Fertilizer Potassium Recovery Efficiency By Irrigated Soybeans

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Summary Statement: ***Irrigated soybean [Glycine max (L.)* Merr.*] recovery of the fertilizer K ranged from 61 to 80% from preplant thru the R5 stage applications at one site and 68 to 100% from preplant thru R3 stage applications at a second site. Surface-applied muriate of potash is efficiently recovered by narrow row, irrigated soybeans during vegetative and reproductive growth and can help correct K deficiency.***

Introduction

- Irrigated soybean grown on silt loam soils in Arkansas typically respond to K fertilization. Limited research has been conducted to determine how granular fertilizer-K application time influences the yield of soybean. Knowledge of soybean yield response and uptake of K as affected by application time would be beneficial for 'rescuing' K deficient soybean or managing fertilizer inputs.
- The literature contains few examples describing soybean yield response to in-season K fertilization.

Objectives

- To evaluate irrigated soybean recovery of fertilizer K applied to the soil surface at different times during the growing season on K-deficient silt loam soils.

Hypothesis

- Uptake and recovery of fertilizer K will decrease as granular K fertilizer application time is delayed through reproductive growth on soils that respond positively to K fertilization.

Materials and Methods

- **2016 Trial, Calloway soil**
  - Calloway silt loam (pH = 7.6)
  - Pioneer 47T36R seeded 7 May (38-cm wide rows)
  - 64 (dry) and 52 (moist) mg Mehlich-3 K kg^{-1} (0-10 cm)
  - 112 kg K ha^{-1} as muriate of potash (500 g K kg^{-1}) applied four times during the season with time expressed as days after planting (DAP).
  - Preplant K was applied 7 May (0 DAP) and no fertilizer-K was labeled as harvest application (138 DAP, Table 1)
- **2016 Trial, Calhoun soil**
  - Calhoun silt loam (pH = 8.1)
  - Armor 47-R70 seeded 5 May (38-cm wide rows)
  - 46 (dry) and 23 (moist) mg Mehlich-3 K kg^{-1} (0-10 cm)
  - 112 kg fertilizer-K K ha^{-1} four times during the season with time expressed as DAP
  - Preplant K was applied 5 May (0 DAP) and no fertilizer-K was labeled as harvest application (140 DAP, Table 1)

K Uptake and Recovery

- ✓ A 1-m long section of soybean plants from the second row was flagged during vegetative growth, sampled, cut at the soil surface, and dried for biomass, and analyzed for K concentration.
- ✓ Fertilizer K Recovery Efficiency (FKRE) was calculated using the difference method.

ANOVA and Regression Across Application Times

- ANOVA was performed using SAS v9.4 with K treatment as a fixed effect and block as a random effect.
- