2014 Soybean Management Field Days

RESEARCH UPDATE

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March 2015 Statewide Soybean Grower Edition

Soybean Management Field Days
On-Farm Research
Introduction

Keith Glewen, UNL Extension Educator

The 2014 growing season represented the fourth year replicated field research was conducted at the Soybean Management Field Day locations.

Why the need for conducting on-farm research at these locations? Many practical questions regarding soybean production and natural resource sustainability are not being answered by current federal and industry funded crop research programs. In addition, the diversity of soybean growing environments in Nebraska, changes in climate and advancements in production technologies are causing growers to question many long-held assumptions associated with soybean production. Add to this, today's consumer are asking questions about how and where their food comes from, the increasing world demand for soybeans, and the importance natural resources such as soil and water has on meeting this growing demand. Subsequently, growers are increasingly challenged to grow soybeans more responsibly and to document sustainability.

Faculty and staff representing theUniversity of Nebraska-Lincoln greatly appreciate the financial investment you the soybean growers of Nebraska have made through your Checkoff contribution in supporting the research undertaken in this project. We would also like to thank the Nebraska Soybean Board for their part in support and management of this effort. Their input into the selection of research topics and in some cases treatments was extremely valuable.

We would also like to thank each of the four collaborating soybean growers who provided their farm as a research location.

After reviewing the report, if you have additional questions, we encourage you to contact researchers associated with the study. Their names appear in the write up of each study and their contact information is listed on the back cover.

Research update reports are available online at: http://ardc.unl.edu/soydaysresearch.

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Soil textures and overall crop management at each location of the 2014 SMFD study

Location	Soil Textures*	Planting Date	Herbicide Program		Harvest Date	Trial Avg. Yield (bu/A)	Tillage Practice
			Date	Chemical and Rate/A			
Auburn	Yutan silty clay loam	5/7/2014	5/21/2014	Roundup 32oz	10/6/2014	59	No-Till
				AMS 17lb/100gal			
			6/13/2014	Roundup fl 32oz			
				Pursuit 4 fl oz			
				Clethodim 12 fl oz			
				AMS 17lb/100gal			
Shickley	Crete silt loam	5/6/2014	4/15/2014	Sonic 4 fl oz	10/7/2014	79	Tilled
			5/22/2014	Clethodim 12 fl oz			
			6/12/2014	Roundup fl 32oz			
				Pursuit 4 fl oz			
				Clethodim 12 fl oz			
				AMS 17lb/100gal			
Belgrade	Hall silt loam	4/28/2014	5/23/2014	Roundup 32oz	10/8/2014	76	No-Till
				AMS 17lb/100gal			
			6/19/2014	Roundup fl 32oz			
				Pursuit 4 fl oz			
				Clethodim 12 fl oz			
				AMS 17lb/100gal			
Snyder	Moody/Nora silty clay loam	5/6/2014	5/23/2014	Roundup 32oz	10/10/2014	68	No-Till
				AMS 17lb/100gal			
			6/13/2014	Roundup fl 32oz			
				Pursuit 4 fl oz			
				Clethodim 12 fl oz			
				AMS 17lb/100gal			

* At each location, surface texture between research topic areas may differ.

**Note all plots at Snyder were no-tilled except for the Integrated Evaluation of Common Input plot which received a light tillage operation.

Effect of Early Season Nitrogen on Soybeans

Authors: Charles Shapiro (UNL Extension Soil Scientist – Crop Nutrition),
Brian Krienke (UNL Extension Educator – Soils)
Josh Miller (UNL Graduate Research Assistant and Doctor of Plant Health student)

TAKE HOME POINTS:

- SMFD field day sites in 2014 had mostly adequate fertility for high yields, two sites (Auburn and Belgrade had soil P values slightly below the 0-8" soil test critical level)
- Soil textures ranged from silty clay loam to loam and represented the soil resources in Nebraska
- Nitrogen additions increased yields slightly with an average of 0.4 bu and 2.8 bu/A for 50 and 100 lbs N/A applied at V2 stage. These yield increases at present prices would not be profitable
- Use of the slow release N source knifed in at V2 decreased soybean yields by 1.4 bu/A compared to UAN applied at the same time and manner
- Residual soil nitrates at the end of the season were at normal levels and none of the applied nitrogen increased nitrate levels to 48 inches
- Nitrogen additions and source did not affect protein or oil in any practical amount

Introduction

The desire to achieve high yields in soybeans continues to challenge researchers and producers, alike. There are many ideas on what is holding back yields, and what might increase them. It is impossible to test all the ideas in one study, yet there may be combination effects that are missed in a single factor study, so there is a place for both types of studies. In the 2014 SMFD Nitrogen Study, the focus was on nitrogen rates applied early in the season. Many studies have tried applying nitrogen at various times in the season; this study compared a slow release nitrogen source with a readily available N source (UAN). Comparisons exist between these two sources at two rates that were knifed in the ground at the V2 growth stage. In 2013, we did get some small yield increases (4-5 bu/Are) with 300 plus pounds of nitrogen per acre; this year, our objective was an attempt to get similar yield response with less nitrogen. In the 2013 study, half the yield increase was achieved with 100 lbs N/acre early in the season. Literature reported some success with a slow release nitrogen source knifed in the ground. This would postpone when the soybean plant had access to the nitrogen since; theoretically, the nitrogen would not release in a large surge, which would cause a momentary pause in the root nodule growth and inhibit yield. A slow release nitrogen source would take time for the roots to grow to the source, and would theoretically allow both the applied N to be taken up, while not inhibiting nodule fixation.

Methods

Treatment Application

This study was a smaller trial that was conducted in conjunction with the larger Integrated Study reported in Section II of this publication. The nutrient component of the large factorial study tested the effect of adding a small amount of nitrogen early in the season, as well as a complete foliar package near flowering. In this study we focused on trying to increase yields with a slow release nitrogen source that is knifed in. The experiment was a randomized complete block design with 4 replications. Nitrogen (N) rates were applied at 0, 50, and 100 lbs/acre as listed in Table 1. The two N sources used were 28 % UAN (readily available) and Nitamin NFusion® (slow release 22-0-0), supplied by Koch Agronomic Services, LLC. The N was applied at the V2 growth stage with a 4-row knife applicator that injected the N 6 inches to the side of the row and between 6 and 7 inches deep. Most of the cultural practices were similar to the ones in the factorial study. Row spacing was 30 inches, the same fungicide and insecticide seed treatments were used from the factorial study, as well as the late season fungicide, insecticide, and foliar package, which included N Rage™ and Soy Grow™ (Nachurs Alpine Solutions, Marion, OH). Field cultural practices were conducted as described in the section about the factorial experiment.

Data Collection

Canopy reflectance data was collected twelve times over the growing season using a handheld crop canopy sensor, RapidScan™ (Holland Scientific, Lincoln, NE). The RapidScan™ is an active optical sensor that converts pseudo reflectance into vegetative indices. A vegetative index, simply put, is used as an indication of aboveground biomass and relative “greenness”. The intent was to determine if the plant had different reflectance with the nitrogen treatments compared to the controls. Harvest was as described in the Integrated Study for the 30 inch row soybeans. Seed samples were taken at harvest and analyzed at the Stewart Seed Lab – UNL East Campus, analysis - near infrared (NIR) spectroscopy for protein, oil, and fiber content. After harvest at each site, one soil sample, 0-8 in, consisting of 10 cores randomly taken across all replications was used to assess general fertility (Table 1). For each experimental unit, deep soil nitrate soil samples were composited from two sub-samples at 0-12, 12-24, and 24-48 inch depths. Samples were analyzed by Ward Laboratories (Kearney, NE).

Table 1. General fertility level of soybean nitrogen study after harvest 2014 (mean of 4 samples, ppm unless noted.)

(0-8" sample)				
	Auburn	**Belgrade**	**Shickley**	**Snyder**
CEC (me/100g)	17.7	11.2	17.7	25.5
% H Sat	28.0	15.0	24.0	7.0
% K Sat	2.0	5.0	5.0	2.0
% Ca Sat	56.0	64.0	58.0	67.0
% Mg Sat	13.0	15.0	11.0	22.0
% Na Sat	1.0	1.0	1.0	0
pH	6.0	6.2	6.1	6.4
Buffer pH	6.5	6.8	6.6	6.8
1:1 S Salts (mmho/cm)	0.2	0.2	0.3	0.3
OM (%)	2.9	1.2	2.5	2.7
Nitrates (ppm)	3.2	3.0	6.4	0.9
Nitrates (lbs/8 in)	8.0	7.0	15.0	2.0
P (Mehlich 3)[1]	9.0	8.0	23.0	41.0
K	157.0	231.0	379.0	238.0
Sulfate	7.0	7.0	7.0	2.0
Zn[2]	0.8	1.3	3.7	2.3
Fe	44.2	36.6	65.3	50.7
Mn[3]	20.4	13.2	19.0	13.5
Cu[4]	1.0	0.5	1.1	1.7
Ca	1991.0	1433.0	2063.0	3428.0
Mg[5]	274.0	198.0	242.0	684.0
Na	25.0	17.0	32.0	25.0
Nitrates (lbs N/48 inches)	19.0	20.0	25.0	24.0

[1]Multiply Mehlich 3 P values by 0.85 to get Bray 1P values.
[2-6]Wardguide low values are 0.26-0.5 for Zinc[2], 0.6-1.0 for Managanese[3], 0.11-0.20 for Copper[4], and 11-20 for Magnesium[5]. All in ppm.

Results

Statistical analysis was performed to identify treatment effects on yield, grain protein, grain oil, and soil nitrates. The complete set of yields and statistics are reported in Table 2. Yields were different at each site with Auburn (59 bu/A) the least and Belgrade and Shickley the highest (79 and 82 bu/A, respectively). The effect of nitrogen rate varied between locations with Shickley having the greatest range (78, 82, and 85 bu/A for 0, 50, and 100 lbs N/A, respectively). Overall the yields were 70, 70, and 72 for 0, 50, and 100 lbs N/A, respectively. The use of the slow release N source consistently reduced yield, but not by much (1.4 bu/A).

The grain quality was not affected too greatly, although there were a few significant effects. We are not sure why, but the data from Shickley averaged 22% protein, compared to 34 % for the other sites, oil also was off at Shickley. We suspect a laboratory error so the overall averages in Tables 3 and 4 reflect the data without Shickley. The relative differences are probably correct within the Shickley site. Protein and oil differed slightly at each location, but the differences were not of practical significance. This is similar to what we found in 2013, but there was more of an increase in percent protein in 2013 because of the high N rates (400 vs 100 lbs N/A).

The only nutrient that might be considered low was phosphorus at Auburn (9 ppm Mehlich P III) and Belgrade (8 ppm Mehlich P III), and the pH was in an acceptable range for soybean production. Table 5 shows the effect of treatments on soil nitrate levels. They are presented with the three sampling depths combined (0-48 inches) and reported as lbs N as nitrate/A. There are slight differences by location, but the trends are similar with low profile N, less than 30 lbs/acre nitrate nitrogen and there was no effect of N applications. The individual layers are not reported due to the low levels and lack of differences.

The reflectance data was collected as part of a larger project looking at the potential uses of crop sensors in soybean production. In this report, all readings are reported as NDRE, or Normalized Difference Red Edge, an index calculated from near infrared and red edge light. Two things of note were gleaned from the data after preliminary analysis – the treatments had an effect on the reflectance of the plant, and there was a correlation between reflectance during the year and relative yield. Readings were collected twelve times over the course of the year and a difference was noticed between treatments around the end of July and beginning of August (Figures 1 and 2). This is also close to the time when the highest correlation was seen between the reflectance readings and the final yield. Figure 3 illustrates the correlation between each of the 12 readings for the year and the final yield. It is clear that the highest correlations were observed during the fourth, fifth and sixth readings of the year, which corresponds to the R4 to R6 growth stages.

Figure 1. NDRE values for select readings that showed differences by treatment. Averaged over 4 locations.

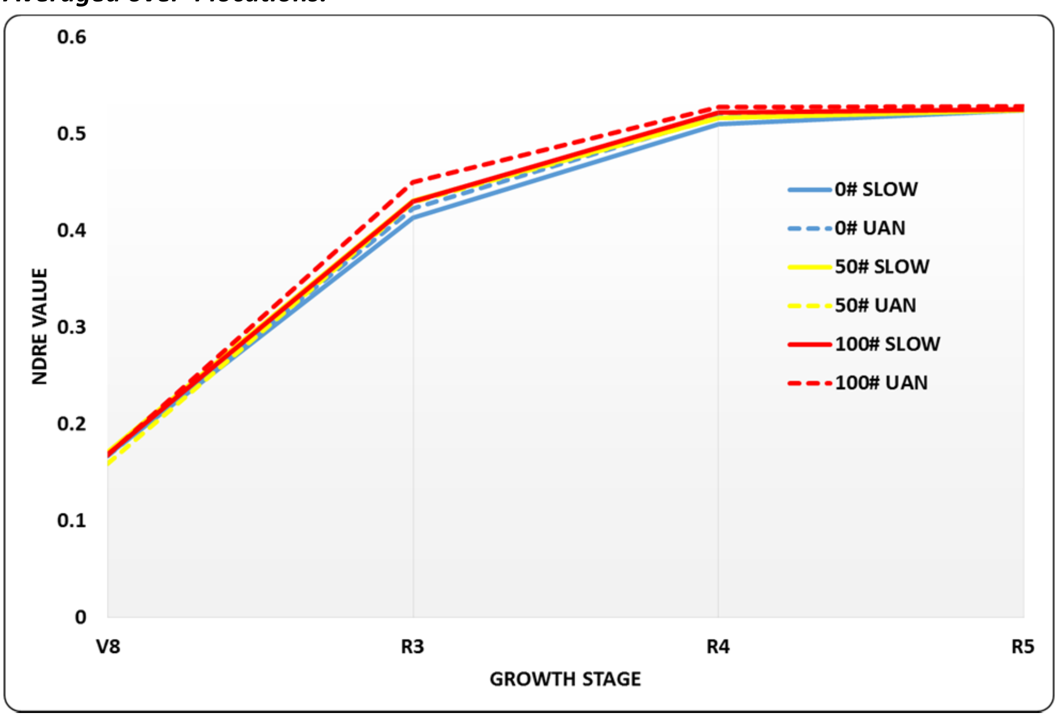


Figure 2. NDRE values for two select readings that showed differences by treatment. Averaged over 4 locations.

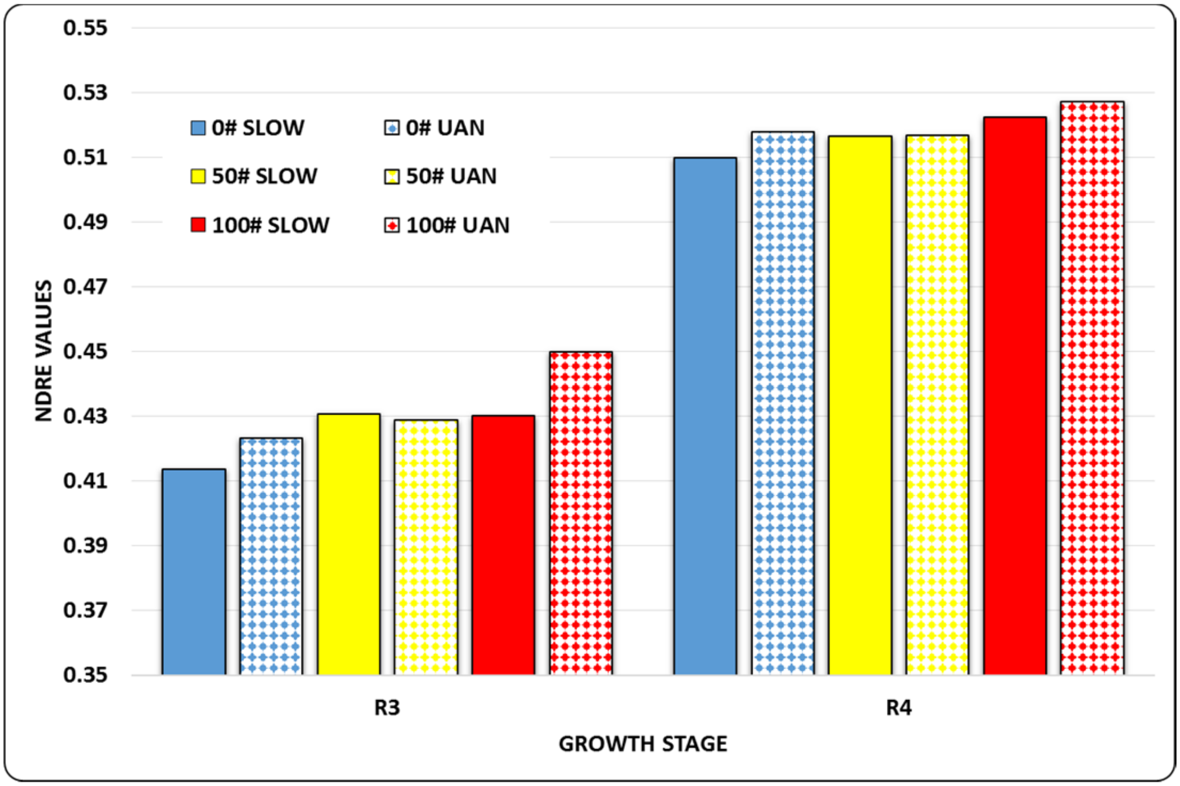
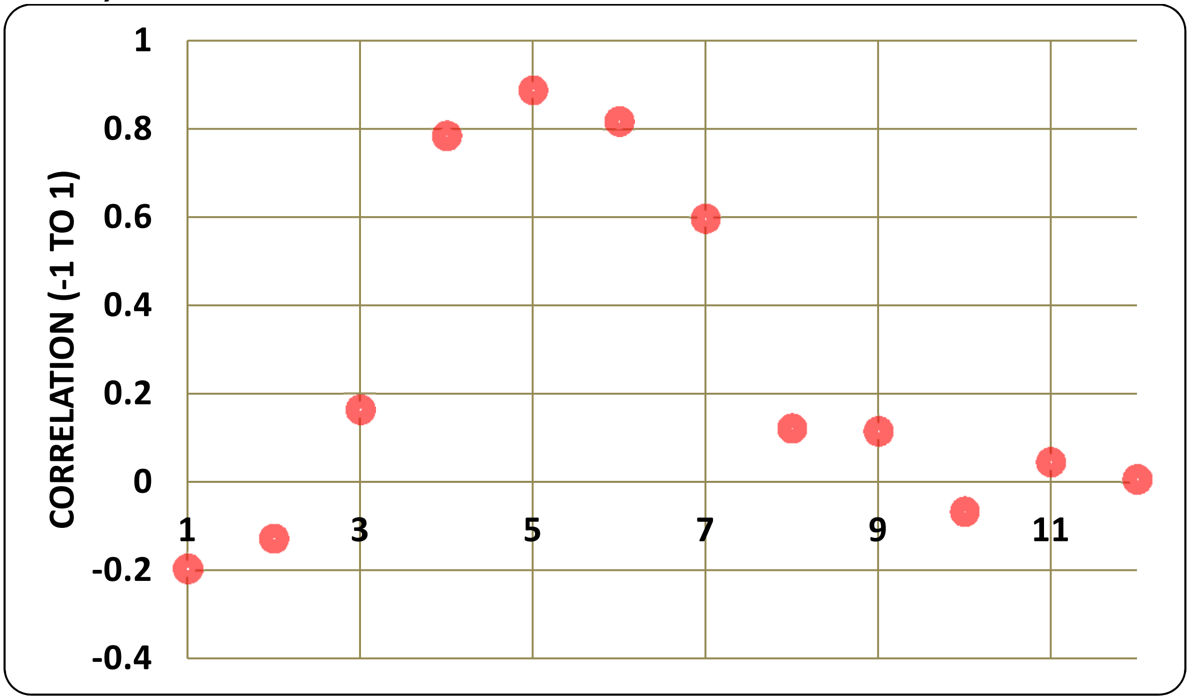


Figure 3. Correlation between the reflectance readings taken over the course of the season with the relative yield.



Discussion

It is interesting to note that the significant yield increases were seen in the locations that had the higher yields (Belgrade and Shickley). This is consistent with the idea that soybeans need extra nitrogen when their yield potential is greater than what symbiotic nitrogen fixation and soil nitrogen can supply. Yields were slightly increased, but soybean quality was minimally affected. The greatest yield increase was 8 bushels at Shickley with 100 lbs N/A. This equates to 12.5 lbs added N for each bushel increase. Soybeans remove about 3.8 lbs of N/bushel so this was a very inefficient use of nitrogen with only 30 percent recovery and this was the best case. In 2014 our goal was to improve upon the 2013 results which gave us a 5 bushel increase with 300-400 lbs of nitrogen applied. In 2014 we increased yields an average of 3 bu/A with 100 lbs. of N/A.

