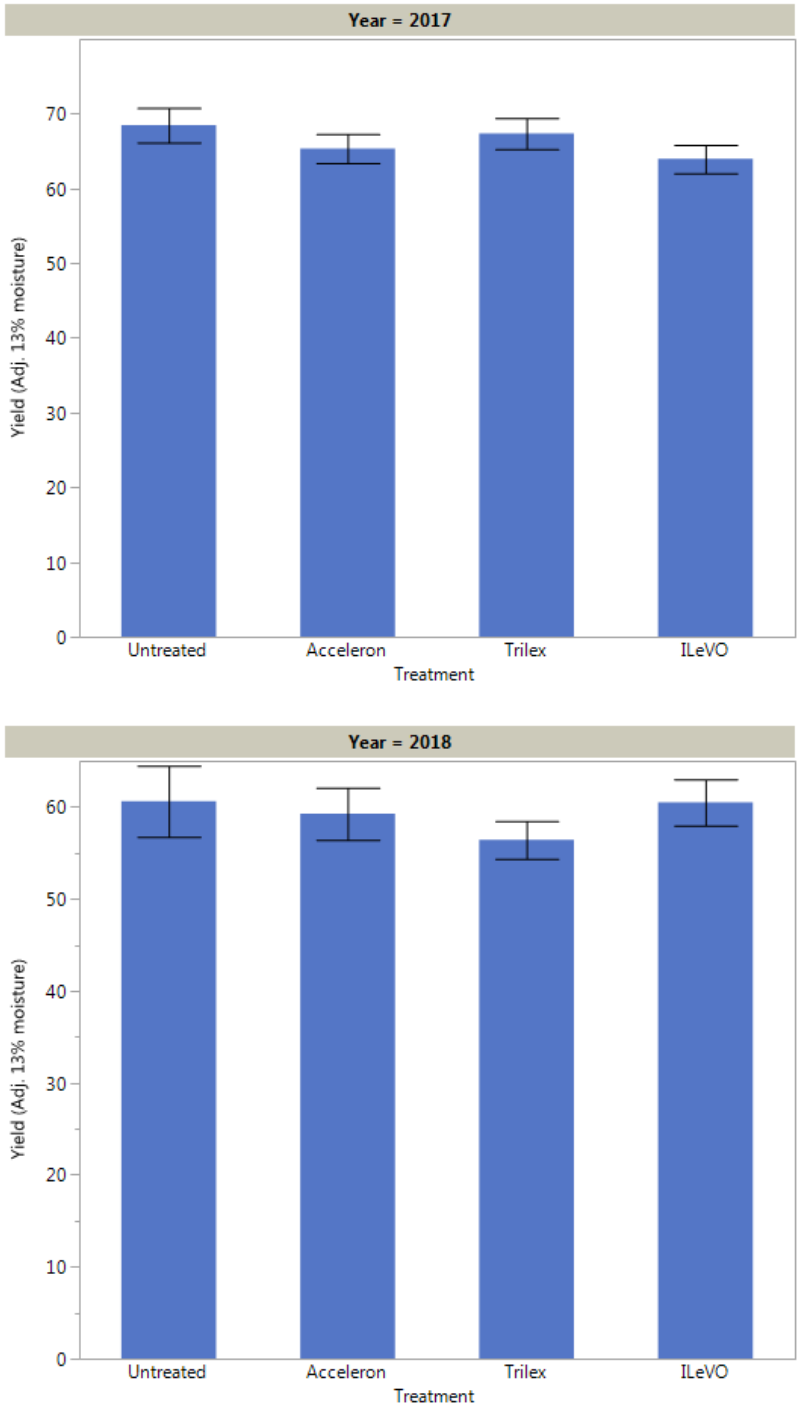
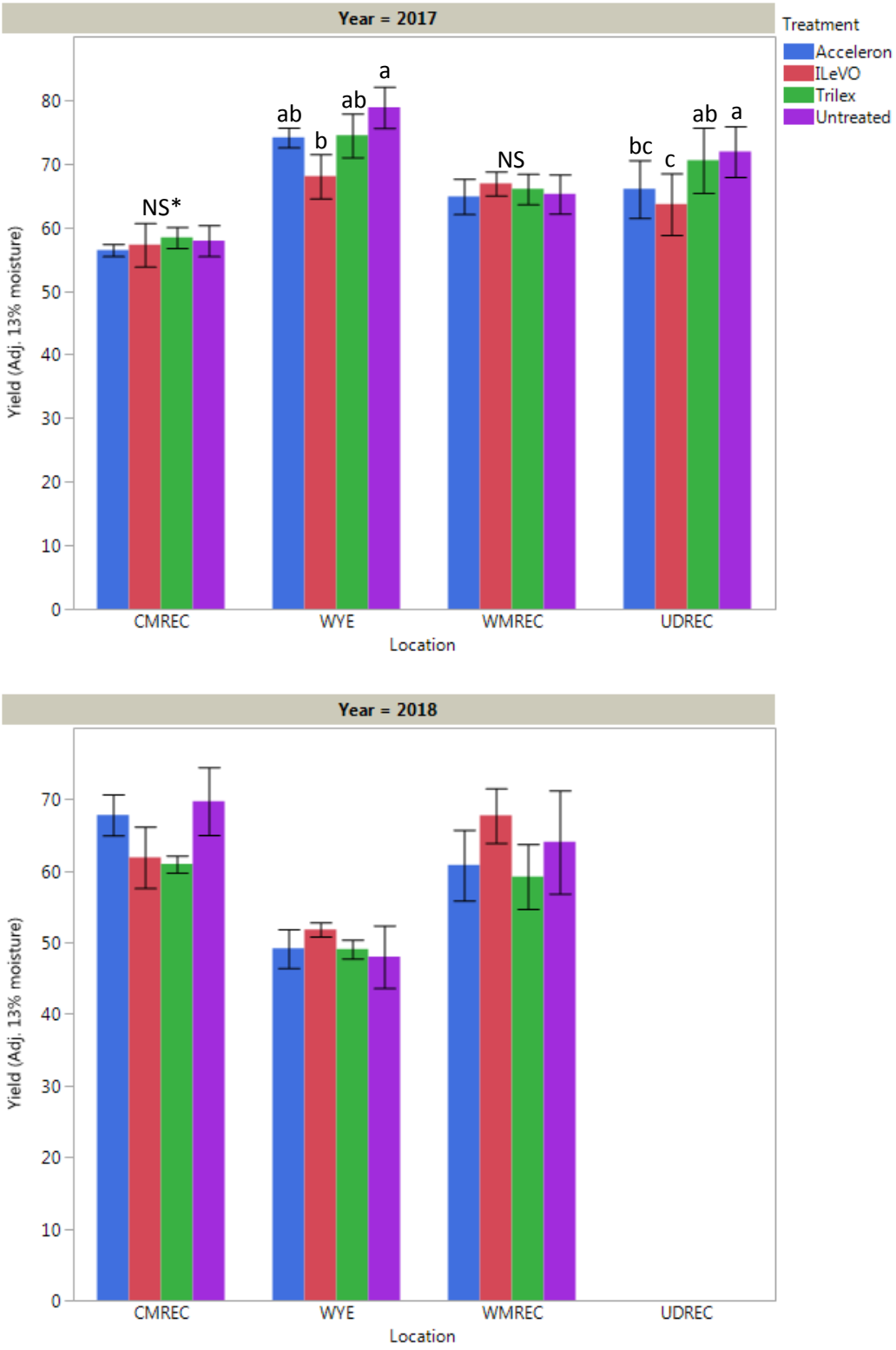


