Non-foliar yield enhancement products in NC Soybeans

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Introduction: Various non-foliar yield enhancement products are available to North Carolina soybean producers. Profit margins are currently narrow for soybeans and much thought should go into the potential yield advantages and associated costs from the use of these various non-foliar yield enhancement products. Our goal at NC State University is to provide unbiased data on the impact of these products on soybean yield in diverse environments across the state. The NC State Soybean Extension program has been conducting non-foliar yield enhancement trials for the past five years in diverse environments across the state. Over the years, we have been able to identify some trends which will be discussed throughout this publication.

Materials and Methods: This study was conducted across 15 North Carolina environments from 2014-2018 (Table 1). At each environment, all treatments were planted by the Soybean Extension Team with a John Deere vacuum planter on 15-inch row spacing at ~130,000 seeds/A. Pre-plant fertility was applied based on soil test recommendations and herbicide program was based on cooperating grower standard practices. No over-the-top fungicides or insecticides were applied by the cooperating grower. Each treatment was evaluated in four replications per environment. Non-foliar products evaluated are available in Table 2. Grain yield was collected using a small-plot combine. Soybean yield data is reported at 13% moisture. All data analysis was conducted using PROC Mixed in SAS 9.4. Estimate statements were used to compare treatments to a nontreated control. If a *P*-value is <0.10 we consider that significant and the product likely to impact soybean yield.

Table 1. Trial environments by County, year, average yield, participating County Extension Agent, and cooperating grower.

County	Year	Average Trial Yield	Agent	Grower	Variety	Planting Date
Johnston	2018	49 bu/A	Tim Britton	Keith Smith	SG 6985XT	6/6
Onslow	2018	38 bu/A	Melissa Huffman	Tim Huffman	AG 56X8	6/5
Yadkin	2018	56 bu/A	Tim Hambrick	Greg Moxley	S58RY78	5/25
Alamance	2017	48 bu/A	Dwayne Dabbs	Michael McPherson	P 5526RYS	6/1
Forsyth	2017	63 bu/A	Tim Hambrick	Stacy Manning	DG 52RS86	7/11
Greene	2017	59 bu/A	Roy Thagard	Tommy Hardy	S67-B7	6/14
Wake	2017	44 bu/A	Emily Mueller	Ryan Broadwell	SG 5221	5/31
Greene	2016	27 bu/A	Roy Thagard	Tommy Hardy	USG75B75R	6/11
Hyde	2016	51 bu/A	Andrea Gibbs	Dawson Pugh	DG 32RY55	6/17
Johnston	2016	45 bu/A	Tim Britton	Keith Smith	AG 6536	6/31
Beaufort	2015	41 bu/A	Rod Gurganus	Haslin Farms	S55-Q3	5/27
Johnston	2015	40 bu/A	Tim Britton	Ray Boswell	SS6713NR2	7/8
Union	2015	45 bu/A	Andrew Baucom	Cox Brothers	S5511NR2	6/23
Jones	2014	49 bu/A	Jacob Morgan	Keith Wills	S67-R6	6/24
Pasquotank	2014	54 bu/A	Al Wood	Jeff Small	DG 32RY55	6/12

Table 2. Non-foliar treatment descriptions and years evaluated in the NC State Soybean Extension non-foliar yield enhancement trials.

Type of Product	Product	Application Type	Rate	Years Evaluated
Fungicide/Insecticide/Bionematicide	Evergol/Poncho/Votivo	Seed Treatment	Labeled Rates	2018, 2017
Insecticide/Bionematicide	Poncho/Votivo	Seed Treatment	Labeled Rates	2016, 2015, 2014
Fungicide	Rancona	Seed Treatment	Labeled Rates	2018, 2017, 2016, 2015, 2014
Fungicide	Trilex	Seed Treatment	Labeled Rates*	2015, 2014
Inoculant	Optimize LCO XC	Seed Treatment	1.5 fl oz/cwt	2018, 2017, 2016, 2015, 2014
Inoculant	TagTeam LCO XC	Seed Treatment	1.5 fl oz/cwt	2018, 2016, 2015
Biological	BioForge	Seed Treatment	4 fl oz/cwt	2018, 2017, 2016, 2015, 2014
Inoculant+Biological	Optimize+BioForge	Seed Treatment	1.5 fl oz/cwt +4 fl oz/cwt	2018, 2017, 2016, 2015, 2014
Microbial Stimulant	Agzyme	In-Furrow	12.8 fl oz/A	2018, 2017, 2016, 2015, 2014
Fungicide	Priaxor	In-Furrow	2-7 fl oz/A	2018, 2017, 2016, 2015, 2014
Fungicide	Proline	In-Furrow	14 ft oz/A	2015, 2014
Fungicide	Headline	In-Furrow	7 fl oz/A	2015, 2014
Fungicide	Quadris	In-Furrow	21 fl oz/A	2015, 2014
Microbioal Stimulant	Environoc 401	In-Furrow	1 qt/A	2018, 2017
Fertilizer	ESN (44-0-0) at planting + S*	Broadcast	230 lbs/A	2015, 2014
Fertilizer	ESN (44-0-0) pre-bloom + S*	Broadcast	230 lbs/A	2015, 2014
Fertilizer	Ammonium sulfate (21-0-0-24) at planting	Broadcast	475 lbs/A	2015, 2014
-	Nontreated Control	-	-	2018, 2017, 2016, 2015, 2014

*Treated by Bayer CropScience at labeled rates

Results and Discussion:

Fungicide seed treatments: When combining over environments, the use of a fungicidal seed treatment did not impact soybean yield (*P*=0.69). Most of these trials were planted in June or July (Table 1). It is possible that fungicidal seed treatments would have more of an impact at earlier soybean planting dates, when conditions are generally cooler and wetter, which can intensify seedling diseases. The Soybean Extension Program has a collaborative project with Drs. Bill Foote and Lindsey Thiessen in 2019 and 2020 looking at the value of fungicidal seed treatments at earlier planting dates (mid-March through early May) with varieties varying in germination (72-92%). There has been much discussion about protecting the seed that has a chance of germinating moving into 2019 with the lower germination percentages we are seeing in some varieties from seed quality production issues in 2018. Fungicidal seed treatments may be more important this year to protect the seed quality we do have and to prevent re-plant necessity due to limited seed quantities of some varieties.

Insecticidal/Biological seed treatments: The Poncho/Votivo seed treatment was evaluated over eight environments and had no impact on soybean yield (*P*=0.97). We clearly did not comprehensively evaluate insecticidal or nematicidal seed treatments in this trial and that was not our goal. Dr. Dominic Reisig and colleagues have done abundant work on this topic and their results have consistently shown no yield advantage to using an insecticidal seed treatment on soybeans in North Carolina. In addition to lack of yield response, the use of an insecticidal seed treatment in soybeans can intensify resistance development to these seed treatments used in other crops, like cotton, where they are needed. In separate NC State studies, nematicide seed treatments show inconsistent results for reducing damage from nematodes. With inconsistency in yield response from nematicidal seed treatments, their use appears to be best placed in systems with moderate nematode populations, and are likely not economical in low or high nematode population environments.

Inoculant seed treatments: Soybeans can fix their own nitrogen through a symbiotic relationship with bacteria (*Bradyrhizobia japonicum*) that can convert atmospheric nitrogen (N_2) into a plant useable form. For this reason, soybeans are often not fertilized with any additional N fertilizer, and farmers generally depend on N-fixation and residual soil N to fulfill soybean N demand. There has been recent interest in the value of inoculating soybeans with appropriate bacteria to promote N-fixation. In this trial we evaluated two seed applied inoculants. The two inoculants evaluated in this study, Optimize LCO XC and TagTeam LCO XC, provided a slight yield advantage from the nontreated control (+1.1 bu/A, *P*=0.12). Other University conducted trials also have observed modest yield increases from the use of the Optimize inoculant product (Marburger et al, https://coolbean.info/library/documents/SB_Innoc_Tillage_2016_FINAL_web.pdf). Seed-applied inoculants are relatively inexpensive ($5-6/140,000 seeds). Previous work by Dr. Jim Dunphy would indicate that in-furrow inoculants are generally more effective than seed applied inoculants. It is generally believed that inoculating soybeans is more valuable on a field that has not produced soybeans for 4-5 years, than one which has had soybeans consistently in the rotation.

Biological seed treatments: BioForge is a biological plant growth promoter marketed by Stoller that claims to promote early root growth by reducing stress. This product was evaluated as a seed application over five years in this study and did not impact soybean yield (*P*=0.60). Other