Table 2: Effect of six nitrogen treatments on soybean yield at four locations (bu/A). 2014

TRT #	Total N rate lbs N/acre (V2)	Nitrogen Source	Auburn	Belgrade	Shickley	Snyder	Treatment Means	Nitrogen Rate Means
A	0	UAN	61.0	78.9	78.8	64.9	70.9	69.8
B	50	UAN	58.5	79.4	81.8	60.3	70.0	70.2
C	100	UAN	61.3	82.2	86.8	64.2	73.6	72.5
D	0	SLOW	59.1	75.2	76.4	63.8	68.6	
E	50	SLOW	56.2	79.8	82.9	62.5	70.3	
F	100	SLOW	57.2	80.1	83.7	64.8	71.5	
Means			**58.9**	**79.3**	**81.7**	**63.4**	Over Locations	
							LOC	0.0001
	Source	Prob > F	0.01	0.26	0.21	0.54	NSource	0.02
	Rate	Prob > F	0.07	0.12	0.00	0.02	NRate	0.0004
	R x S	Prob > F	0.61	0.55	0.31	0.37	LOC*NRate	0.003
		CV (%)	3.8	4.7	3.4	3.6	LOC*NSource	0.22
	Source	LSD 0.05	1.9	3.3	2.4	2.0	NSou*NRate	0.125
	Rate	LSD 0.05	2.4	4.0	3.0	2.4	Loc*NS*NR	0.89

Table 3: Effect of six nitrogen treatments on soybean seed protein at four locations (%). 2014.

TRT #	Total N rate lbs N/acre	At planting/ early (V2)	Auburn	Belgrade	Shickley	Snyder	Treatment Means	Nitrogen Rate Means
A	0	UAN	33.9	34.9	22.6	34.8	35.0	34.8
B	50	UAN	34.8	35.0	22.3	35.0	35.2	
C	100	UAN	34.3	35.0	22.0	35.2	34.8	35.1
D	0	SLOW	34.4	35.4	21.6	35.3	34.5	34.8
E	50	SLOW	34.8	35.4	23.3	35.5	34.9	
F	100	SLOW	34.0	35.2	22.1	35.0	34.8	
Means			**34.4**	**35.2**	**22.3**	**35.1**	**34.9**	
							Over Locations (Prob>F)	
	Treatment	Prob > F	0.09	0.16	0.65	0.43	LOC	0.01
		CV (%)	1.4	1.2	6.3	1.4	NSource	0.03
	Treatment	LSD 0.05	0.70	0.7	2.2	0.7	NRate	0.51
							LOC*NRate	0.06
							LOC*NSource	0.39
							NSou*NRate	0.11
							Loc*NS*NR	0.88

Table 4: Effect of nitrogen treatments on soybean seed oil (%). 2014.

TRT #	Total N rate lbs N/acre	N source	Auburn	Belgrade	Shickley	Snyder	Treatment Means	Nitrogen Rate Means
A	0	UAN	20	19	13	19	19	Not applicable due to no difference
B	50	UAN	20	19	13	19	19	
C	100	UAN	20	19	13	19	19	
D	0	SLOW	20	19	13	19	19	
E	50	SLOW	20	19	13	19	19	
F	100	SLOW	20	19	13	19	19	
Means			**20**	**19**	**13**	**19**	**19**	
							Over Locations (Prob>F)	
	Treatment	Prob.> F	0.24	0.53	0.57	0.11	LOC	0.0001
		CV (%)	0.9	0.87	1.9	0.42	NSource	0.81
	Treatment	LSD 0.05	0.28	0.25	0.38	0.12	NRate	0.3
							LOC*NRate	0.36
							LOC*NSource	0.05
							NSou*NRate	0.6
							Loc*NS*NR	0.43

Table 5: Effect of nitrogen treatments on end of season soil nitrates (lbs/ac). 2014.

			0 - 48 in profile			
TRT #	**Total N rate lbs N/acre**	**N Source**	**Auburn**	**Belgrade**	**Shickley**	**Snyder**
A	0	UAN	26	18	30	22
B	50	UAN	25	15	24	20
C	100	UAN	28	16	26	20
D	0	SLOW	24	18	34	23
E	50	SLOW	24	17	27	20
F	100	SLOW	22	16	26	22
		Mean	25	17	28	21
	Trt	Prob > F	0.71	0.62	0.51	0.83
		CV (%)	24	15	26.3	18
		LSD 0.05	9	4	11	6

Integrated Evaluation of Common Inputs To Increase Soybean Yield in Nebraska (2014)

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TAKE HOME POINTS:

- Narrower row spacing generally increases soybean yields
- Early season treatments increased populations at all sites but did not consistently increase yields
- Late season foliar treatments varied in yield response, but an overall trend was seen that the addition of a fertility or insecticide application to the fungicide treatment increased yield

Introduction

Soybean farmers continue to try various strategies to increase soybean yields. Most inputs include row width, seed treatments, foliar fungicide and insecticide applications at pod set, and varying levels of fertility. Soybean farmers and researchers have had varying success improving yield with these inputs. In past years of the Soybean Management Field Day trials, we have evaluated different products and/or treatments within several of these input groups. In 2013, we put some of these strategies together in the same experiment. Even though it adds complexity, what we call, an Integrated Study examines the combined effect of using multiple inputs. Briefly below we describe our logic in choosing the inputs we included. In 2014, we performed the same experimental design with similar inputs.

Nitrogen application to soybeans has been studied with mixed results for the past 40 years. The logic is that in very high yield situations the nitrogen contributions from the soil and that fixed by the plant can't supply enough nitrogen. Some studies have shown increases, others have not. The previous research usually indicates the yield increases are not enough to consistently pay for the added nitrogen. Nitrogen use is recommended in situations where nodulation is not expected or as insurance when cropping ground that has not been in soybeans before or for a long time. The challenge is to not inhibit the symbiotic bacterial fixation of nitrogen, but to supplement it. This has led to later season timing of nitrogen application in the R1-R3 range. To determine the value of early season nitrogen, when soil conditions inhibit nitrogen mineralization or soils levels are low, and symbiotic nitrogen fixation is not established, we included an application of early nitrogen (V2) to two of the early season treatments. To address the mid-season nitrogen question nitrogen was included in several of the foliar treatments. In a companion study discussed in the previous section is a more in-depth nitrogen study.

In addition to nitrogen, some have suggested that soybean yield will be enhanced by foliar application of micronutrients in mid-season. Nebraska soils tend to have sufficient micronutrients, with the exception of zinc and iron in some areas. However, there could be a period of rapid growth where the soybean plant might need more of a specific nutrient than what the soil can supply. It has also been suggested that micronutrients can stimulate growth, which would cause the soybeans to use more of other nutrients, and subsequently increase yields. To address this need, a mix of foliar micronutrients was applied wherever the nitrogen was applied midseason.

Seed treatments are becoming more common with soybean farmers. This input is critical for fields with a history of stand problems but not all fields in Nebraska will benefit from use of a seed treatment. When making product comparisons it is important to make sure there are not significant chemistry changes when one selects an added insecticide treatment. Many companies continue to market new combinations that typically shift some aspect of the fungicide composition with an added insecticide for their “full protection” product. To address this input category we had a seed treatment fungicide combination treatment with and without an insecticide.

Foliar fungicide and insecticide applications at the pod set (R3) growth stage have been evaluated in several studies in Nebraska with varying results. In 2011, we observed an average of 2.1 bu/A yield increase for a fungicide application and this was nearly doubled (4.1 bu/A) when the insecticide was added. In 2012 and our 2013 integrated study (Research update reports available online at: http://ardc.unl.edu/soydaysresearch), there were no effects observed with these applications. Across the North Central Region many are showing positive results with the combination of a fungicide and insecticide at the R3 timing. These applications are typically made in the absence of any measurable disease or insect pressure. This is not consistent with integrated pest management strategies, but is a practice many farmers are adopting. To address the R3 fungicide and insecticide application input we have a fungicide containing a strobilurin fungicide with and without the insecticide.

After the evaluation of several kinds/brands of treatments over the past years, we have selected a representative treatment for each input. Products chosen do not indicate that the University of Nebraska endorses them over others, just that they fit the specifications of our project. *The goal of this project was to evaluate the effects of a set of early and late season treatments in a way that significantly enhances our ability to detect significant effects of the varying factors alone or in combination.*

Methods

A factorial designed experiment was conducted at all four locations of the Soybean Management Field Days. These locations were near Auburn, Shickley, Belgrade, and Snyder, Nebraska. The Belgrade and Auburn sites were no-tilled while Shickley and Snyder received a tillage operation prior to planting. Soybeans were planted at all four sites were irrigated and maintained with adequate moisture to ensure high yield production. The soybean variety used was Asgrow 2733, and planted at 140 K seeds/A. The actual design was complicated and is called a split plot alpha lattice design with incomplete blocks. At all sites except Auburn the row spacing blocks were randomized for each replication. At Auburn all the 15 inch treatments were in one block and the 30 inch rows were in another block. Because of this we cannot statistically compare row spacing directly at Auburn. The separation of row spacing is done for practical reasons and agronomic. The alpha lattice design is used to reduce the effect of soil property changes over the large experimental area. This is important when there are a lot of treatments. In this case there were 60 treatments (2 row spacings x five early season treatments x six pod set treatments).

There were two replications at each site, and each replication had two plots with the same treatment. The study was a split plot with blocks of 15 and 30 in row spaced soybeans; the other treatments were randomized within the row spacing blocks in specific groups of six. Each treatment unit was 10 ft wide and 30 ft long. Overall management and soil type information is provided in the table on the inside cover of this booklet. Information about the water balance is given in more detail in the irrigation report but we have included a rough water balance in Table 8. A summary of all treatments is given in Table 6.

Table 6. Specific treatments tested in the 2014 SMFD factorial experiment that were "Early Season Inputs" and "Pod Set Inputs". All seed treatments were applied to the seed prior to planting and all foliar applications were applied in a 15 gal. /A application volume.

