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Evaluation of Growth-Promoting Products for Soybean Production

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JUSTIFICATION

Soybean farmers have had many new products come on the market in recent years touted as growth-promoting products intended to help growers attain high-yielding soybeans. Many of these products contain growth regulators, hormones, humic acids, carbon, sugars, and/or fertilizer. Limited replicated university research has been done with these products to assess their application and utility in Maryland's unique climate and growing conditions.

RESEARCH OBJECTIVES

1. Test several seed, pre-plant, and foliar growth-enhancing products on full season soybeans planted at two sites in Maryland to determine their effects on plant response, emergence, growth, and yield.

METHODS

Plot Design

Field trials were established at two University of Maryland Research farms: Western Maryland Research & Education Center in Keedysville, MD (WMREC) and Wye Research and Education Center in Queenstown, MD (WYE). Experimental design consisted of 10 treatments (Table 1) in 11'x30' plots replicated 5 times at each location and arranged in a spatially-balanced randomized complete block design.

Table 1. Treatment application rates and timing.

Treatment	Trade Name *Active Ingredient(s)*	Application Rate (& Timing)
Non-treated Control	None	N/A
Take Off ST	Take Off ST (seed treatment) *0.75% citric acid + 0.25% glutamate + 0.25% Proline (prothioconazole)*	0.3 oz/140,000 seeds (seed treatment)
Take Off Foliar	Take Off LS (liquid solution) *5% K_2O + 2% S + 0.10% B + 0.20% Fe + 0.25% Mn + 0.25% Zn*	2 pints/acre (R1)
Take Off ST + Take Off Foliar	Take Off ST (seed treatment) *0.75% citric acid + 0.25% glutamate + 0.25% Proline (prothioconazole)* Take Off LS (liquid solution) *5% K_2O + 2% S + 0.10% B + 0.20% Fe + 0.25% Mn + 0.25% Zn*	0.3 oz/140,000 seeds (seed treatment) 2 pints/acre (R1)
Take Off ST + K fert.	Take Off ST (seed treatment) *0.75% citric acid + 0.25% glutamate + 0.25% Proline (prothioconazole)* Monty's K28 Liquid Potash *28% K_2O*	0.3 oz/140,000 seeds (seed treatment) 0.36 pints/acre (R1)
K fert.	Monty's K28 Liquid Potash *28% K_2O*	0.36 pints/acre (R1)

Carbon	Monty's Liquid Carbon *1% organic carbon + 2% humic acid*	0.5 gallons/acre (pre-plant)
Carbon + Agri-Sweet	Monty's Liquid Carbon *1% organic carbon + 2% humic acid* Monty's Agri-Sweet *61% glucose*	0.5 gallons/acre (pre-plant) 24 oz/acre (R1)
Seed+	Seed+ Graphite *28% talc + 7% graphite + 4% Ca + 5% S + 2% Zn + 1% Fe + 0.7% Mn + 0.07% Co + 0.09% Cu + 0.08% Mo*	4 oz/100 lbs seed (in planter box w/seed)
Seed+ + Crop+	Seed+ Graphite *28% talc + 7% graphite + 4% Ca + 5% S + 2% Zn + 1% Fe + 0.7% Mn + 0.07% Co + 0.09% Cu + 0.08% Mo* Crop+ *1% N + 1% K_2O + 3.5% S + 0.08% B + 0.055% Co + 1% Cu + 1.3% Fe + 1.1% Mn + 0.04% Mo + 2.3% Zn*	4 oz/100 lbs seed (in planter box w/seed) 8 fl oz/acre (R1 & R3)

Pre-plant and Seed Treatments

Plots receiving pre-plant treatments were applied with a tractor-mounted sprayer one day prior to planting. Order of planting was: non-treated seeds were planted first, then Take Off ST treated seeds, then Seed+ treated seed. Planter seed box(s) and seed tubes were cleaned between each treatment to reduce cross-contamination. Full plot planting and harvest information are found in Table 2.