Figure 2. Yield (bu/a) vs. treatment for all tested locations, 2017 & 2018. Each error bar is constructed using 1 standard error from the mean. There was no significant treatment effect on yield (α=0.05).

Overall yields were higher in 2017 than 2018, which is to be expected due to the later planting dates in 2018 as a result weather and field conditions.

Figure 3 shows average yield vs. treatment broken out by location for 2017 & 2018. There was a significant treatment effect at two locations in 2017 (Wye and UDREC) where fungicide seed treatments significantly decreased yield compared to the untreated control. At those locations, untreated controls yielded the highest and ILeVO the lowest. Due to the yield variability in 2018, there was no significant treatment effect on yield.



*NS = not significant

Figure 3. Each error bar is constructed using 1 standard error from the mean, 2017 & 2018. Treatments within the same trial location connected by the same letter are not significantly different from each other (α=0.05). No significant treatment effect on yield in 2018.

As part of an economic analysis, we calculated net profit for each treatment based on planting population (150,000 seeds/acre), local market price for soybean ($9.10), retail prices for seed ($50.95/bag of 140,000 seeds), seed treatment (Acceleron=$19.20/bag, Trilex=$5.50/bag, ILeVO=$15.00/bag) and production costs, including variable and fixed costs. Variable and fixed costs were calculated using the 2017 University of Maryland Crop Budget Calculator[6].