Early Season Inputs	Pod Set (Stage R3) Inputs
No Treatment	No Treatment
Nitrogen (N) **(15 lb N as 28-0-0 applied at growth stage V2)**	Fertility [UAN (28-0-0) 25 lb N/A +N-Rage (23-4-2, slow release N plus Mn) 1 gal/A + Soy Grow (0.04 Fe EDTA, 0.05 Mg EDTA, 0.27 Mn EDTA, 0.16 Zn EDTA) 1 pt/A]
Fungicide Seed Treatment (ST) **(Apron XL 7.5 g/100 kg seed + Maxim 4FS 2.5 g/100 kg seed + Vibrance 2.5 g/100 kg seed)**	Fungicide (Stratego YLD 4.0 fl oz/A)
Fungicide ST + Insecticide ST **(Apron XL 7.5 g/100 kg seed + Maxim 4FS 2.5 g/100 kg seed + Vibrance 2.5 g/100 kg seed + Thiamethoxam 50 g/100 kg seed)**	Fungicide + Fertility (Stratego YLD 4.0 fl oz/A) +[UAN (28-0-0) 25 lb N/A +N-Rage (23-4-2, slow release N plus Mn) 1 gal/A + Soy Grow (0.04 Fe EDTA, 0.05 Mg EDTA, 0.27 Mn EDTA, 0.16 Zn EDTA) 1 pt/A]
Fungicide ST + Insecticide ST +N **(Apron XL 7.5 g/100 kg seed + Maxim 4FS 2.5 g/100 kg seed + Vibrance 2.5 g/100 kg seed + Thiamethoxam 50 g/100 kg seed) + (15 lb N as 28-0-0 applied at growth stage V2)**	Fungicide + Insecticide (Stratego YLD 4.0 fl oz/A + Leverage 360 2.8 fl oz/A)
	Fungicide + Insecticide + Fertility (Stratego YLD 4.0 fl oz/A + Leverage 360 2.8 fl oz/A) +[UAN (28-0-0) 25 lb N/A +N-Rage (23-4-2, slow release N plus Mn) 1 gal/A + Soy Grow (0.04 Fe EDTA, 0.05 Mg EDTA, 0.27 Mn EDTA, 0.16 Zn EDTA) 1 pt/A]

Preseason soil samples were collected at each SMFD location, for the general area. One composite sample from 0-8 in. was taken at random over the whole area. The results are given in Table 7. Overall plot fertility was in the adequate to high range for all nutrients except P, but the results came back too late to apply P at these sites.

Table 7. Soil analysis results from spring soil samples (0-8 in.) taken over the whole Soybean Management Field Day site in April prior to planting in 2014. Information in ppm unless indicated.

(0-8 in. sample)				
	Auburn	**Belgrade**	**Shickley**	**Snyder**
Soil Series	Yutan silty clay loam	Crete silt loam	Hall silt loam	Moody/Nora silty clay loam
CEC (me/100g)	17.0	15.0	8.0	23.0
pH	6.0	5.9	6.7	6.4
Buffer pH	6.7	6.8	-	6.9
OM (%)	3.3	3.0	1.5	3.9
Nitrates (lbs/8 in)	27.0	30.0	24.0	144.0
P (Mehlich 3)[1]	8.0	54.0	11.0	7.0
K	232.0	377.0	220.0	327.0
Sulfate	11.0	11.0	11.0	18.0
Zn[2]	0.7	2.6	1.9	3.5
Fe	45.0	60.0	30.0	65.0
Mn[3]	18.0	14.0	7.0	13.0
Boron[4]	0.6	0.5	0.4	0.8
Mg[5]	375.0	245.0	165.0	570.0
Cu[6]	1.1	0.85	0.4	1.5

[1]Multiply Mehlich 3 P values by 0.85 to get Bray 1P values.
[2-6]Wardguide low values are 0.26-0.5 for Zinc[2], 0.6-1.0 for Managanese[3], 0.11-0.25 for Boron[4], 11-20 for Magnesium[5], and 0.11-0.20 for Copper[6]. All in ppm.

Evaluated Inputs.
The entire study was conducted in both 15 and 30 inch row spacing at each location. Early season inputs included seed treatments, early season nitrogen and combinations of the two. Inputs at pod set included fungicide, insecticide fertility and a combination of the individual products. A complete list of the treatment details for each product and input is in Table 6. The selection of the chemistry tested in this study is not an indication that this is the best product; it is intended to be representative of a product group. For example, we have selected Stratego YLD as a fungicide input at R3. This product could be comparable to other fungicides which have a strobilurin included in their composition.

Soil Fertility Inputs. Early season (V2) nitrogen was applied at 15 lbs N/A as UAN (28-0-0) with drop nozzles between the rows after soybean emergence. The drop nozzles were 15 and 30 inches apart for the two row spacings to ensure the application was made in the center between the rows. For the added fertility at growth stage R3, 25 lbs N/A was applied with Nachurs N-Rage™ which contains nitrogen, phosphorus, potash, and manganese and Nachurs Soy Grow™ which is a combination of several micronutrients (details in Table 6.).

Data Collection. Plant populations were assessed by counting the total number of plants in two 10 ft. sections of row in each plot. Plots were evaluated for foliar diseases and insect defoliation on a linear percentage scale of 0-100 with 0=no disease or insect feeding present. Assessment was a total percentage of canopy damage or injury. The only disease observed in these studies was brown spot at relatively low levels with the exception of Auburn which had over 30% severity at the later reproductive stages. Yield was determined with a small plot combine and all yields were adjusted to 13% grain moisture. The two middle rows were harvested for yield in the 30 inch plots. The combine head was modified to push down the middle row in the 15 inch row plots. The two 15 inch rows harvested were adjusted to take this into account.

Immediately after harvest, soil samples were taken at each site. Four cores were taken at random within each replication at 0-8 in, 8-24 in, and 24-48 in depths. The surface (0-8 in) sample was analyzed for all relevant nutrients, pH, base saturation, organic matter and electrical conductivity. All analysis was conducted by Ward Laboratories (Kearney, NE). The results are given in Appendix Table 1.

Statistical analysis. The experimental data was analyzed by individual sites and as a combined experiment using an alpha lattice design. However, an error in the experimental design during planting at Auburn prevented the use of this site to compare row spacing across all locations. All other treatments were considered across all locations.

For the most part, the sites were different, and the best approach to understanding the data is to determine the effects of row spacing, early season treatments and pod set treatments for each site. Tables 8-13 are set up to show the means for each variable for each site, the overall means for the treatments across all locations, and the appropriate statistics. Table 7 does not include the overall means for the treatments across all locations because disease severity varied significantly between sites.

Results

End of season soil analysis for the SFMD combined trial shows that all sites were within normal ranges for most of the parameters. Some exceptions occurred, Auburn and Belgrade were low in phosphorus, all sites had high soil potassium levels and the pHs were in the acceptable range.

Row spacing. The effect of row spacing was not significant at three of the four locations where it can be compared (Table 8). The 15 inch row spacing was higher in all four locations and the average across the three locations that could be merged was 4.7 bu./A higher in the 15 inch rows compared to the 30 inch spacing. The greatest difference observed due to row spacing was at Belgrade where 15 inch rows had 11.1 bu./A higher yield than the 30 inch row spacing.

Table 8. Yield results for the effect of row spacing at each of the 2014 SMFD locations and overall average yields.

Row Spacing (in.)	Location and Yield (bu/A)				
	Auburn	**Belgrade**	**Shickley**	**Snyder**	Average[z]
15	60.7	81.3	80.6	68.2	72.7
30	56.3	70.2	77.5	67.8	68.0
Prob >F	NA[y]	0.1505	0.2768	0.8618	<0.0001
CV (%)	8.2	10.8	7.1	7.5	12.1
LSD (α=0.05)	LSD's are not calculated when there are only two treatments in a factor. In this case only the overall row spacing effect was significant.				

[z] Average yields in the combined data are generated from all locations. ANOVA values (Prob.> F and CV) do not take into account Auburn due to experimental design error.
[y] NA – Statistical comparison values not available due to experimental design error at planting.

Early Season Inputs. Soybean populations were affected significantly by the early season inputs at all locations. Populations determined in both early (Table 9) and harvest (Table 10) were consistently higher in those treatments which contained a fungicide. Seed treatment fungicides increased stand significantly where we observed effects of the treatments and the average across the four locations was higher in the seed treatment fungicide compared to the "no treatment".

Table 9. Soybean populations for the early season inputs at each 2014 SMFD location and overall average populations over both row spacing in the experimental design.

Early Season Input	Location and Population (plants/A)									
	Auburn		**Belgrade**		**Shickley**		**Snyder**		Average	
	21 DAP[z]	**33 DAP**	**25 DAP**	**38 DAP**	**21 DAP**	**38 DAP**	**21 DAP**	**35 DAP**	**21 DAP**	**35 DAP**
No Treatment	91,584	102,290	73,328	87,828	91,202	85,451	94,741	98,153	87,714	93,430
Nitrogen(N)	89,189	100,366	75,397	85,904	86,993	86,194	95,213	97,318	86,698	92,446
Fungicide Seed Treatment (ST)	100,457	113,303	82,310	93,905	96,936	94,868	97,480	101,200	94,296	100,819
Fungicide ST + Insecticide ST	102,417	107,154	82,220	89,117	100,493	98,877	108,731	106,608	98,466	100,439
Fungicide ST + Insecticide ST + N	96,864	107,642	76,285	88,263	107,443	97,681	105,284	106,027	96,469	99,903
Site average	96,102	106,151	77,908	89,003	96,613	92,614	100,290	101,861	92,729	97,407
Prob >F	NA[y]	NA	0.0073	0.0093	<.0001	0.0002	<.0001	0.0203	<0.0001	<0.0001
CV (%)	16.4	15.7	20.6	20.1	13.1	13.8	15.8	16.4	20.4	17.7
LSD (a=0.05)	6,367	6,568	5,551	5,451	6,498	6,412	6,438	6,622	NA	NA

[z] DAP = number of days after planting
[y] NA – Statistical comparison values not available due to experimental design error at planting.

Table 10. Harvest soybean populations for the early season inputs at each 2014 SMFD location and overall average populations over both row spacings and pod set treatments.

Early Season Input	Location and Population (plants/A)				
	Auburn	**Belgrade**	**Shickley**	**Snyder**	Average
No Treatment	97,699	77,211	76,123	84,216	83,812
Nitrogen (N)	95,884	78,572	77,248	84,143	83,962
Fungicide Seed Treatment (ST)	107,225	78,209	81,276	84,960	87,917
Fungicide ST + Insecticide ST	103,215	79,552	82,220	90,875	88,966
Fungicide ST + Insecticide ST + N	99,495	79,407	83,472	90,948	88,330
Prob >F	NA[z]	0.8525	0.0538	0.0248	0.0016
CV (%)	14.5	15	12.1	15.4	16.6
LSD (α=0.05)[++]	5,877	4,778	3,930	5,427	2,887

[z] NA – Statistical comparison values not available due to experimental design error at planting.
[++]LSDs only reported when Prob > F is significant

While stands were affected by early season treatments, there were not consistent yield effects observed across the four locations (Table 11). In several cases, the fungicide treatment was not the highest yield. For example, at Belgrade the highest yield was in the full treatment (Fungicide+Insecticide+N) which was statistically similar to the No Treatment. At Shickley, all treatments were higher than the "No Treatment" but the treatments with fungicides and additional components were all similar. At Snyder, the highest yield was in the full treatment and was 4.4 bu./A higher than the "No Treatment".