Table 2. Planting and harvest specifications.

	WMREC	**Wye**
Seed:	Soybean, Mid-Atlantic Seed 4077	
Previous Crop:	Corn	
Tillage:	No-till	
Planting Date:	5/5/2020	5/21/2020
Planter:	John Deere 1590	Great Plains
Row Spacing:	15"	15"
Population:	150,000 plants/acre	150,000 plants/acre
Harvest Date:	11/18/2020	11/23/2020
Harvester:	Almaco R1 research combine	Almaco R1 research combine
Harvest Area:	30' from Center 5' of plot	30' from Center 5' of plot

Emergence

Emergence ratings were conducted at each location approximately two weeks after planting by counting the number of emerged plants (plants at least VE growth stage) per 60 feet of plot row. Relative emergence was calculated by dividing plot emergence by the non-treated control average and reported as a percentage for proper statistical comparison between treatments across locations.

Foliar Applications

Foliar treatments were made to plots per label rates as seen in Table 1, with the exception of K28, which was applied at a custom rate to deliver an equivalent rate of potash per acre as Take Off LS. This treatment was added to compare Take Off LS to an equal rate of potassium fertilizer. All foliar treatments were applied with a tractor-mounted sprayer and a 10 foot side-mounted boom at R1 (plus R3 for Crop+), consistent with label directions.

NDVI and Canopy Height

Normalized Difference Vegetation Index (NDVI) ratings were collected at two points during the growing season at R6 and R7 using a handheld GreenSeeker (Trimble Inc., Sunnyvale, CA) held approximately 2 feet above the crop canopy. Average canopy height ratings were also collected at R7.

Statistics

All data were analyzed in a mixed model ANOVA using JMP Pro 14 software (SAS Institute, Cary, NC). Year by location, as well as replicate, were treated as random effects in the model. Treatment effects were separated at α=0.10 and pairwise comparisons made using Fisher's protected LSD.

RESULTS

Emergence

Take Off ST treated seed provided significantly greater number of emerged plants relative to the control than all other seed treatments or pre-plant treatments (Table 3). This effect was significant at the WMREC location only. The model shows that Take Off ST enhanced emergence by nearly 36% averaged across both locations. Compared to non-treated controls at individual locations, Take Off ST enhanced emergence by 63% at WMREC, which was significantly greater than all other treatments, but only 3.3% at the WYE, which was not significantly different than non-treated controls (Figure 1).

Table 3. ANOVA data table for emergence.

Treatment	Relative Emergence (% of control)	Emerged Plants (plants/ft of row)
Non-treated	104.4 b	2.16 b
Take Off ST	140.2 a	2.63 a
Seed+	110.1 b	2.20 b
Carbon	106.8 b	2.18 b
P>F	*0.0002*	*<0.0001*

Treatments with the same letters within the same column are not significantly different than each other (α=0.10).