Table 3 shows a significant treatment effect on net profit per acre in 2017. As seen in figure 4, untreated soybean seed returned the highest average profit per acre ($368.31) across all locations, statistically greater than all other treatments (P=0.0002). Seed treatment ILeVO returned the lowest net income, with an average across all locations of $193.29 per acre.

Table 3. Mix model ANOVA results for net profit for all sites replicated in Delaware and Maryland, 2017.

	Net income	
Source	**F Ratio**	**Prob > F**
Treatment	7.6032	0.0002

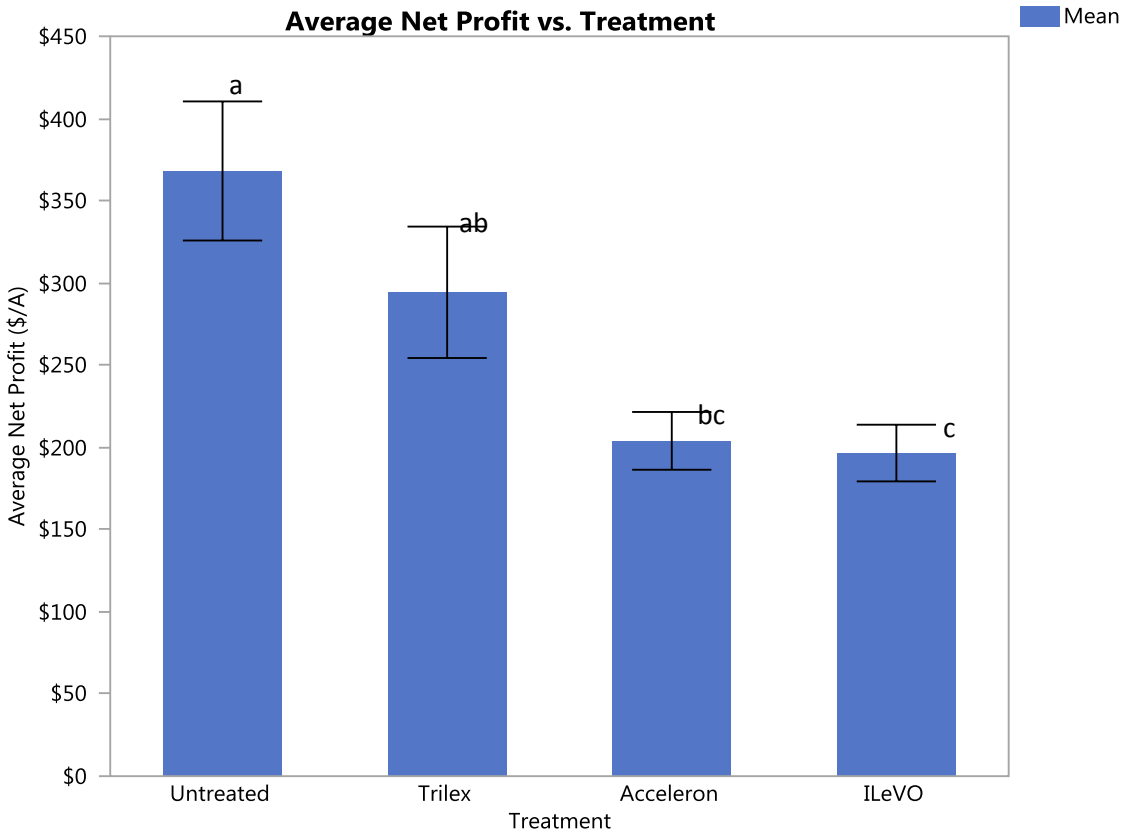


Figure 4. Net profit vs. treatment. Each error bar is constructed using 1 standard error from the mean. Treatments connected with the same letter are not significantly different from each other (α=0.05).

2017 Summary

Data from first-year trials indicate that fungicide seed treatments may increase soybean emergence over untreated seed in low-pressure soilborne disease situations; however, this increase in emergence and stand did not translate into a statistically significant increase in yield when compare to untreated controls. Yields were also significantly lower in treated seed at two of the locations. In addition, fungicide seed treatments did not increase profitability; the added expense for treated seed coupled with no increase in yield resulted in an average loss of $136.50 per acre compared to untreated seed.