Table 11. Yield results for the early season inputs at each 2014 SMFD location and overall average yields over both row spacings and pod set treatments.

Early Season Input	**Location and Yield (bu/A)**				
	Auburn	**Belgrade**	**Shickley**	**Snyder**	Average
No Treatment	57.3	76.1	77.6	66.9	69.5
Nitrogen (N)	58.2	77.0	78.1	67.2	70.1
Fungicide Seed Treatment (ST)	58.0	75.1	79.8	65.9	69.7
Fungicide ST + Insecticide ST	59.1	74.1	80.0	69.6	70.7
Fungicide ST + Insecticide ST + N	60.0	76.6	79.9	70.5	71.7
Prob >F	NA[z]	0.0228	0.3995	0.0001	0.174
CV (%)	8.2	10.8	7.1	7.5	13.5
LSD (α=0.05)[++]	1.9	3.3	---	2.1	---

[z] NA – Statistical comparison values not available due to experimental design error at planting.
[++]LSDs only reported when Prob > F is significant

Pod Set Inputs. There were overall very low levels of brown spot observed at the trail locations with the exception of Auburn (Table 12). At 28 days after the pod set application, the severity was less than 10% in all locations. Even with the low disease severity there were significantly lower levels in the fungicide treated plots at all 4 locations. In all locations the "No Treatment" plots had the highest level of severity. At 42 – 45 days after application, the disease progressed to a more severe level at the Shickley and Auburn sites. Auburn had over 30% in the "No Treatment" and Shickley had over 10% severity for brown spot.

Table 12. Brown Spot Severity ratings for the pod set inputs at each 2014 SMFD location.

Pod Set (Stage R3) Inputs	**Location and Brown Spot Severity[z] (%)**							
	Auburn		**Belgrade**		**Shickley**		**Snyder**	
	28 DAA[y]	42 DAA	28 DAA	42 DAA	28 DAA	45 DAA	28 DAA	42 DAA
No Treatment	4.8	33	3.7	3.0	4.4	10.4	4.7	3.7
Fertility	4.6	31	3.4	2.3	4.5	10.1	4.6	3.7
Fungicide	4.1	24	2.6	2.1	3.7	8.5	4.4	3.1
Fungicide + Fertility	4.2	22	2.0	2.0	3.7	8.6	3.8	3.2
Fungicide + Insecticide	4.1	20	2.4	2.0	3.4	9.6	2.6	2.2
Fungicide + Insecticide + Fertility	4.2	21	2.4	1.9	3.4	9.0	2.5	2.3
Prob >F	0.0027	<0.0001	<0.0001	<0.0001	0.0007	0.0641	<0.0001	<0.0001
CV (%)	32	31	40	46	37	40	36	39
LSD (α=0.05)	0.74	2.4	0.49	0.5	0.63	1.7	0.6	0.5

[z] Estimated across the entire plant canopy of the two center rows of each plot on a percentage scale (0-100%)
[y] DAA: Number of days after application

Fertility. Because there were no significant differences for the early or pod set treatments, there is no evidence that these treatments would be cost effective. The rates of nitrogen and the additional treatments were fairly low. In the companion study on specific nitrogen management strategies at V2 indicated that 100 lbs. N/acre increased yields, but the response was minimal (3 bu/A) and probably not profitable.

Table 13. Yield results for the pod set inputs at each 2014 SMFD location and overall average yields.

Pod Set (Stage R3) Inputs	Location and Yield (bu/A)				
	Auburn	**Belgrade**	**Shickley**	**Snyder**	Average
No Treatment	55.6	75.8	78.8	63.9	68.5
Fertility	57.8	75.8	78.9	68.0	70.2
Fungicide	58.0	73.7	79.5	65.4	69.2
Fungicide + Fertility	58.7	78.9	79.9	70.2	71.9
Fungicide + Insecticide	60.1	77.0	77.4	70.4	71.2
Fungicide + Insecticide + Fertility	60.8	73.4	80.0	70.1	71.1
Prob >F	NA[z]	0.0003	0.3680	<.0001	0.0121
CV (%)	8	11	7	8	14
LSD (α=0.05)[++]	2.1	3.6	---	2.3	2.1

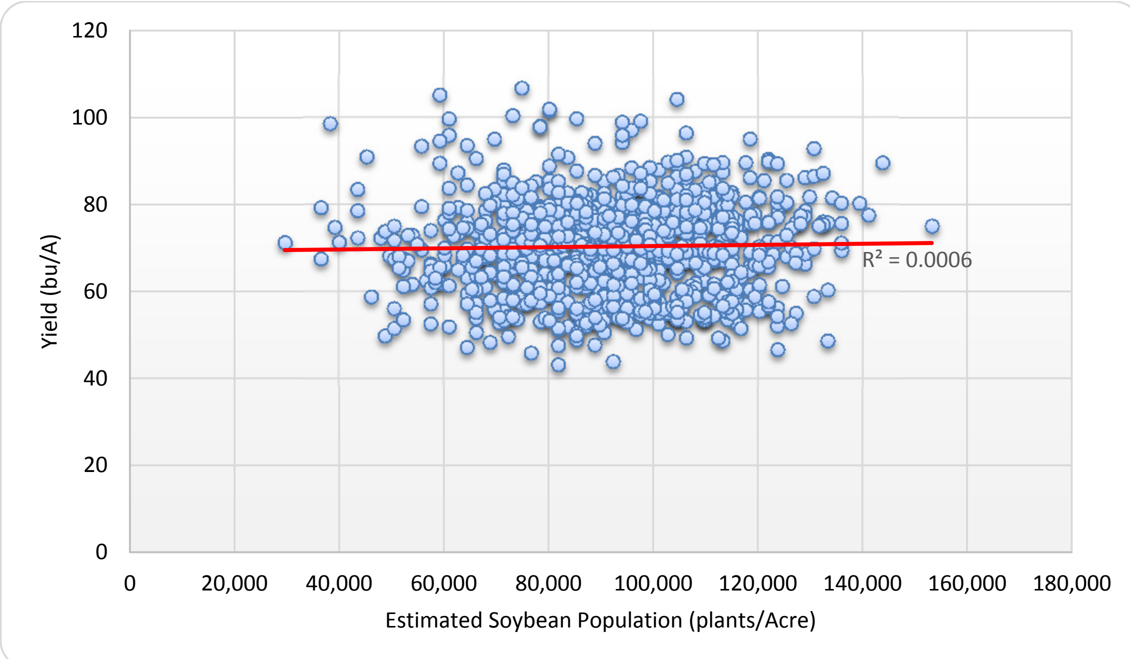
[z] NA – Statistical comparison values not available due to experimental design error at planting.
[++]LSDs only reported when Prob > F is significant

Discussion

There were strong indications that several of the factors tested increased yields. The row spacing data collected for yields indicated that narrow row spacing increased yields overall when comparing the 15 inch rows to the 30 inch rows (5 bu/A increase). This data is supported by observations in other states which also show that higher yields occur in rows narrower than 30 inch spacing, however this does not always occur as was indicated in our 2013 study was set up in the same design as the 2014 study. While 15 inch rows typically yield higher than the 30 inch rows, year to year and site to site variation does not guarantee greater yields in all years.

In the trials conducted here, there was a consistent effect of the early season seed treatment on soybean stand, but this did not consistently increase yield. The overall lack of a relationship of soybean stand to yield is well documented as soybean plants are known to compensate for plant density by increasing plant mass in lower populations. Figure 4 shows the lack of relationship when all the data from this study is plotted against soybean yield. Typically, greater yield effects will occur under lower populations. In this study we planted 140,000 seed per acre and resulting populations were around 100,000 plants per acre for the seed treatment plots. Many studies will show no yield differences between 75,000 and 100,000 plants for an ending population.

Figure 4. Relationship of early season soybean population to yield at all locations.

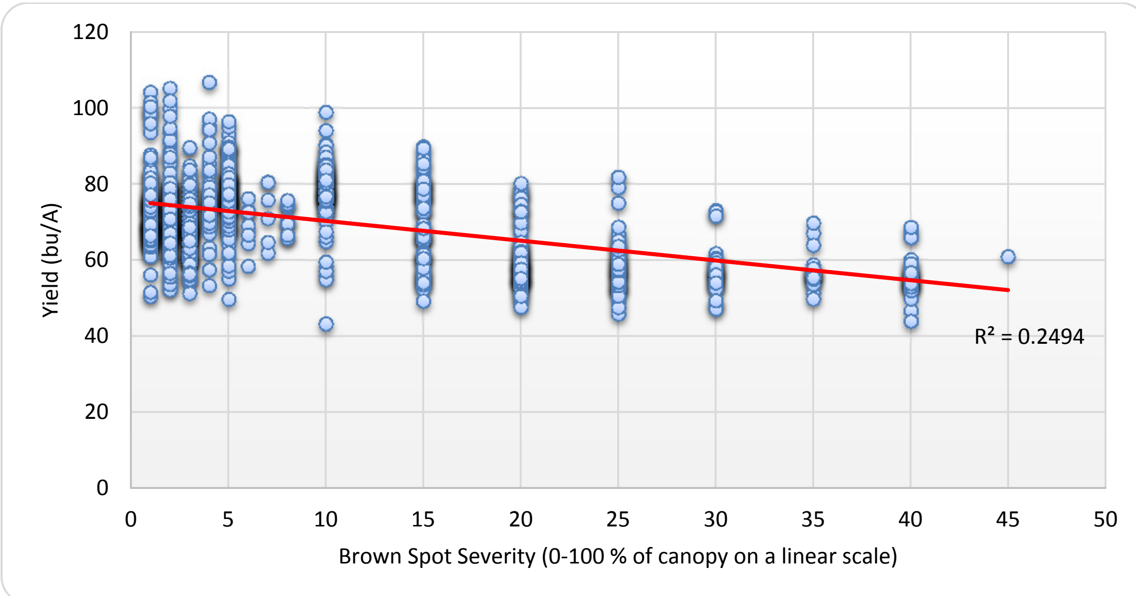


It should be noted, that fields with a history of stand problems will typically benefit by getting a higher percentage of seed to establish, however, this will not consistently result in higher yield. It should also be noted that maximum yield will not be achieved without having a strong and well established root system which seed treatments are known to facilitate under stressful environmental conditions. The early season conditions in 2014 were very conducive for seedling disease which is why we observed higher populations in the fungicide treated plots. The environmental conditions in August, however, were very favorable for soybean yield which resulted in less long-term effect and an overall lack of significant yield impacts with the early season treatments.