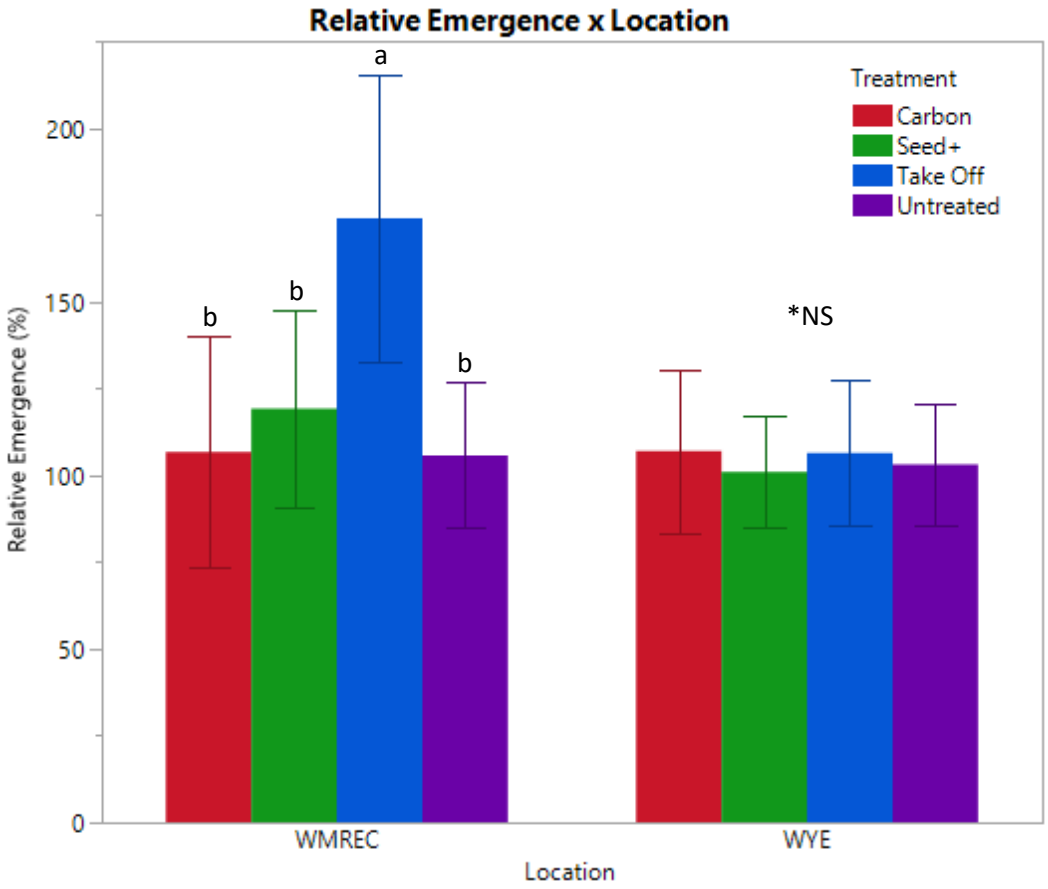

Figure 1. Relative emergence by location. Each error bar is constructed using one standard deviation from the mean. Treatments connected by the same letter are not significantly different (α=0.10). *NS= no significant differences.

NDVI and Canopy Height

NDVI ratings collected at R6 and R7 at both locations revealed no difference in plant greenness (Figure 2) or canopy height (Figure 3, P=0.7468).

