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: early May, mid-May, and early June. 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 2020, no yield differences were observed by planting date (Table 1). Although the Mid-May planting had the highest absolute yield (75.9 bu/acre) and late planting was the lowest (72.1

bu/acre), they were not statistically different. Soil characteristics and nutrient concentrations are not supposed to vary in this study. Randomized blocking of the treatments resulted in no differences in soil pH, organic matter content, and cation exchange capacity (CEC). There were some nutrient differences be planting date, with soil P and S highest in the mid and later planted plots, and soil Cu highest in the late planting (Table 1). This did not influence yield.

The only pathogen observed in the 2020 study was diaporthe, which was isolated to a specific section of the field and not related to any specific treatment effect.

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

	Yields (bu/acre)	pH	OM (%)	CEC	Soil P (ppm)	Soil S (ppm)	Soil Cu (ppm)
Early	74.0	6.6	1.35	6.8	214.8 b	9.49 b	1.88 b
Mid	75.9	6.5	1.37	7.0	231.9 a	9.87 a	1.94 b
Late	72.1	6.5	1.30	7.0	236.03 a	9.97 a	2.09 a
p-value	*0.1969*	*0.1689*	*0.4951*	*0.1767*	*0.0601*	*0.0314*	*0.0084*

Soybean Nutrient Uptake

All leaf tissue nutrients (upper trifoliate R1/R2) were within their optimum ranges, except K which was above the range in early and mid-May plantings, but within the range for the early June planting (Table 2). Nutrient contents varied by planting date for all nutrients except B and the non-essential element Na (Table 2).

Separation among nutrient contents was consistent, with early and mid-May plantings always similar, whether their concentrations were higher or lower than the early-June planting. The two earliest plantings were higher in leaf tissue K, Ca, S, Cu, Fe, and the non-essential element Al (Table 2). The early June planting leaf tissue was higher in P, Mg, Mn, and Zn. Some potential reasons for these differences could be organic matter mineralization, which would have increased release of P later in the season. However, the same mineralization would have increased the concentrations of soil S and B, which did not see increased levels in later planted soybeans. Additionally, these tissue samples were taken at R1/R2, where early planted soybeans still would have had access to the P added through mineralization. June planted soybeans did have the highest P concentrations, but all plots were well above crop needs. Potassium and Mg had opposite relationships with planting date and uptake. While K may have been more available earlier in the season, possibly leaching below the root zone prior to June, it doesn’t seem likely that it would be enough to cause differences in uptake. All soils were at optimum levels, and the difference in nutrient uptake had no evident effect on yields.

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*
	---ppm --											
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*
Early May	0.48 b	2.90 a	0.96 a	0.34 b	0.29 a	35.09 b	39.33 b	10.97 a	138.1 a	40.88	30.05	203.8 a
Mid May	0.48 b	2.85 a	0.95 a	0.34 b	0.29 a	35.83 b	39.39 b	10.86 a	134.0 a	39.77	29.01	183.0 a
Early June	0.55 a	2.2 b	0.84 b	0.39 a	0.25 b	41.96 a	42.66 a	8.95 b	83.09 b	38.99	30.08	19.8 b
p-value	0.0015	0.0001	0.0001	0.0001	0.0001	0.0001	0.0264	0.0001	0.0001	0.4306	0.8865	0.0001

** Na and Al are not essential nutrients.*

Table 3: Correlations of yield and tissue macronutrients toe ach other and the tissue micronutrient concentrations.