Pod set inputs did result in increased yields at several locations. One observation made was that the fungicide with either fertility or the insecticide addition performed similar or the fungicide with fertility was better in yield. Previously we have observed maximum yields with the fungicide and insecticide combination. This may be accounted for by excellent soybean growing conditions after the application was made at the locations and an unexplained interaction with fertility.

The effect of disease control on yield is known to be a positive effect for major foliar diseases of field crops. In general, brown spot is not considered a major yield limiting disease, but in this study there was strong relationship of yield to brown spot with higher levels of brown spot being associated with lower yields. (Figure 5) Previously, we have observed a greater benefit of a fungicide application in fields with over 10% brown spot severity late in the season which is comparable to our 42-45 days after application evaluations in this study. The Auburn location clearly followed this observation and may explain some of the yields increases for the later season treatments.

Figure 5. Correlation of Brown Spot Severity ratings at 42-45 days after application for the pod set inputs at each 2014 SMFD location and overall average severities.



Overall, there were no clear relationships with any of the treatment strategies which resulted in maximum soybean yield in 2014. While there were effects with the early season inputs, there were none that consistently increased yield. Similarly, late season inputs did not consistently increase yields and there was no association of an early season treatment being related to any late season treatment for maximum yields. We are continuing to analyze the data and this tentative finding might change. Based on this study and the study conducted in 2013, it appears that soybean farmers should continue to use solid strategies to manage their crop based on field history and it is critical to determine the economic impact of investing in all the treatments we tested to achieve maximum yields. Location and soil continue to be one of main effects on overall yields as is represented by the overall range in yields at the four locations.

Table 14. Soil water balance for each location of the 2014 SMFD trials.

Soil Water Balance	**Auburn**	**Belgrade**	**Shickley**	**Snyder**
Beginning Soil Water (in.)	3.0	3.0	3.0	3.0
Ending Soil Water (in.)	3.0	2.7	3.0	2.1
Water Used from Soil (in.)	0.0	0.3	0.0	0.9
Rainfall and Irrigation (in.) May 27-Sept. 30	14.8	20.0	18.6	27.6
Total Crop Water Use (in.) (Evapotranspiration) – weather station data – For the growing season.	16.2	14.9	17.2	15.6
Total Water Soil, irrigation and rainfall (in.)	14.8	20.3	18.6	28.5

Appendix Tables.

Appendix Table 1. End of season soil property assessment of 2014 SMFD Integrated sites.				
	(in ppm unless otherwise noted)			
	Auburn	**Belgrade**	**Shickley**	**Snyder**
Soil Property				
CEC (me/100g)	22	7	18	23
% H Sat	20	1	12	7
% K Sat	2	7	6	3
% Ca Sat	60	76	67	67
% Mg Sat	17	15	14	22
% Na Sat	1	1	1	0.5
pH	6	6.6	6.4	6.4
Buffer pH	6.6	7	6.8	6.9
1:1 S Salts mmho/cm	0.3	0.1	0.3	0.3
OM (%)	3	0.9	2.7	3
Nitrates (0-8") ppm	4	2.3	1	3
P (Mehlich 3)[1]	9	6	32	28.5
K	201	196	420	243
Sulfate	9	8	8	9
Zn[2]	1.4	1.7	3.6	1.3
Fe	54	22	59	38
Mn[3]	27	8	17	10
Cu[4]	1.4	0.4	1	1.2
Ca	2714	1080	2388	3.47
Mg[5]	462	128	289	594
Na	28	11	38	26
Soil nitrates				
0-8" Nitrates (lbs/A)	10	6	2	7
8-24" Nitrate (lb/A)	8	4	34	7
24-48" Nitrate (lb/A)	11	6	12	7
0-48" nitrate (lb/A)	29	16	48	21

[1]Multiply Mehlich 3 P values by 0.85 to get Bray 1P values.
[2-6]Wardguide low values are 0.26-0.5 for Zinc[2], 0.6-1.0 for Managanese[3], 0.11-0.20 for Copper[4], and 11-20 for Magnesium[5]. All in ppm.

Soybean Management Field Day Irrigation Management Trial

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TAKE HOME POINTS:

- Irrigation before R3 may produce taller soybean plants that are prone to lodging
- R3 irrigation recommended for deep medium or fine textured soils and full soil profile
- Some Irrigation may be required during vegetative growth stages on sandy and sandy loam soils
- Highest Irrigation Water Use Efficiency achieved by 50% early - full irrigation after R5 Treatment

Introduction

Soybean acreage in Nebraska has increased from 43,000 acres of irrigated production in 1972 to 1.95 million acres of irrigated production in 2013. With rising fuel costs and declining crop prices soybean growers are looking for ways to reduce operating costs. Following two years of severe drought over much of the state of Nebraska, several Natural Resources Districts have implemented irrigation water pumping restrictions. Over 1.5 million irrigated acres are currently under some form of irrigation water allocation.

Proper irrigation management is critical to optimize both yields and irrigation water use efficiency. Recent UNL research has shown that the optimal time to begin irrigating soybeans is at the R3 growth stage (Irrigating Soybean, NebGuide G1367). Watering before the R3 stage can lead to taller plants which may lodge before harvest. Lodging may impede grain harvesting equipment thus leading to yield reductions. Research has also shown that irrigation applications during the vegetative growth stage have little impact on soybean yields. Irrigation applications during the reproductive growth stage have shown to give the most yield response for a limited water supply.

Methods

Soybean plots were laid out with four irrigation treatments and four replications. The variety planted at all four SMFD locations was Asgrow 2733. Each soybean plot was four rows wide and twenty feet long with a 30-inch row spacing. A non-irrigated buffer row separated each plot to reduce the possibility of soybean plants pulling soil water from an adjacent irrigation treatment. Plots were watered with a subsurface drip tape laid on the soil surface next to the soybean row. Plumbing with a main line and valves controlled the water application to the four rows in each plot. The center two rows of each plot were harvested for yield comparisons. A set of three Watermark soil water sensors were installed in the first two replications to monitor the soil water level in the top three feet of soil. The Snyder, Shickley and Auburn sites were located on a silty clay loam soil. For a silty clay loam soil, field capacity has a sensor reading of 30 cb and 50% of plant available water has a sensor reading for approximately 150 cb (UNL EC 783). The Belgrade site was located on a sandy loam soil. Sensor readings of about 10 for field capacity and about 50 for 50% of plant available are expected for a sandy loam soil.

The four irrigation treatments were as follows:

Full Irrigation - Irrigations were scheduled by monitoring soil water and to maintain soil water levels above 35% depletion.

75% Irrigation – Irrigation amounts were 75% of the full irrigation treatment for the entire season.

50% early - full late – Irrigation amounts were 50% of the full irrigation treatment until the R5 Growth Stage then Full Irrigation from then on.

Rainfed Treatment – no irrigation water was applied to this treatment.

Due to significant rainfall in the months of June and August at some locations, it was not possible to maintain the target irrigation application treatments.

An Irrigation Water Use Efficiency (IWUE) was calculated for each treatment. Irrigation Water Use Efficiency is a measure of how many bushels of grain were produced for a given treatment minus the rainfed yield and the result divided by the irrigation water applied to that treatment.

$$IWUE = \frac{Yi - Yr}{I}$$

IWUE – Irrigation Water Use Efficiency, bu/in
Yi – Irrigated Yield, bu
Yr – Rainfed Yield, bu
I – Irrigation amount, inches

Results

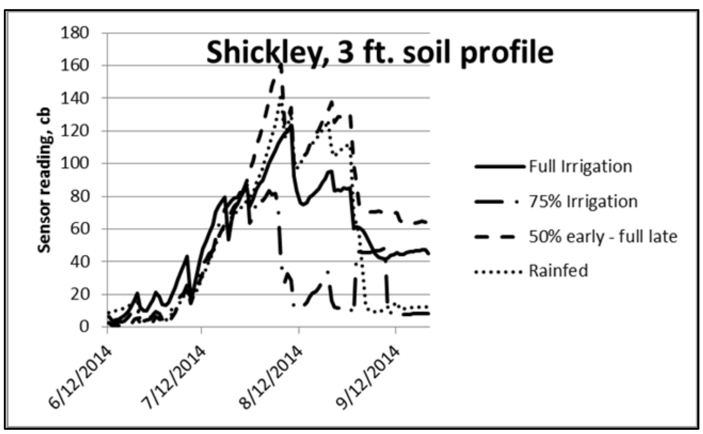
Shickley Site

The irrigation plot was located on a dryland pivot corner on a silty clay loam soil. Yield results for the four treatments ranged from 74.6 to 82.9. The 50% early and full irrigation after R5 did have a significantly higher yield than the other treatments. All irrigation treatments received 3.0 to 5.0 inches of water. The highest Irrigation Water Use Efficiency was from the treatment that stressed the soybeans during the vegetative growth stage and supplied full water after the R5 growth stage.

Table 15. Shickley site treatments

Treatment	Soybean Yield-bu/A	Irrigation-inches	Irrigation Water Use Efficiency-bu/inch
Full Irrigation	76.7 b	5.0	0.3
75% Irrigation	74.6 b	3.0	- 0.3
50% Early – Full Late	82.9 a	4.0	1.9
Rainfed	75.4 b	-	-
Average	77.4		
Rainfall June 1- August 31 = 13.83 inches			

Following is a graph of the soil water for each of the irrigation treatments.



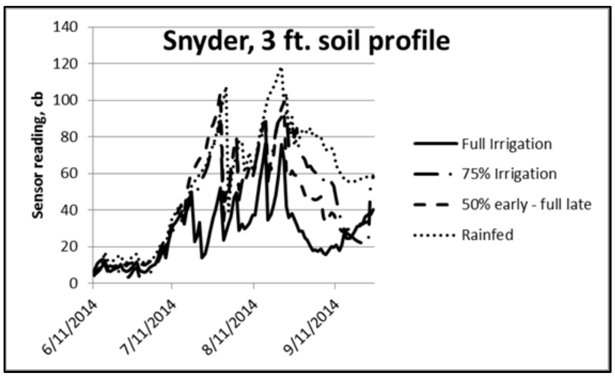
Snyder Site

The irrigation plot was located on a dryland pivot corner on a silty clay loam soil. Yield results for the four treatments ranged from 53.0 to 61.4 with no statistical difference among treatments. Irrigation treatments received 3.0 to 5.0 inches of water. The highest Irrigation Water Use Efficiency was from the treatment that stressed the soybeans during the vegetative growth stage and supplied full water after the R5 growth stage.