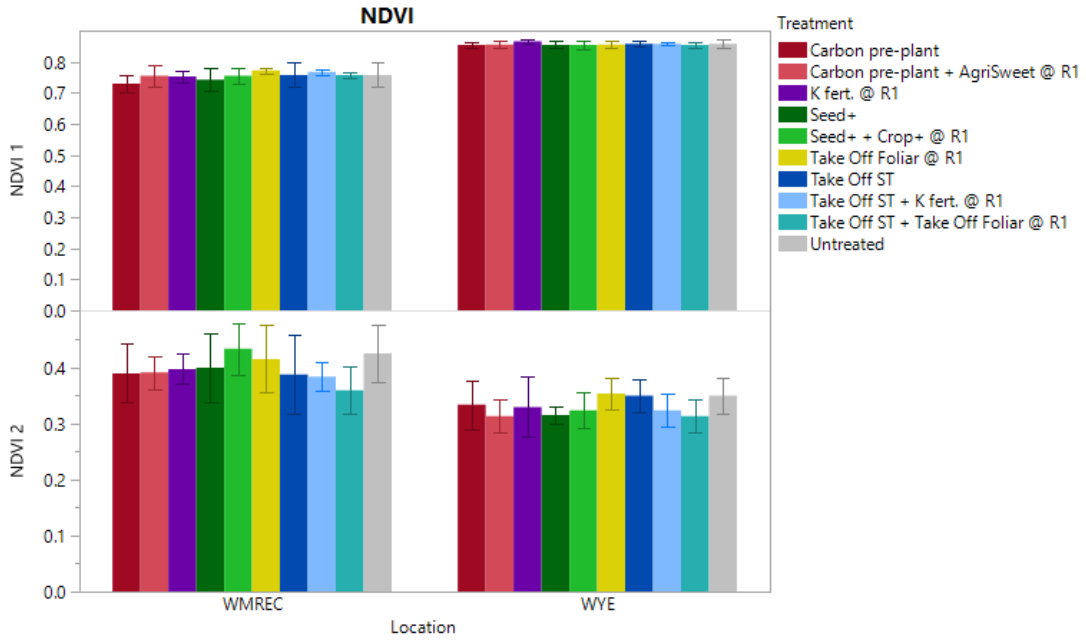

Figure 2. NDVI ratings for R6 (NDVI 1) and R7 (NDVI 2) soybeans at WMREC and WYE trial locations. Error bars are constructed using one standard deviation from the mean. No significant differences between treatments (α=0.10).

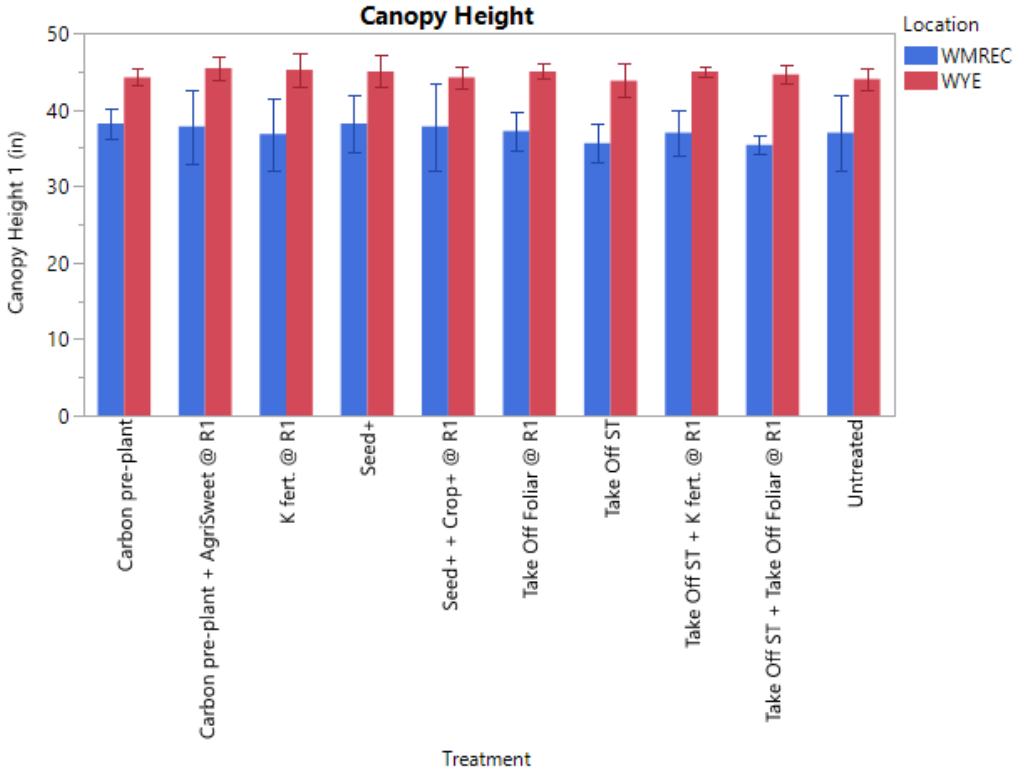

Figure 3. Average canopy height at R7. Each error bar is constructed using one standard deviation from the mean. No significant differences between treatments (α=0.10).