Using fungicide seed treatments on soybeans may not provide any significant economic benefit when planted in fields that are not conducive for soilborne disease development and/or that do not have a history of soilborne diseases. This is only the first year of a multi-year study; more data needs to be collected over multiple years and sites to improve the robustness of the dataset and to make sound production recommendations for growers in our region.

2018 Summary

A wet spring delayed planting by several weeks and resulted in the UDREC trial location having to be pulled from the experiment. The later planting dates likely contributed to a more consistent plant emergence, which could be why we did not observe a treatment effect on emergence like we did in 2017. Prolonged wetness and rain in 2018 likely contributed to the variability in yield observed across plots. Overall lower yields in 2018 in comparison to 2017 are likely a combination of wet weather and later planting dates.

The seed treatments tested in this study did not provide any agronomic benefits and would have been an additional expense incurred on production. Even in a record-breaking wet year, the seed treatments did not provide a benefit and demonstrates the fact that planting into proper field conditions (even if it means waiting several weeks) is important when trying to manage for seedling diseases. Based on this work, we would not recommend a fungicide seed treatment on soybean seed planted into fields that are not prone to soilborne/seedling diseases and should be saved for those acres planted early in the spring when soils are cool and wet, and/or for fields that are prone to wet soils or have a history of soilborne and seedling diseases. We also did not observe any “plant health” benefits as a result of using fungicide seed treatments.

Acknowledgements

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References

1. Bradley, C. A. 2008. Effect of fungicide seed treatments on stand establishment, seedling disease, and yield of soybean in North Dakota. Plant Dis. 92:120-125.

2. Poag, P. S., M. Popp, J. Rupe, B. Dixon, C. Rothrock, and C. Boger. 2005. Economic Evaluation of Soybean Fungicide Seed Treatments. Agron. J. 97:1647-1657. doi:10.2134/agronj2005.0095.

3. Mueller, D. S., Hartman, G. L., and Pedersen, W. L. 1999. Development of sclerotia and apothecia of Sclerotinia sclerotiorum from infected soybean seed and its control by fungicide seed treatment. Plant Dis. 83:1113-1115.

4. Guy, S. O., and E. S. Oplinger. 1989. Soybean Cultivar Performance as Influenced by Tillage System and Seed Treatment. J. Prod. Agric. 2:57-62. doi:10.2134/jpa1989.0057.

5. H.M. van Es, C.P. Gomes, M. Sellmann, and C.L. van Es. Spatially-Balanced Complete Block designs for field experiments. Geoderma 140(4):346-352. doi: http://dx.doi.org/10.1016/j.geoderma.2007.04.017.

6. Maryland Crop Budgets. Maryland Grain webpage. University of Maryland Extension. http://extension.umd.edu/grainmarketing/crop-budgets.

Appendix

Weather Summary: WYE, Queenstown 2017								
Month	**Max Temp. (F)**	**Max Temp. (°C)**	**Avg Temp. (F)**	**Avg Temp. (°C)**	**Min Temp. (F)**	**Min Temp. (°C)**	**Precip. (in)**	**Precip (mm)**
April	89	32	61	16	39	4	2.49	63.246
May	93	34	64	18	44	7	6.79	172.466
June	95	35	76	24	51	11	2.15	54.61
July	96	36	80	27	62	17	9.17	232.918
August	91	33	75	24	62	17	10.13	257.302
September	86	30	71	22	57	14	2.18	55.372
October	84	29	64	18	42	6	2.94	74.676
November	77	25	48	9	26	-3	2.49	63.246
							38.34	973.836
Weather Summary: WMREC, Keedysville 2017								
Month	**Max Temp. (F)**	**Max Temp. (°C)**	**Avg Temp. (F)**	**Avg Temp. (°C)**	**Min Temp. (F)**	**Min Temp. (°C)**	**Precip. (in)**	**Precip (mm)**
April	86	30	61	16	33	1	2.37	60.198
May	93	34	63	17	37	3	5.32	135.128
June	95	35	74	23	51	11	2.74	69.596
July	95	35	78	26	57	14	5.35	135.89
August	93	34	73	23	32	0	2.85	72.39
September	92	33	69	21	48	9	1.45	36.83
October	86	30	62	17	39	4	3.54	89.916
November	73	23	46	8	20	-7	1.62	41.148
							25.24	641.096
Weather Summary: CMREC, Beltsville 2017								
Month	**Max Temp. (F)**	**Max Temp. (°C)**	**Avg Temp. (F)**	**Avg Temp. (°C)**	**Min Temp. (F)**	**Min Temp. (°C)**	**Precip. (in)**	**Precip (mm)**
April	90	32	61	16	34	1	4.12	104.648
May	92	33	62	17	36	2	6.37	161.798
June	94	34	73	23	48	9	1.8	45.72
July	95	35	78	26	56	13	8.51	216.154
August	91	33	73	23	56	13	7.59	192.786
September	88	31	68	20	48	9	1.91	48.514
October	84	29	61	16	34	1	3.56	90.424
November	76	24	46	8	22	-6	2.28	57.912
							36.14	917.956
Weather Summary: UDREC & HARB, Georgetown/Harbeson 2017								
Month	**Max Temp. (F)**	**Max Temp. (°C)**	**Avg Temp. (F)**	**Avg Temp. (°C)**	**Min Temp. (F)**	**Min Temp. (°C)**	**Precip. (in)**	**Precip (mm)**
April	89	32	61	16	33	1	3.21	81.534
May	92	33	63	17	44	7	5.53	140.462
June	94	34	74	23	48	9	2.08	52.832
July	95	35	78	26	56	13	6.88	174.752
August	91	33	74	23	55	13	5.3	134.62
September	87	31	69	21	49	9	2.25	57.15
October	85	29	62	17	35	2	3.76	95.504
November	76	24	48	9	22	-6	2.38	60.452
							31.39	797.306

