Potassium Sidedress on Soybeans

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Introduction and Objectives

There are three primary macronutrients, Nitrogen (N), Phosphorus (P), and Potassium (K). Of those three, K is relatively easy to manage, as it bonds to the soil cation exchange capacity (CEC) and is typically plant available (Bertsch and Thomas, 1985). On the Mid-Atlantic Coastal Plain, soil surface textures can range from loamy sand to silt loam, with sandier textures also imparting a lower CEC. Crop production requires that soils hold a suite of nutrients and lower CEC soils will have a limited ability to hold enough K to maintain greater yields. In particular, K will compete with Ca and Mg on the CEC, and K has a lower affinity (Bertsch and Thomas, 1985). As newer soybean genotypes produce greater yields, a subsequent higher use of K may be observed, requiring higher tissue concentrations (Stammer and Mallarino, 2018). In soils with lower CEC, maintaining greater K levels will be restricted, as K may leach below the root zone prior to plant uptake (Rosolem et al., 2010).

To overcome the potential loss of K prior to plant uptake, it is proposed that split applications like sidedressing N may be necessary. If applied during a more rapid uptake period for soybeans, the plant may have access to a greater portion of K fertilizer before it moves below the root zone. This has the potential to improve soybean yields, while also improving the efficient use of K fertilizer.

Methods

A sandy field at the University of Delaware Research Farm in Georgetown, DE was selected for the study. A composite soil sample was from the field was taken to determine soil K status. Three treatments included a 1) control (0 lbs/acre), 2) all pre-plant (60 lbs/acre), 3) split application (30 pre/30 split lbs/acre). The split application was applied at a later vegetative stage prior to flowering.

Each treatment included ten replications for a total of thirty plots. Plots were fifteen feet wide and 100 feet long and setup in a randomized complete block design (Figure 1). Soil samples were taken from each plot prior to sampling from the upper eight inches. Pre-plant K was applied for treatments 2 and 3 and soybeans were planted in 30 inch rows at 180,000 seeds per acre. Prior to reproductive stages, at V5-6, K was sidedressed with 0-0-62 granules using a Valmar spreader. The upper trifoliate leaves were collected from the plots prior to applying sidedress and a second time at R1/R2.

Statistical Analyses

Each plot was harvested with a plot combine and yields were calculated based on the length and width of each plot. Results were analyzed in SAS as a randomized complete block design using

PROC GLM. Correlations amongst continuous variables were analyzed in SAS using PROC CORR.

Reading Statistical Analyses in the Tables

For this statistical analysis, a p-value greater than 0.1 was determined to not provide significant differences between the treatments and is listed as NS in the tables. The smaller the p-value, there is greater likelihood that the K treatments are not the same (e.g 0.001 is more significant than 0.010) . If the relationship is significantly different, treatment values (Yield, Soil K, ect) will be followed by letters (a, b, ect). Any yield or soil K value with the same letter, whether separate or together (eg, a or ab) is considered similar in value.

Results and Discussion

Yield

There were no statistical differences in yield by K application, with the control (No K) having the highest yields. Most soils at the research farm have optimal K levels, which is why the UD recommended K rate was 70 lbs K_2O/acre (Table 1). A significant block effect was present, indicating field variability contributing to yields. This variability may have masked some differences in treatments, although it is accounted for in the statistical model.

Only post-harvest soil test K and pre-sidedress tissue K significantly correlated to yield (Table 2). Post side-dress tissue tests may not have correlated to yield because any deficiencies were eliminated. The correlation prior to side-dressing to tissue levels indicates that this stage has a better relationship with yield than later stages….

Table 1: Average values for soil test K, plant tissue K, and yield by treatment. Treatments include no K applied, all pre-plant, and split-applied. Values followed by different letters are significantly different (a=0.1) within each column.