Table 16. Snyder site treatments

Treatment	Soybean Yield-bu/A	Irrigation-inches	Irrigation Water Use Efficiency-bu/inch
Full Irrigation	57.9 a	5.0	1.0
75% Irrigation	53.7 a	3.0	0.2
50% Early - Full Late	61.4 a	4.0	2.1
Rainfed	53.0 a	-	-
Average	56.5		
Rainfall June 1- August 31 = 24.05 inches			

Following is a graph of the soil water for each of the irrigation treatments.



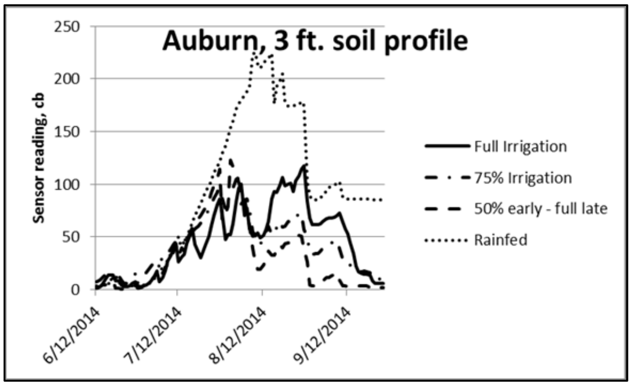
Auburn Site

The irrigation plot was located on a dryland pivot corner on a silty clay loam soil. Yield results for the four treatments ranged from 58.9 to 67.9. Only the 50% early and full water after R5 and the rainfed yields were significantly different. Irrigation treatments received 2.0 to 3.0 inches of water. The highest Irrigation Water Use Efficiency was from the treatment that stressed the soybeans during the vegetative growth stage and supplied full water after the R5 growth stage.

Table 17. Auburn site treatments

Treatment	Soybean Yield-bu/A	Irrigation-inches	Irrigation Water Use Efficiency-bu/inch
Full Irrigation	64.2 ab	3.0	1.8
75% Irrigation	63.3 ab	2.0	2.2
50% Early - Full Late	67.9 a	2.0	4.5
Rainfed	58.9 b	-	-
Average	63.6		
Rainfall June 1- August 31 = 18.95 inches			

Following is a graph of the soil water for each of the irrigation treatments.



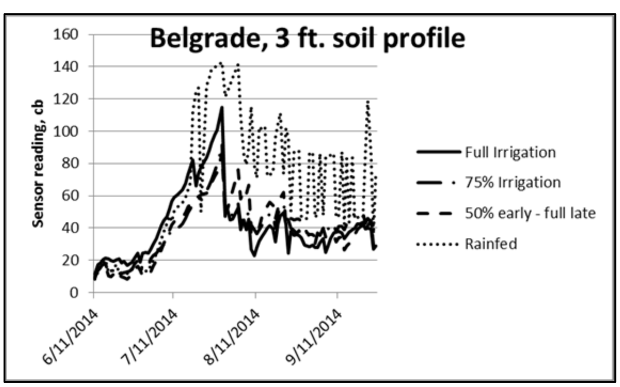
Belgrade Site

The irrigation plot was located on a dryland pivot corner on a sandy loam soil. Yield results for the four treatments ranged from 77.4 to 83.0 with no statistical difference. All irrigation treatments received 3.0 inches of water. The highest Irrigation Water Use Efficiency was from the treatment that stressed the soybeans during the vegetative growth stage and supplied full water after the R5 growth stage.

Table 18. Belgrade site treatments

Treatment	Soybean Yield-bu/A	Irrigation-inches	Irrigation Water Use Efficiency-bu/inch
Full Irrigation	79.7 a	3.0	0.8
75% Irrigation	80.3 a	3.0	1.0
50% Early - Full Late	83.0 a	3.0	1.9
Rainfed	77.4 a	-	-
Average	80.1		
Rainfall June 1- August 31 = 18.5 inches			

Following is a graph of the soil water for each of the irrigation treatments.



Discussion

There were a few significant soybean yield differences for the irrigation treatments at some of the sites. The 50% early - full irrigation after the R5 growth stage treatment had the greatest yield at each location and it was significantly greater than the other treatments when averaging all locations and had the highest Irrigation Water Use Efficiency at all locations. If you are operating under an allocated or limited water supply, this irrigation strategy bears consideration. Based on these demonstrations, irrigation based on growth stage can be an important tool to produce more bushels with a limited amount of water. The other two irrigation treatments, which aimed to keep water stress to a minimum for the entire season, produced fewer bushels per inch of irrigation water applied.

It is also important to note that irrigated yields were not a lot different from the rainfed yields. This was due to ample rainfall received at all locations during the month of August. Regardless of irrigation treatment one should expect 3-3.5 bushels per inch of irrigation water used by the crop. With similar irrigation amounts applied, one should expect similar yields. Only the 50% early - full after R5 treatment approached the target Irrigation Water Use Efficiency.

Table 19. Average Soybean Yield and Irrigation Water Use Efficiency for all sites in 2014.

Treatment	Soybean Yield- bu/A	Irrigation- inches	Irrigation Water Use Efficiency- bu/inch
Full Irrigation	69.6 b	4.0	0.9
75% Irrigation	68.0 b	2.8	0.6
50% Early- Full Late	73.8 a	3.3	2.3
Rainfed	66.2 b	0.0	-
Average Rainfall	18.8 inches		

Thanks to Nebraska Extension Educators: Troy Ingram, Gary Zoubek, Nathan Mueller and Gary Lesoing for taking weekly readings and managing the irrigation systems.

Evaluation of Plant Growth Enhancement Products on Irrigated Asgrow 2733 Soybean Growth, Development and Yields in Nebraska, 2014

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TAKE HOME POINTS:

- Seed treatments did not affect plant population
- Sequential foliar treatments of RyzUp SmartGrass® resulted in increased developing pods at all locations
- High yield variation was noted, with differences of 13 bushels/acre not statistically different
- Increased developing pod numbers did not result in consistent yield increases

Introduction

Economically increasing crop yields is a high priority and necessary for continued success for many soybean producers. A number of products are marketed as increasing growth and could therefore potentially result in increased economic soybean yield. Available research data have documented that a few products do consistently increase soybean growth, but subsequent yield data are less available. As production conditions vary across the Nebraska and differ from other states as well, a need for Nebraska derived data exists for growers to make informed decisions.

This experiment was initiated to document the responses of soybean growth and yield responses to seed and/or foliar applied biostimulants.

Methods and Materials

The 2014 experiments were conducted in center pivot irrigated fields at four locations in eastern Nebraska (Auburn, Shickley, Belgrade, and Snyder) where Asgrow 2733 soybeans were planted with a four row planter at a seeding rate of 140,000 seeds/acre utilizing 30 inch rows. According to product literature, this variety is a 2.7 relative maturity Genuity7 Roundup Ready2Yield7 soybean combining broad adaptability, high yield potential, solid agronomic traits, and protection against soybean cyst nematode and phytophthora.

Each site had fairly heavy crop residue (corn) from the previous year, which slowed plant germination (up to three weeks after planting) and resulted in uneven emergence. Planting dates and field information were as follows:

Location	Planting dates	Soil type	Field notes
Auburn	May 7	Yutan silty clay loam	Hillside, terraces between plots
Belgrade	April 28	Hall silt loam	Fairly flat, slight slope
Shickley	May 6	Crete silt loam	Flat
Snyder	May 5	Moody/Nora silty clay loam	Hillside

Biostimulant Seed Treatments

Two biostimulants were used as seed treatments. BioForge® (2-0-3 fertilizer and proprietary ingredients; Stoller USA) was used at rate of 4 oz./100 lbs.. The second product was Optimize® (a combination of a lipochitooligosacharride and *Bradyrhyzobium japonicum*; Novozymes BioAg), used at the rate of 3.2 oz./100 lbs. seed. Seeds were treated prior to planting. Non-biostimulant treated seeds were also included for comparison plots. Treatment application dates of products in relation to planting dates in this experiment are shown in Table 20.

<u>Foliar Treatments</u>
Three foliar treatments were applied to soybeans: RyzUp SmartGrass®, Ratchet™, and Ascend®. Treatments were applied using a ShurFlo 600 back-pack sprayer equipped with a boom containing three Lurmark 04F80 flat fan nozzles, with spray volume of 42 gallons/acre.

RyzUp SmartGrass® 40WDG (active ingredient = gibberellic acid$_3$, Valent USA) is a product being developed for soybeans that had been noted in 2013 University of Nebraska Extension experimentation to result in 10+% more pods/plant at harvest when applied at 0.3 oz./acre at both unifoliate and first trifoliate leaves. It was applied at 0.4 oz./acre at the unifoliate leaf and 0.3 oz./acre at the first trifoliate leaf stage in this experiment.

AgriSolutions™ Class Act[7] NG[7] (distributed by Winfield Solutions, LLC, St. Paul, MN) was added as a surfactant to this treatment. Class Act[7] NG[7] is a water conditioning agent/non-ionic surfactant blend at a rate of 1.25% v/v. Class Act[7] NG[7] consists of 50.5% ammonium sulfate, corn syrup and alkyl polyglycoside, and 49.5% constituents ineffective as spray adjuvants. This formulation contains 1.3 lbs. of sugar and 3.4 lbs. of dry ammonium sulfate/gallon.

Ratchet™ (Novozymes BioAg) is a product that contains a lipo-chitooligosacharride molecule designed for foliar application rather than seed/soil placement. It is in the same class of chemistry as Optimize®. It was applied at 4 oz./acre at the fourth trifoliate leaf stage of development. No surfactant was used with this treatment.

Ascend® is a unique product in that it contains three plant growth hormones: 0.09% cytokinin (as kinetin); 0.03% gibberellic acid (specific gibberellic acid not listed), and 0.045% indole butyric acid. This is equivalent to 0.12 oz. cytokins, 0.04 oz. gibberellic acid and 0.06 oz. indole butyric acid/gallon. Ascend® is distributed by Winfield Solutions, LLC, St. Paul, MN. Data from previous University of Nebraska experimentation with this product on soybeans was not available or does not exist. It was applied at 6.4 oz./acre at the R-2 stage of development. No surfactant was used with this treatment.

<u>Treatment Design</u>
Ratchet™ and Ascend® were applied to untreated soybeans as well as BioForge® and Optimize® treated soybeans, resulting in 9 treatments (3 seed treatments x 3 foliar treatments). RyzUp SmartGrass® was applied only to untreated soybeans for the 10th treatment in this experiment. Treatment design was a randomized complete block.

