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 13th, April 26th, and May 11th. 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

No disease issues were noted in the fields, although some freeze damage did occur with the earliest planting. Yields ranged from 67-68 bushels per acre and were not significantly different among the three planting timings (Table 1). When soils were sampled at the R2 growth stage for each planting timing, the P was higher in plots sampled a little earlier (although soil sampling was only different by roughly one week). Potassium was 20 to 30 ppm higher when sampled later in the later planted plots, which could be related to soil availability or plant uptake. There were no differences observed in soil Ca or Mg by sampling date.

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 13	67.0	242.2ab	167.8 b	649.8	60.9
April 26	68.0	260.5a	174.0 b	674.2	61.0
May 11	67.9	231.0b	194.6 a	634.8	63.5
p-value	*0.2395*	*0.0195*	*0.0353*	*0.5017*	*0.5991*

For micronutrients differences were not observed for Mn or Zn based on planting timing sampling date (Table 2). Based on a p-value of 0.1096, Fe was higher for the marginally earlier sampling. While Cu availability increased with later sampling with no explainable reason, soil S decreased, perhaps due to leaching or reduced availability from soil organic matter. Both Na and Al were more available for extraction with the earlier planting date sampling.

Table 2: Soil micronutrient concentrations among the three timings, sampled at the R2 soybean growth stage (a = 0.1).

Planting	Soil Mn	Soil Zn	Soil Cu	Soil Fe	Soil S	Soil Na	Soil Al
April 13	16.3	4.0	2.06b	165.0	15.5a	8.6a	838.9a
April 26	16.5	4.0	2.28a	173.9	14.1ab	6.5b	848.7a
May 11	16.1	3.9	2.11ab	157.0	13.4b	6.1b	806.7b
p-value	*0.9944*	*0.7212*	*0.0533*	*0.1096*	*0.0524*	*<0.0001*	*0.0418*

<u>Soybean Nutrient Uptake based on Leaf Tissue at R2</u>

All leaf tissue nutrients (upper trifoliate R1/R2) were within their optimum ranges, but some (S, Ca) were close to the lower end of the values (Table 3). Nutrient contents varied by planting date for all nutrients except Mn and Cu (Table 3). For macronutrients, P, K, Ca, and Mg were all higher for the earlier planted soybeans, with only Ca different for each planting date. Tissue S levels were lower for the first planting date, even though soil levels were higher (Table 2). This may indicate that S measured at R2 in the soil is what is remaining after reduced uptake. None of the macronutrients correlated to their soil concentrations (Table 4).

Table 3: 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*	*0.25-0.7*	*0.25-0.6*	*17-100*	*21-80*	*4-30*	*25-300*	*20-60*	*n/a*	*n/a*
April 13, 2022	0.47a	2.91a	0.79b	0.33a	0.27b	50.6	47.3a	9.4	85.0a	42.5b	16.1b	61.5a
April 26, 2022	0.48a	2.92a	0.82a	0.34a	0.29a	47.0	43.9b	10.2	83.5ab	42.1b	13.5b	47.2b
May 11, 2022	0.42b	2.80b	0.75c	0.31b	0.28a	48.7	42.2b	10.4	79.8b	47.5a	29.1a	27.2c
p-value	0.0069	0.0346	0.0044	0.0495	0.0060	0.4445	0.0188	0.6922	0.1005	0.0166	0.0004	0.0003

** Na and Al are not essential nutrients.*

Table 4: Correlations of Yield and Tissue Concentrations to their soil counterparts. Those in green are positive relationships and those in red are negative. Otherwise they are not significant.

	P	**K**	**Ca**	**Mg**	**S**	**Mn**	**Zn**	**Cu**	**Fe**	**B**	**Na***	**Al***
Yield	0.17859	0.02813	0.17061	0.26436	0.03707	0.01933	0.38348	0.08478	0.05059	-0.1427	-0.23505	-0.01579
	0.345	0.8827	0.3674	0.158	0.8458	0.9192	0.0364	0.656	0.7906	0.4516	0.2112	0.934
Tissue P	-0.1570	-0.5187	0.02518	0.00782	0.02469	0.10823	-0.01181	-0.20255	0.00076	0.04107	0.13103	-0.2204
	0.4072	0.0033	0.8949	0.9673	0.897	0.5692	0.9506	0.2831	0.9968	0.8294	0.4901	0.2419
Tissue K	0.07729	-0.1709	0.16016	0.17083	0.11781	0.06857	0.59484	-0.08037	0.05597	0.06753	0.22315	-0.00786
	0.6848	0.3665	0.3979	0.3667	0.5352	0.7188	0.0005	0.6729	0.769	0.7229	0.2359	0.9671
Tissue Ca	0.4369	-0.2294	0.24048	-0.03994	0.23665	0.08907	-0.10721	0.41599	0.48026	-0.0921	0.05569	0.30043
	0.0158	0.2225	0.2005	0.834	0.208	0.6397	0.5728	0.0222	0.0072	0.6281	0.77	0.1067
Tissue Mg	-0.2550	-0.5134	-0.15774	-0.0605	-0.1438	0.23366	-0.26212	-0.15673	0.02391	0.18899	-0.10985	-0.33201
	0.1738	0.0037	0.4051	0.7505	0.4481	0.214	0.1617	0.4082	0.9002	0.3172	0.5633	0.0731

For micronutrients, Zn, Fe and Al were all higher on the first two planting dates, with Al having separation between all three dates (Table 3). Sodium and B were both higher on the third and final planting date within the soybean tissue. Again, although there are differences in nutrient uptake within soybeans by very close planting dates spread out over early spring, they remain within expected ranges and had no effect on yield. However, if any nutrient was lacking or unavailable within the soil, these differences in uptake may become larger issue. Of the micronutrients, only soil Zn had any correlation with yield. It also had a positive relationship with tissue K levels. Tissue Ca had positive relationships with soil concentrations of Cu and Fe, while Mg had negative relationships with soil K and Al. The relationship with K is probably due to the higher-than-normal K concentrations.

Conclusions

In 2022, the earliest planting had freeze damage, but that had no negative effect on yield overall, so soybeans were able to recover. Like the 2020 and 2021 study of planting timings, Al concentrations were lower in the tissue with later plantings, with a pH relationship only occurring during the earliest planting. The uptake of Al within soybeans can be variety or pH related, but in all three years has certainly been planting date related.

Calcium also had similar trends to the other years of this study, where it was lowest at the final planting date. Calcium was borderline deficient by tissue concentrations, which also occurred in other years of the study. Sulfur was also on the lower end of the tissue concentrations, regardless of planting date, and could warrant further evaluation for the effects on yield.

Most of the tissue nutrients had some differences in uptake by planting date, but still fell within expected ranges. So, while planting date can influence tissue concentrations of nutrients, it may only matter when fertility is lacking, or an antagonistic relationship occurs. This could include drought conditions, which were not evaluated in this study. Currently, we would not recommend any variation in soil fertility based on planting date, but antagonistic relationships with Al uptake should be studied.