Weather Summary: UDREC, Georgetown 2018								
Month	**Max Temp. (F)**	**Max Temp. (°C)**	**Avg Temp. (F)**	**Avg Temp. (°C)**	**Min Temp. (F)**	**Min Temp. (°C)**	**Precip. (in)**	**Precip (mm)**
April	81	27	52	11	33	1	5.38	136.652
May	90	32	68	20	41	5	10.23	259.842
June	93	34	73	23	54	12	6.82	173.228
July	97	36	77	25	52	11	3.74	94.996
August	96	36	78	26	56	13	2.06	52.324
September	95	35	74	23	54	12	7.06	179.324
October	89	32	60	16	32	0	4.22	107.188
November	73	23	47	8	23	-5	6.55	166.37
							46.06	1169.924
Weather Summary: CMREC, Beltsville 2018								
Month	**Max Temp. (F)**	**Max Temp. (°C)**	**Avg Temp. (F)**	**Avg Temp. (°C)**	**Min Temp. (F)**	**Min Temp. (°C)**	**Precip. (in)**	**Precip (mm)**
April	84	29	52	11	30	-1	3.67	93.218
May	90	32	69	21	39	4	8.46	214.884
June	92	33	71	22	50	10	5.43	137.922
July	96	36	76	24	55	13	8.69	220.726
August	94	34	77	25	56	13	6.5	165.1
September	92	33	73	23	55	13	8.96	227.584
October	87	31	58	14	31	-1	4.13	104.902
November	73	23	43	6	25	-4	7.44	188.976
							53.28	1353.312
Weather Summary: WMREC, Keedysville 2018								
Month	**Max Temp. (F)**	**Max Temp. (°C)**	**Avg Temp. (F)**	**Avg Temp. (°C)**	**Min Temp. (F)**	**Min Temp. (°C)**	**Precip. (in)**	**Precip (mm)**
April	86	30	51	11	27	-3	5.02	127.508
May	92	33	70	21	46	8	8.16	207.264
June	94	34	73	23	52	11	8.51	216.154
July	97	36	78	26	59	15	6.4	162.56
August	95	35	78	26	58	14	8.96	227.584
September	95	35	72	22	54	12	9.5	241.3
October	88	31	60	16	35	2	2.19	55.626
November	75	24	42	6	24	-4	7.61	193.294
							56.35	1431.29
Weather Summary: WYE, Queenstown 2018								
Month	**Max Temp. (F)**	**Max Temp. (°C)**	**Avg Temp. (F)**	**Avg Temp. (°C)**	**Min Temp. (F)**	**Min Temp. (°C)**	**Precip. (in)**	**Precip (mm)**
April	84	29	53	12	35	2	3.19	81.026
May	89	32	70	21	62	17	8.42	213.868
June	93	34	73	23	53	12	4.27	108.458
July	98	37	79	26	59	15	8	203.2
August	93	34	79	26	62	17	2.36	59.944
September	84	29	76	24	68	20	6.55	166.37
October	87	31	61	16	41	5	7.04	178.816
November	71	22	46	8	23	-5	6.99	177.546
							46.82	1189.228