		Soil K (ppm)		Tissue K (%)		Yield
Treatment	**Pre-Plant**	**Harvest**	**Δ Soil K***	**Pre-Split**	**Post-Split**	**(bu/acre)**
No K	148.7	119.9	28.9 b	2.8	2.56 b	48.4
Pre-Plant	151.0	127.6	52.4 a	2.8	2.65 a	47.5
Split-Applied	145.4	126.6	47.8 a	2.7	2.57 b	46.4
Treatment p-value	NS	NS	0.0722	NS	0.1072	NS
Block p-value	0.0120	<0.0001	0.5161	NS	0.0026	0.0072

* *Δ Soil K = Total soil K (initial + fertilizer) minus final soil K.*

Soil Test and Plant Tissue K

Pre-plant soil K levels ranged from 145 to 151 ppm and were not significantly different by treatment, but did vary across the treatment blocks. We did not expect differences by treatment at this point, since on K had been added.

Post-harvest K levels were also not significantly different, although the control (No-K) plots did have the lowest amount of K remaining (Table 1). This would be expected, as without any K fertilizer and loses through plant uptake, values should be lower for the control plots. That they are only 10ppm lower, versus 30 ppm, indicates some K was either returned from plant tissue, or excessive K in the fertilizer treatments leached lower into the soil profile. When in-situ K, fertilizer K, and post-harvest K levels are accounted for (Δ Soil K), there were differences by treatment. Approximately 30ppm K was unaccounted for in the No-K treatment (Table 1), which is close to expected uptake based on yield. The pre-plant and split-applied treatments received an additional 30ppm K per plot, but were missing about 20 ppm more K than the control plots. This may indicate that these soils with optimal K levels did not adequately utilize K and it was leached from the soil. Luxury uptake of K by the soybean crop is another explanation.

As mentioned above, post-harvest soil test K had a positive (but weak) relationship with yield as well as post-sidedress leaf K (Table 2). At planting soil K did not correlate to yield. This could mean that maintaining K through the season did have a positive effect on yield, even though it could not be seen in the average treatment yields (Table 1). At planting soil K levels also had a positive relationship with post-sidedress leaf K and had a stronger relationship than harvest soil K levels. In this field, the stronger relationship with increased leaf K does appear to be initial soil K levels, and not split application later in the season.

Leaf tissue K was increased by applying the full rate pre-season, but not through split application (Table 1). Leaf tissue K did not vary prior to split applying K though, and we don't have a theory as to why split applying didn't raise K levels higher in that treatment versus pre-applied K.

Table 2: Correlations and p-values of soil test K (pre-plant and harvest), leaf tissue K (pre and post sidedress) and yield. Example: Pre-Soil K and Yield have a significant (p=0.0008) positive correlation (0.58).

	Yield	Pre Tissue K	Post Tissue K	AtPlant Soil K	Harvest Soil K
Yield	1	0.31544	-0.0179	0.2024	0.34297
		0.0895	0.9252	0.2834	0.0635
Pre Tissue K		1	-0.13899	-0.24844	0.04271
			0.4639	0.1856	0.8227
Post Tissue K			1	0.66974	0.60124
				<.0001	0.0004
AtPlant Soil K				1	0.67078
					<.0001
Harvest Soil K					1

Conclusions

Splitting K applications did not result in subsequent yield increases*;* however, there are some trends in K uptake with fertilizer applications. Post season soil K levels had a positive relationship with yield, so yield was higher as post-season K was higher. This indicates that maintaining good soil K values can help maintain yield. However, losses of K were greater in treatments receiving fertilizers. These soils were at optimum levels, so that K recommendations are based on plant uptake. It is possible that split applications would perform better on low CEC soils with medium to low fertility index values.

At this time, we would not recommend split application of K in Delaware soils when optimal levels are present. It could also be considered to skip K applications all together.

References

Rosolem, C.A., T. Sgariboldi, R. A. Garcia and J. C. Calonego (2010) Potassium Leaching as Affected by Soil Texture and Residual Fertilization in Tropical Soils, Communications in Soil Science and Plant Analysis, 41:16, 1934-1943, DOI: 10.1080/00103624.2010.495804

Stammer, A. J., and A. P. Mallarino. 2018. Plant Tissue Analysis to Assess Phosphorus and Potassium Nutritional Status of Corn and Soybean. Soil Sci. Soc. Am. J. 82:260-270. doi:10.2136/sssaj2017.06.0179