	Yield	TPhos	K	Ca	Mg	Mn	Zn	Cu	Fe	B	S	Na	Al
Yield		-0.04	-0.07	0.05	-0.01	0.13	0.15	-0.08	-0.21	0.12	0.04	0.01	-0.25
		0.8241	0.6944	0.7914	0.9666	0.4569	0.3778	0.6367	0.2186	0.48	0.8126	0.972	0.142
TPhos			-0.61	-0.68	0.80	0.40	0.53	-0.51	-0.44	-0.58	-0.69	0.07	-0.32
			<.0001	<.0001	<.0001	0.0144	0.0009	0.0014	0.0067	0.0002	<.0001	0.6795	0.0608
K				0.62	-0.86	-0.45	-0.30	0.77	0.65	0.28	0.85	0.20	0.56
				<.0001	<.0001	0.0053	0.0797	<.0001	<.0001	0.097	<.0001	0.2403	0.0004
Ca					-0.60	-0.48	-0.47	0.55	0.52	0.25	0.68	-0.26	0.46
					0.0001	0.0032	0.0039	0.0005	0.0012	0.1456	<.0001	0.1215	0.0045
Mg						0.40	0.43	-0.62	-0.49	-0.50	-0.75	-0.20	-0.38
						0.015	0.0088	<.0001	0.0022	0.002	<.0001	0.2304	0.0213

One of the most interesting uptake effects is that of Al, which significantly dropped as the season continued. This is another outcome without good explanation, particularly because soil Al levels were highest in plots from the early-June treatment. Whether this is an artifact of 2020, or an annual effect will take multiple site years to study.

Leaf Tissue Correlations

None of the leaf tissue nutrient contents were related to yield (Table 3). This was not part of the study design; however it supports the fact that although nutrient uptake varied with planting timing, it had no observable effect on yield. Phosphorus uptake was strongly correlated with all macronutrients, having a negative relationship with K, Ca and S and a positive relationship with Mg (Table 3). For micronutrients, P had a positive relationship with Zn, which is supposed to be an antagonistic nutrient.

Potassium had a positive relationship with Ca, but a negative relationship with Mg. In terms of competition for uptake, Mg has a larger influence on K in the plant tissue. Magnesium also had a negative relationship with Al while Ca had a positive relationship.

Drone Measurements

Although no yield differences were observed, higher NDVI (leaf area) was observed in the early and Mid-May plots compared to the early planted June (Late) plots (Table 4). This relationship continued through the reproductive stages in August until sensese in October, when the later planted plots remained green longer.

Table 4: Selected drone NDVI and DSM (plant height) measurements of the trials.

		NDVI			DSM (meters)	
	June 22	**Aug 25**	**Oct 6**	**July20**	**Aug7**	**Sept22**
Early	0.2641 a	0.9547 a	0.6355 c	0.6256 a	1.111 b	0.7257 b
Mid	0.2996 a	0.9545 a	0.6738 b	0.6575 a	1.140 a	0.7331 b
Late	0.2076 b	0.9534 b	0.7040 a	0.5708 b	1.078 c	0.7923 a

For plant height (DSM), the early and mid-May plots were highest in July, while mid-May were taller in August, and late plantings were tallest in September. This data is not surprising, considering the growth patterns of indeterminate soybeans. Drone imagery does support the known growth patterns of soybeans, and may be useful if annual variability in weather has a greater effect on plant growth and yield based on planting date.

Conclusions

In 2020, the earliest planting was the first week of May, which missed some of the cooler weather that may have caused disease or damage to growth. The drought conditions in the early summer may have also had an effect across all three plantings, although this field was irrigated. Regardless, there were no observable differences in yield by planting from early May to early June in 2020.

There were differences in nutrient uptake, with interesting patterns in macro and micronutrients based on planting timing. This had no effect on yield in this study, but does raise the question about nutrient uptake where there is low or excessive concentrations. The optimum levels in this study may not have affected yield as they may in a field with wider variability in nutrient contents. That Al uptake, a toxic non-essential nutrient, dropped off in uptake with later plantings, is an interesting path to explore. It was obviously not high enough in the earlier planting to effect yield though.

Drone imagery found differences in growth within all three planting dates. Early and Mid-may were similar for leaf area (NDVI) throughout the growing season, while the June planting was always behind. In a year with freeze damage or drought in May, we may see a separation in early and mid-May plantings. This supports multiple years to study a question on soybean growth and improving yields. Plant heights had similar patterns, but the mid-May plantings were higher in August, which may be important, or an artifact of the 2020 study. Future replications of this study across the mid-Atlantic will improve our understanding of planting timing, soybean growth, and nutrient uptake.