IMPACT OF STARTER FERTILIZERS IN SOYBEAN PRODUCTION IN OKLAHOMA

DEPARTMENT OF Plant & Soil Sciences

Luciano Cegobias and Brian Arnall

Oklahoma State University

DEPARTMENT OF Plant & Soil Sciences

Introduction

Soybean [Glycine max (L.) Merrill] is an important oilseed globally due to its high protein content and significant level of oil. Soybeans acreage have increased across the state of Oklahoma, as well as, efforts to adjust crop production due to warm and dry conditions in the summer. The use of starter fertilizers provides readily available nutrients where undeveloped root system of the seedling can easily access and allows early planting, where soil nutrient availability often is lower than later in the season because mineralization is depressed.

Objective

To evaluated the effects of different starter fertilizer sources on soybean production in Oklahoma and provide information about this method for farmers statewide.

Materials and Methods

- The study was conducted over a two-year period (2015-2016) at five locations in North Central and North East Oklahoma.
  - Lake Carl Blackwell (LCB) 2015
  - Lake Carl Blackwell (LCB) 2016 - Irrigated
  - Perkins 2015
  - Lahoma 2016
  - Lamont 2016
- A randomized complete block design was used for this study. In 2015, the study consisted of 13 treatments replicated three times. In 2016, the study consisted of 15 treatments with three replications at Stillwater and four replications at Lahoma and Lamont.
- Commonly used, commercially available and experimental starter fertilizers were used in this study. For comparison, an unfertilized plot was included (Table 1).
- Evaluations:
  - Stand counts at V1;
  - NDVI (Normalized Difference Vegetation Index) measurements were taken using GreenSeeker™ sensor at R1 (NDVI 1) and R5 (NDVI 2);
  - Canopy closure measurements were taken using Canopeo at R1 (Canopeo 1) and R5 (Canopeo 2);
  - Yield and grain quality (protein and oil content) were measured after harvest.
- All data were subjected to ANOVA and means were separated using LS-means at α =0.05.

Table 1. Analysis and commercial name of starter fertilizers sources.

Treatment	Name	Source†	Rate (L ha^{-1})	Additive	Rate (L ha^{-1})	N	P_2O_5	K_2O	S	Mg	Mn	Fe	Zn
						kg ha^{-1}							
1		Check											
2	APP	10-34-0	23			3.3	11.2						
3	APP	10-34-0	23	H_2O	23	3.3	11.2						
4	APP	10-34-0	23	Accomplish$^{\$\$}$	2.3	3.3	11.2						
5	APP	10-34-0	23	MicroBolt Zn$^{\%}$	2.3	3.3	11.2						0.27
6	9-18-9	9-18-9	23	H_2O	2.3	2.8	5.6	2.8					
7	9-18-9	9-18-9	23	H_2O Soygrow$^{\%}$	23 2.3	2.8	5.6	2.8		0.014	0.074	0.011	0.044
8	K-Leaf*	0-0-30	23	H_2O	23			9.4					
9	Pro-Germinator**	9-24-3-0.1Fe	23			2.8	7.5	0.9				0.001	
10	DAP	18-46-0	112‡			20.2	51.7						
11	Potash	0-0-60	112‡					67.4					
12	MESZ#	12-40-0-10S-1Zn	129‡			15.5	51.7		12.9				1.3
13	SulfurTrap$	0-0-60-12S	14	H_2O	33			10.1	2.0				
14	Rhyzo-Link$^{\%}$	3-10-13	14	H_2O	33	0.5	1.8	2.3					
15	Triple Option$^{\%}$	4-13-17	14	H_2O	33	0.8	2.5	3.2					

† Concentration of nitrogen, phosphorus and potassium in the formulation. Other nutrients are shown according to the symbol at periodic table.
‡ Dry fertilizers applied broadcast. Rate in kilogram per hectare
* ENC-Helena (Collierville, TN)
** Agro-Culture (St. Johns, MI)
# Mosaic (Plymouth, MN)
$ Chemical Products (Oklahoma City, OK)
$$ Loveland (Greeley, CO): Microorganisms <1%.
% Nachurs (Marion, OH)

Results

Perkins 2015		LCB 2015		LCB 2016		Lahoma 2016		Lamont 2016	
Treatment	1,000 plants ha^{-1}	Treatment	1,000 plants ha^{-1}	Treatment	1,000 plants ha^{-1}	Treatment	1,000 plants ha^{-1}	Treatment	1,000 plants ha^{-1}
10	290.6	12	136.3	15	394.7	11	320.2	1	320.2
1	265.5	1	132.7	6	351.6	4	309.5	11	301.4
11	254.7	8	129.2	9	340.8	3	296.0	14	293.3
2	247.6	10	125.6	13	337.4	7	290.6	10	290.6
12	240.4	9	122	7	333.7	15	288.0	13	287.9
13	236.8	3	111.2	12	333.7	1	277.2	7	284.2
4	211.7	13	104.1	1	326.5	10	266.4	12	277.2
8	201.0	6	100.5	11	326.5	8	261.0	3	274.5
9	193.7	5	96.9	14	326.5	14	258.4	2	258.3
3	183.1	7	93.3	2	322.9	13	258.3	5	253.0
6	161.5	11	93.3	8	322.9	9	250.3	15	247.6
7	150.7	2	82.5	3	319.3	6	247.6	9	244.9
5	147.1	4	79	10	319.3	2	239.5	4	239.5
p value = 0.0052		p value = 0.7647		4	308.6	12	239.5	8	239.5
				5	297.8	5	236.8	6	223.3
				p value = 0.3376		p value = 0.2444		p value = 0.1519	