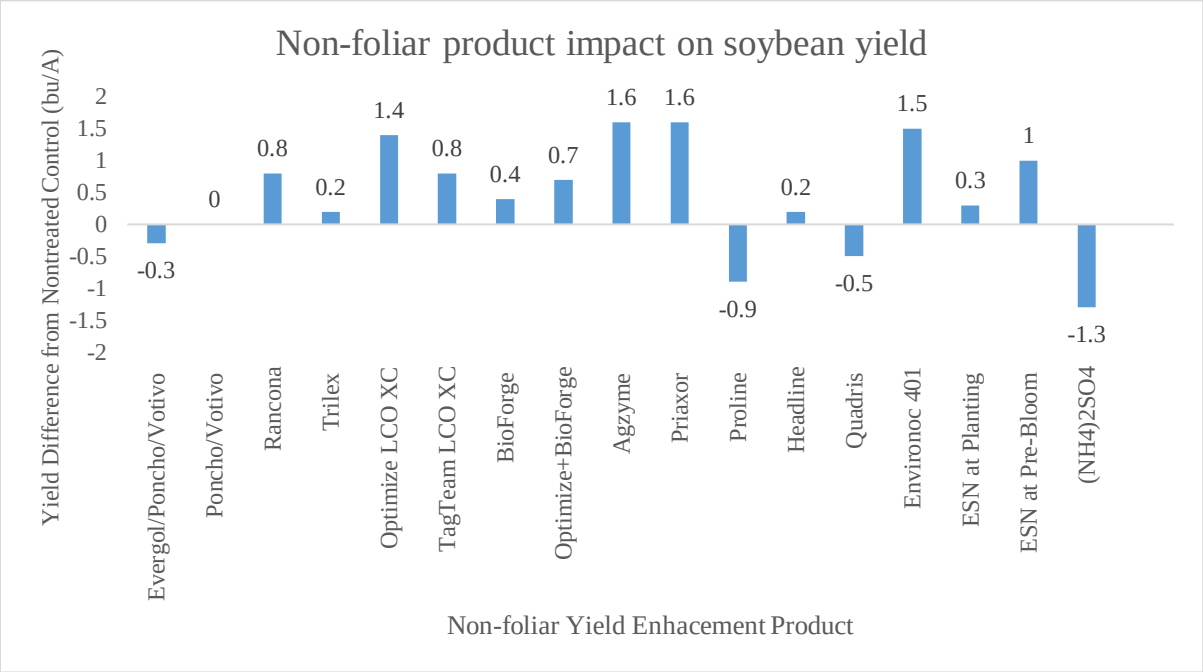
University research has found that BioForge applied both as a seed treatment and a foliar treatment was more effective at impacting soybean yield than use as a seed treatment alone (Staton, https://www.canr.msu.edu/news/bio_forge_effects_on_soybean_yields_in_michigan).

In-furrow fungicides: The use of Quadris, Proline, and Headline did not impact soybean yield across environments (P=0.69, P=0.43, P=0.83), however Priaxor did increase soybean yield (+1.6 bu/A, P=0.04). It should again be noted that the trials were generally planted in June and July (Table 1); a larger impact on soybean yield may have been observed from in-furrow fungicide use at earlier soybean planting dates when environmental conditions might be more conducive for disease development. In-furrow fungicides are best used in environments with high disease risk (cool, wet soils), as fungicide resistance develops rapidly in soilborne fungi populations. Continued use of the same fungicide chemistry could result in fungicide-resistance, which would make future disease management more challenging.

In-furrow microbial stimulants: Agzyme is a microbial stimulant product marketed by AgConcepts that is advertised to enhance microbial activity. Agzyme increased soybean yield by 1.6 bu/A (P=0.04) when evaluated over five years in these trials. Environoc 401 is a microbial stimulant product marketed by Biodyne that is advertised to enhance microbial activity. Environoc 401 trended towards increasing soybean yield when evaluated over two years in this study (+1.5 bu/A, P=0.13)

Fertilizer applications: There is some question about the necessity of adding additional N fertilizer to soybeans as we push yields higher. At some point, the evaluation of both ESN and ammonium sulfate applications in soybeans was of interest to growers in North Carolina. In this trial, the use of ESN at planting or pre-bloom did not impact soybean yield (P=0.99). The use of ammonium sulfate at planting did not impact soybean yield (P=0.26). There are many field experiments that have been conducted in North Carolina that show that inorganic N fertilizer applications to effectively nodulated soybeans are rarely profitable. A nationwide publication has been recently released on the value of adding inorganic N to soybean (https://coolbean.info/library/documents/Nstudy.pdf); this study found in most environments there was a minimal effect of N fertilizer application on soybean yield and that this practice would rarely return profits.

Figure 1. Soybean yield as impacted by various non-foliar yield enhancement products compared to the nontreated control in the NC State Soybean Extension non-foliar yield enhancement program from 2014-2018.



Conclusions: Over the years the non-foliar yield enhancement products evaluated in this program have provided modest soybean yield increases, if any. Our evaluation of these products across 15 environments is context specific to late-May through early July planting. Many of these products are relatively inexpensive; growers must decide if the modest increases in soybean yield observed with some of these products coupled with the risk of resistance development would justify investment.

Questions? Please contact Dr. Rachel Vann, Soybean Extension Specialist in the Crop and Soil Sciences Department at NC State, at rachel_vann@ncsu.edu or 919-616-6775.