Grain Yield

Overall, yields were higher at WYE than WMREC, with a trial average of 77.37 and 37.96 bushels per acre, respectively (Table 3, Figure 4). Test weights were higher at WYE than WMREC (Table 3). There were no statistical differences between any of the treatments at either trial location for yield, test weight, or grain moisture (Table 3).

Table 3. Grain yield data by location for WMREC and WYE locations.

Treatment	WMREC			WYE		
	[1]Yield (bu/a)	Test Weight (lbs)	Grain Moisture (%)	Yield (bu/a)	Test Weight (lbs)	Grain Moisture (%)
Non-treated Control	33.4	54.1	13.5	76.8	55.2	11.2
Take Off ST	36.7	53.4	13.4	81.9	55.2	11.1
Take Off Foliar	35.0	53.5	13.5	74.2	55.0	11.2
Take Off ST + Take Off Foliar	37.2	53.6	13.5	76.4	55.3	11.2
Take Off ST + K fert.	39.2	53.8	13.6	75.1	55.5	11.2
K fert.	36.8	53.5	13.5	81.4	55.4	11.2
Monty's Carbon	39.8	53.4	13.5	76.2	55.9	11.1
Monty's Carbon + Agri-Sweet	41.4	54.3	13.6	78.2	55.1	11.2
Seed+	38.0	53.6	13.6	77.4	55.4	11.2
Seed+ + Crop+	42.1	53.3	13.7	76.1	55.0	11.2
Trial Average	38.0	53.7	13.5	77.4	55.3	11.2
P>F	*0.8306*	*0.7509*	*0.9159*	*0.6862*	*0.7969*	*0.6958*

[1]Grain yield reported in bushels per acre adjusted to 13% moisture. No significant differences (α=0.10).

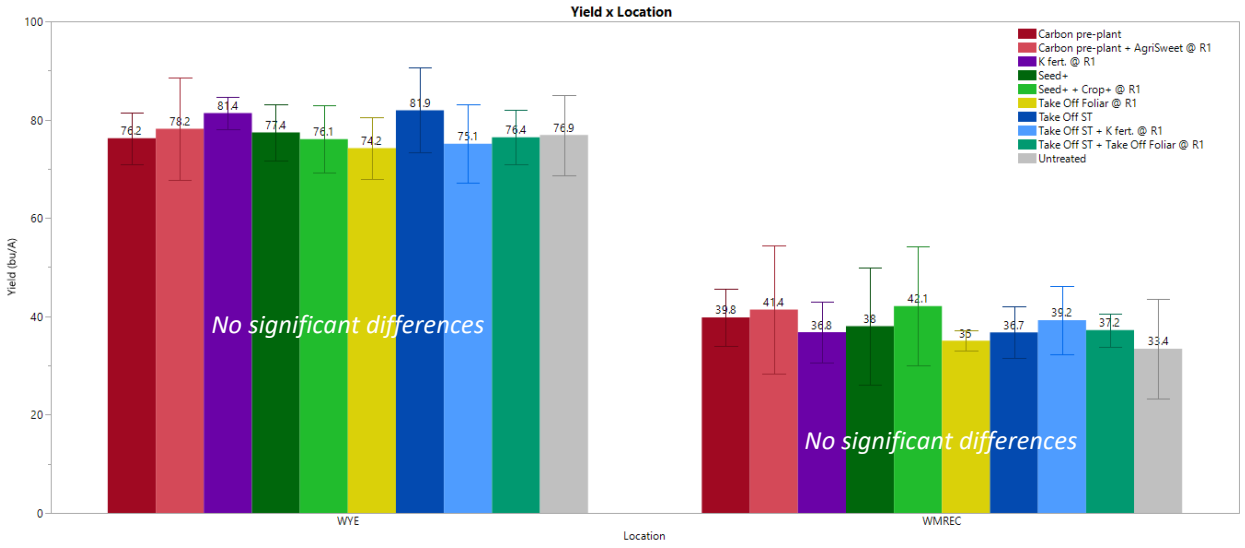

Figure 4. Grain yield by location. Each error bar is constructed from one standard deviation from the mean. No significant differences between treatments (α=0.10).