Table 2. Effect of starter fertilizer s on plant population (plants ha^{-1}) at Perkins 2015, Lake Carl Blackwell (2015), Lake Carl Blackwell (2016), Lahoma (2016), and Lamont (2016).

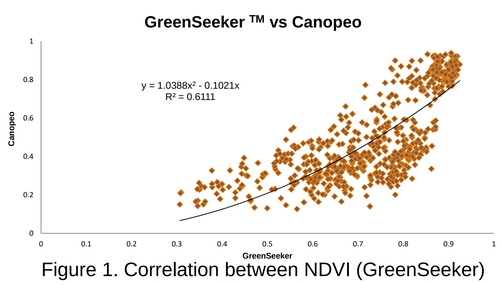

Figure 1. Correlation between NDVI (GreenSeeker) and canopy closure (Canopeo) measurements.

LCB 2015		LCB 2016		Lahoma 2016	
	YIELD		YIELD		YIELD
NDVI1	R² = 0.42 p <.0001	NDVI1	.	NDVI1	R² = 0.72 p <.0001
NDVI2	R² = 0.69 p <.0001	NDVI2	R² = -0.39 p= 0.0081	NDVI2	R² = 0.70 p <.0001
Canopeo 1	R² = 0.41 p <.0001	Canopeo 1	.	Canopeo 1	R² = 0.63 p <.0001
Canopeo 2	R² = 0.65 p <.0001	Canopeo 2	R² = -0.28 p= 0.0655	Canopeo 2	R² = 0.67 p <.0001

Table 3. Correlation between NDVI and canopy closure measurements with soybeans yield.

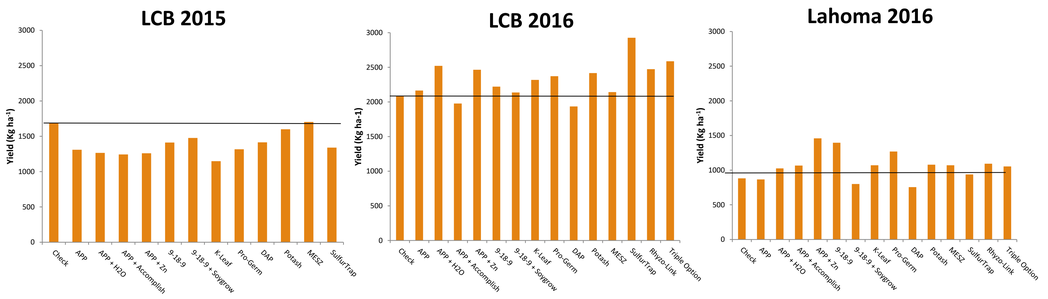

Figure 2. Influence of starter fertilizers on soybean yield at Lake Carl Blackwell (2015), Lake Carl Blackwell (2016), and Lahoma (2016). No significant difference at α =0.05

Discussion

- Treatments had significant affect in plant population in Perkins (Table 2). Four of the best five treatments were not in directly contact to the seed, which is related to low tolerance of soybean to fertilizer salts. However, specific environmental conditions at this location (pH 4.9 and fine-loamy soil) may have contributed to the variability.
- There is a positive correlation among GreenSeeker and Canopeo measurements (Figure 1). NDVI explains up to 61% of canopy closure variability.
- NDVI and canopy closure presented a positive correlation to soybean yield (Table 3). The negative correlation in LCB 2016 is explained by the loss of yield potential due to failure in the irrigation system and drought stress after the readings.
- Starter fertilizers did not affect the yield across site year^{-1}. It is due to the low rates of fertilizers applied because of the low tolerance of soybean to fertilizer salts, as well as, the water as limiting water to soybean production.
- Water balance was negative at some point in reproductive stage at locations, resulting in yield losses.

Conclusions

- In acid soils with low clay content, fertilizers applied in-furrow as starter fertilizer affected soybeans plant population.
- GreenSeeker and Canopeo can be used to estimate yield. However, any unpredicted event after the readings may decrease the final yield.
- The correlation GreenSeeker / Canopeo may be very useful for quick evaluations in-field. Further analysis should be done in order to establish a solid relation among them.
- Water was the most limiting factor for soybean production in these trials, thus limiting the response to the starter fertilizers