Each treatment had four replications at each location. Plots were approximately 40 feet long by 4 rows (10 feet) wide. A four row border was also planted on each side of the experimental block.

<u>Sampling methods</u>
Data was collected at various intervals during the season. Developing pods/plant were counted and recorded in both late July and again in early-mid August. Five random plants/plot were selected at random during these time periods. Pod counts were also documented at harvest at Auburn and Shickley by utilizing 10-15 consecutive plants.

Pod counts at harvest were not collected at Belgrade and Snyder as these sites had received damage from hail storms earlier in the year, which greatly affected RyzUp SmartGrass treated soybeans as they were much taller than other soybeans. This did not allow 10-15 consecutive undamaged plants for sampling.

The Snyder site was also greatly affected by presence/absence of corn stalks and resultant residue, which created large diagonal, non-parallel streaks across the plot area and resulted in significant differences in plant growth and development by mid-June. While sampling methods allowed comparisons for residue/non-residue areas within plots (data from only residue areas are included in this report to be consistent with all other 2014 Soybean Management Field Day locations), it precluded any reliable yield data to be collected as residue/non-residue streaks differed in each plot.

Harvest

Plots were harvested beginning in late September using a 2 row mechanical harvester. Thirty feet of the middle two rows of each plot were harvested, measured, weighed and recorded.

Data analyses

Data was analyzed and treatment means statistically separated using Tukey's Honestly Significant Difference (HSD) test (JMP 10.0.0, SAS Institute Incorporated, Cary, NC).

Results

Early emergence and stand

Seed treatments did not result in differences in early emergence or plant populations when measured during late May, nor were any trends evident (Table 21).

Pods/plant

Significant differences existed in numbers of pods/plant in late July (Table 22), and early August (Table 23). Soybeans treated with RyzUp SmartGrass® had the most developing pods at each location for both sampling periods, while no other treatment was different than untreated soybeans. Overall average number of developing pods for RyzUp SmartGrass® treated soybeans was 72.8 and 91.2 for the late July and early August sampling periods respectively. This was slightly greater than 20 more developing pods than untreated soybeans during each period.

While all plots and sites were not sampled for numbers of pods/plant at harvest, RyzUp SmartGrass® and untreated soybeans were sampled at Auburn and Shickley. RyzUp SmartGrass® treated soybeans had approximately 15 more pods/plant than untreated soybeans at harvest, although differences were no longer statistically different (Table 24).

Yields

As small plots were utilized and variances were high, it was difficult to ascertain if true yield differences existed. No statistical differences were noted for soybean yields even when yield differences of 10+ bushels/acre existed at a site (Table 25). Some trends were noted, such as the BioForge®-Ascend® treatment combination resulted in slightly less yield than untreated soybeans at each of the four locations. This combination resulted in the lowest average mean yields across the locations.

It was noted that the higher numbers of pods noted from RyzUp SmartGrass® application when compared to untreated soybeans resulted in divergent yields at Auburn and Shickley when compared with untreated soybeans at this sites. At Shickley, which had the highest overall yield average of the four sites the highest yields were noted from RyzUp SmartGrass® treated soybeans, 8.8 bushels/acre more than untreated soybeans (average = 70.8 bushels/acre).

At Auburn, which had the lowest yields of the four locations (untreated average = 57.4 bushels/acre), the opposite was noted however. RyzUp SmartGrass® treated soybeans averaged 54.0 bushels/acre, which was 3.4 bushels/acre less than the untreated check. It should be noted that yields were not statistically different at any of the locations.

Table 20. Products, rates, and application dates of plant growth enhancement products, University of Nebraska 2014 Soybean Management Field Day locations.

PRODUCT (growth stage when applied)	RATE	Auburn	Shickley	Belgrade	Snyder
BioForge® *Seed treatment prior to planting*	4.0 oz./ 100 lbs. seed				
Optimize® *Seed treatment prior to planting*	2.8 oz./ 100 lb. seed				
FOLIAR APPLICATIONS		**Planting Date** May 7	**Planting Date** May 6	**Planting Date** April 28	**Planting Date** May 5
1st RyzUp SmartGrass® (unifoliate leaf)	0.4 oz./ acre	May 26	May 27	May 28	May 29
2nd RyzUp SmartGrass® (1st trifoliate leaf)	0.3 oz./ acre	June 2	June 3	June 5	June 5
Ratchet™ (4th trifoliate leaf)	4.0 oz./ acre	June 20	June 20	June 21	June 21
Ascend® (R-2 stage)	6.4 oz./ acre	July 9	July 10	July 11	July 11

Table 21. Mean plant population (1,000s/acre) resulting from seed biostimulant treatments applied prior to planting of Asgrow 2733 soybeans at rate of 140,000 seeds/acre at four Nebraska locations, 2014.

Treatment	Auburn	Shickley *(May 23*)*	Belgrade *(May 28*)*	Snyder *(May 29*)*	Average of 3 sites
BioForge®	NA	75.1a	81.3a	91.8a	**82.8**
Optimize®	NA	77.0a	86.0a	88.9a	**83.9**
None	NA	72.9a	86.4a	89.6a	**83.0**

Means in columns followed by the same letter are not statistically different at the P<0.05 level (Tukeys HSD Test, JMP 10.0.0)
*Sample date

Table 22. Means developing pods/plant in late July resulting from seed and/or foliar biostimulant treatments to Asgrow 2733 soybeans at four Nebraska locations, 2014.

Biostimulant Treatment		**Auburn**	**Shickley**	**Belgrade**	**Snyder**	**Average of**
Seed	**Foliar**	*(July 23*)*	*(July 24*)*	*(July 28*)*	*(July 29*)*	**all 4 sites**
BioForge®	Ascend®	48.0 b	60.3 b	44.2 b	39.6 b	**48.0**
BioForge®	Ratchet™	58.3ab	63.0 b	39.6 b	46.3ab	**51.8**
BioForge®	---	50.0 b	61.9 b	40.5 b	41.7 b	**48.4**
Optimize®	Ascend®	75.0ab	59.2 b	41.5 b	44.2 b	**55.0**
Optimize®	Ratchet™	52.0 b	59.3 b	40.2 b	39.7 b	**47.8**
Optimize®	---	65.0ab	57.6 b	40.8 b	43.7 b	**51.8**
---	Ascend®	47.5 b	57.7 b	41.7 b	42.4 b	**47.3**
---	Ratchet™	51.5 b	60.0 b	43.0 b	36.8 b	**47.8**
---	RyzUp SmartGrass®	86.3a	90.5a	56.8 a	57.8a	**72.8**
Control		58.8ab	71.2ab	41.5 b	37.4 b	**52.2**

Means in columns followed by the same letter are not statistically different at the P<0.05 level (Tukeys HSD Test, JMP 10.0.

*Sample date

Table 23. Means developing pods/plant in August resulting from seed and/or foliar biostimulant treatments to Asgrow 2733 soybeans at four Nebraska locations, 2014.

Biostimulant Treatment		**Auburn**	**Shickley**	**Belgrade**	**Snyder**	**Average of all**
Seed	**Foliar**	*(Aug. 7*)*	*(Aug. 8*)*	*(Aug. 11*)*	*(Aug. 14*)*	**4 sites**
BioForge®	Ascend®	57.1 b	87.5 b	78.9ab	59.0 b	**70.6**
BioForge®	Ratchet™	62.4 b	87.2 b	77.3ab	59.3 b	**71.5**
BioForge®	---	59.4 b	93.6ab	75.6 b	55.1 b	**70.9**
Optimize®	Ascend®	53.6 b	86.0 b	69.5 b	58.3 b	**66.9**
Optimize®	Ratchet™	54.1 b	84.5 b	73.5 b	52.9 b	**66.2**
Optimize®	---	55.8 b	88.5 b	69.6 b	59.0 b	**68.2**
---	Ascend®	56.6 b	81.3 b	76.1 b	51.7 b	**66.4**
---	Ratchet™	55.2 b	86.0 b	73.6 b	55.7 b	**67.6**
---	RyzUp SmartGrass®	77.9a	110.6a	99.0a	77.3a	**91.2**
Control		52.9 b	81.8 b	74.5 b	59.1 b	**67.1**

Means in columns followed by the same letter are not statistically different at the P<0.05 level (Tukeys HSD Test, JMP 10.0.0)

*Sample date

Table 24. Mean pods/ Asgrow 2733 soybean plant at harvest resulting from RyzUp SmartGrass® treatment.

Treatment	Auburn	Shickley	AVERAGE
RyzUp SmartGrass®	***64.5a***	***87.6a***	**76.0**
Untreated	**48.8a**	**72.6a**	**60.7**
P value	*0.21*	*0.19*	

Table 25. Mean yields (bushels/acre at 13% H2O) resulting from seed and/or foliar biostimulant treatments to Asgrow 2733 soybeans at four Nebraska locations, 2014.

Biostimulant Treatment		**Auburn**	**Shickley**	**Belgrade**	**Snyder**	**Average**		
Seed	**Foliar**					Auburn + Shickley	All 4 sites	3 sites, no Snyder
BioForge®	Ascend®	56.2a	67.6a	71.0a	60.5a	**61.9**	**63.8**	**64.9**
BioForge®	Ratchet™	55.4a	74.2a	72.7a	62.0a	**64.8**	**66.1**	**67.4**
BioForge®	---	58.3a	76.2a	73.2a	58.1a	**67.2**	**66.4**	**69.2**
Optimize®	Ascend®	55.4a	74.0a	71.9a	61.2a	**64.7**	**65.6**	**67.1**
Optimize®	Ratchet™	55.3a	72.2a	72.2a	58.6a	**63.8**	**64.6**	**66.6**
Optimize®	---	56.2a	73.6a	73.3a	58.5a	**64.9**	**65.4**	**67.7**
---	Ascend®	55.5a	79.2a	73.5a	60.2a	**67.4**	**67.1**	**69.4**
---	Ratchet™	56.5a	70.9a	72.2a	59.1a	**63.7**	**64.7**	**66.5**
---	RyzUp SmartGrass®	54.0a	79.6a	69.4a*	56.1a*	**66.8**	**64.8**	**67.7**
Control		57.4a	70.8a	74.3a	62.8a	**64.1**	**66.3**	**67.5**

Means in columns followed by the same letter are not statistically different at the P<0.05 level (Tukeys HSD Test, JMP 10.0.0)
*Asterisk indicates that stand was significantly reduced by hail earlier in year.

Soybean Management Field Days

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