Comparing relative yield of the treatments as a percentage of the overall trial mean at each location is a way to statistically eliminate location as a variable in the dataset. When yields were compared in this way there were no significant differences in yield between treatments (P=0.8491, Figure 5).

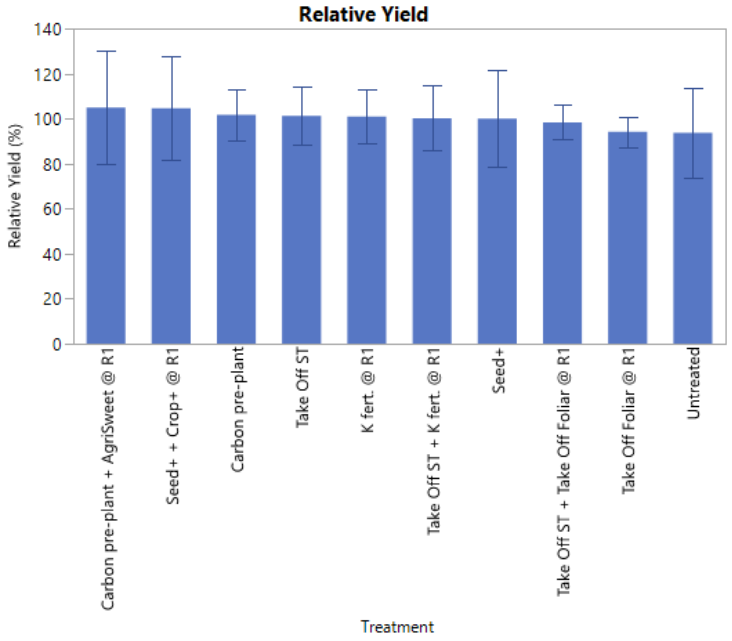

Figure 5. Relative yield for each treatment averaged across WMREC and WYE trial locations. Each error bar is constructed using one standard deviation from the mean. No significant differences between treatments (α=0.10).

CONCLUSIONS, IMPLICATIONS, AND FUTURE WORK

Emergence

Take Off ST treated seed significantly improved soybean emergence over the non-treated control, Carbon, and Seed+ treatments at WMREC but not WYE; we observed this same trend in 2019. Soil type and planting time could be influencing this trend in the data, as in 2020 and 2019, WMREC trials were planted first and into cooler soils. These data indicate a possible benefit to Take Off ST when soybeans are planted into similar soil types and/or early in the season when soils are cooler. Future research will be focused on Take Off ST as a function of planting date to determine if this seed treatment is a viable option for improving soybean stands at earlier planting dates.

As part of this project in 2020, we intended to conduct controlled growth chamber studies with Take Off ST and Seed+ treated seed as various temperatures against a non-treated control to determine if there are any germination differences at different temperatures. Due to COVID-19 precautions, we were not able to conduct this experiment this summer. The growth chamber experiments will resume once COVID telework restrictions are lifted.

NDVI and Canopy Height

NDVI and canopy height ratings indicate no difference between treatments and suggest that these products do no influence these plant characteristics.

Grain Yield

Yields were above average at WYE and below average at WMREC due to summer precipitation. WYE saw record rainfall in August, which made for prolific flower and pod production while WMREC received just over an inch rain for August, causing flower drop and pod abortion.

For a second year in a row, we did not observe any statistical differences in grain yield between treatments. Interestingly, even though Take Off ST improved emergence at the WMREC location, it did not translate into an improvement in yield. This is likely due to the fact that soybeans can compensate for reduced stands by branching, setting more pods, and making more seeds per pod and larger seeds.

None the treatments affected grain moisture or test weight.

Future research will be focused on understanding the effect Take Off ST on soybeans planted at different planting dates in comparison to a non-treated control.

ACKNOWLEDGEMENTS

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