Evaluating Earlier Planting Dates for Increased Soybean Yields

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Introduction and Objectives

The start of indeterminate soybean reproductive stages depends on or the detection of the length of night. As nights become longer, soybeans are triggered to begin the reproductive or "R" stages of maturity. Due to this, later planted beans do not have as much time to develop biomass, or leafy growth. Additional photosynthesis from leaves and nodes for pod production can mean additional yield with more time to grow.

However, issues with earlier planting have occurred where cooler, wetter soils slow germination. This may cause seeds to rot in the ground. Additionally, sudden death syndrome (SDS) infects soybean roots of earlier planted varieties but won't be notices until later in the season. With newer varieties, it is necessary to evaluate the limits of planting earlier in Delaware and determine if additional yield is outweighed by other biotic and abiotic factors.

Methods

Soybeans were be planted at the Carvel Research and Education Center in Georgetown, DE on three different dates: April 12th, April 28th, and May 10th, which was approximately three weeks earlier than the previous year. The same variety (mid group IV) was be planted on all three dates. Tissue and soil samples from each plot were sampled at R1-R2 to observe any differences in nutrient uptake, while bi-monthly drone flights were performed over the growing season. Yield was collected at the end of the growing season using a plot combine.

Tissue and soil samples were analyzed by the University of Delaware Soil Testing Lab. Tissue nutrient content was be correlated to yield, soil nutrient levels, soil type. Trends in yield related to planting date, nutrient content, and soil nutrient status were compared using a completely randomized design in SAS statistical software.

Results and Discussion

Yields, Disease Ratings and Soil Characteristics

In 2021, no yield differences were observed by planting date (Table 1). The late planting had the

highest absolute yield (53.1 bu/acre) but was only three bushels highest than the earliest planting. The first planting suffered from low emergence in two of the four planted rows in each plot, something that was not observed in the later planted dates. It is possible that if these rows had survived, the earliest planting would have produced higher yields. Soil P was similar across the plots, but the average K concentration was higher in the earliest planted plots (Table 1). Soil Ca was lowest in the April 28th plots, which is either a prior application error or related to previous plant uptake, while there were no differences in soil Mg. It is preferable that there is no treatment differences between soil nutrients, so this data may be used to explain tissue uptake, but differences were not intentional.

Table 1: Soybean Yields (bu/acre) and soil properties for each planting (α=0.1).

Planting Date	Yields (bu/acre)	Soil P (ppm)	Soil K (ppm)	Soil Ca (ppm)	Soil Mg (ppm)
April 12	50.1	129.9	151.5 a	625.2 a	56.7
April 28	52.7	124.9	127.2 b	583.1 b	53.2
May 10	53.1	131.3	131.1 b	602.9 ab	55.9
p-value	*0.2387*	*01327*	*0.0001*	*0.0939*	*0.1872*

Soybean Nutrient Uptake

All leaf tissue nutrients (upper trifoliate R1/R2) were within their optimum ranges, but some (Mg, S, Ca) were close to the lower end of the values (Table 2). Nutrient contents varied by planting date for all nutrients except K and S (Table 2).

The earliest planting had the highest concentrations of Ca, Fe, and Al and shared the highest P with the final May 10th planting date (Table 2). The April 12th planting did have the lowest Na content, maybe indicating less irrigation water was used, but otherwise is not clear as to the reason why. The second planting (April 28th) never had the absolute highest tissue nutrient content but shared the highest Mn content with the last planting and had the lowest Cu tissue concentrations. The lower Cu may be a factor of plot placement. The final planting date had the highest Mg as well as the metals Zn, Cu, B and Na (Table 2). Similar to 2020, Al concentration in the tissue dropped with later plantings.

Yield only had positive correlations with tissue Mn and a negative relationship with tissue Al (Table 3). Higher Ca helped suppress Na in the tissue, but Ca was also tied to higher Al contents, an element which had a negative relationship with yield. Ca also had a positive correlation to Fe, which also had a negative correlation to yield. This relationship should be examine further, but may be related to the lower Ca concentrations in the plant. The strongest correlations were P to Mg and Mg to Na, followed by P to K (Table 3). Both K and Mg also increased together in the leaf tissue, where they usually have a negative relationship.

Table 2: Elemental analyses of soil samples including two non-nutrients (Na and Al) and their optimum ranges in Delaware (α=0.1).

	P	K	Ca	Mg	S	Mn	Zn	Cu	Fe	B	Na*	Al*
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Sufficiency Range	*0.3-0.6*	*1.5-2.25*	*0.8-1.4*	*0.25-0.70*	*0.25-0.6*	*17-100*	*21-80*	*4-30*	*25-300*	*20-60*	*n/a*	*n/a*
April 12, 2021	0.40 a	2.6	0.86 a	0.29 b	0.28	30.0 b	35.7 b	8.8 b	133.3 a	25.9 c	22.3 c	205.1 a
April 28, 2021	0.37 b	2.6	0.78 b	0.29 b	0.28	33.9 a	35.6 b	8.2 c	100.1 b	31.0 b	31.0 b	91.0 b
May 10, 2021	0.41 a	2.6	0.80 b	0.31 a	0.28	35.8 a	41.6 a	9.5 a	91.8 b	36.9 a	36.8 a	81.5 b
p-value	0.0100	0.4735	0.0005	0.0001	0.6829	0.0023	0.0001	0.0001	0.0003	0.0001	0.0001	0.0001

** Na and Al are not essential nutrients.*

Table 3: Correlations of Yield and Tissue Concentrations

	P	K	Ca	Mg	S	Mn	Zn	Cu	Fe	B	Na*	Al*
Yield	-0.14	0.25	-0.02	0.07	-0.16	0.32	-0.01	-0.03	-0.41	0.21	0.23	-0.42
	0.42	0.16	0.90	0.69	0.37	0.06	0.96	0.86	0.02	0.23	0.20	0.01
P	1.00	0.50	-0.15	0.72	0.07	-0.15	0.41	0.30	0.02	-0.01	0.19	0.05
		0.00	0.40	<.0001	0.68	0.38	0.01	0.07	0.89	0.97	0.26	0.76
K		1.00	0.18	0.39	-0.06	-0.09	0.23	-0.01	-0.12	-0.09	0.32	-0.07
			0.29	0.02	0.73	0.60	0.18	0.93	0.48	0.62	0.06	0.70
Ca			1.00	-0.19	0.29	-0.12	-0.13	0.14	0.44	-0.41	-0.45	0.45
				0.26	0.08	0.47	0.45	0.43	0.01	0.01	0.01	0.01
Mg				1.00	0.25	0.10	0.53	0.32	-0.23	0.29	0.60	-0.22
					0.14	0.56	0.00	0.06	0.18	0.08	0.00	0.20

Drone Measurements

As expected, the earliest planting date had the highest drone NDVI on April 27th, as the other plots hadn't been planted yet. Since these plots were missing rows with reduced emergence, they had the lowest NDVI by June 23rd and remained that weight through the rest of the season (Table 4). The final planting on May 10th had the highest NDVI on June 23rd and remained that way throughout the rest of the season. Walking the field couldn't see much difference, but the differences in drone NDVI may support the idea that the earliest planted beans (April 12th) may have had higher yields if more plants had survived. The fact that NDVI was lower points to gaps in the canopy which means reduced ability to intercept sunlight, so protecting these seeds with a seed coating or checking for proper depths may have improve our results.

Table 4: Selected dates for drone NDVI measurements of the trials.

	April 27	**May 23**	**June 23**	**July 27**	**Sept 24**
April 12	0.1898 a	0.1148 a	0.3783 b	0.9225 b	0.7454 c
April 28	0.1780 b	0.1124 a	0.4236 a	0.9501 a	0.8243 b
May 10	0.1833 b	0.1041 b	0.3783 a	0.9543 a	0.8422 a

Conclusions

In 2021, the earliest planting was April 12th, where cooler wet weather may have reduced emergence and caused seeds to rot in the ground. If these beans had survived, differences in yield may have been present. Otherwise, two years of this project at Carvel have not shown any advantage to planting earlier, outside of spreading field work across spring hours.

Like the 2020 study, Al concentrations were lower in the tissue with later plantings, which cannot be easily explained. Aluminum was tied to lower yields across all tissue samples, so why more Al would be available or taken up with earlier planting should be elucidated. This may not occur on all soil types, but Delmarva soils have plentiful Fe and Al that can hamper yields and be taken up by plants. Other interesting trends included Na, which was higher in the latest planting, along with Mg. Manganese was tied to both higher yields and the later plantings. Calcium was borderline deficient, and relationships probably determined by pervious plot soil concentrations, while Mg was higher in the tissue with the final planting, similar to 2020.

However, many of these relationships tend to change with each study. It is more interesting that nutrient concentrations differ by planting date. While yields were not different, and all nutrients were within sufficiency ranges, didn't field conditions may give rise to the need for sperate sufficiency levels based on planting dates.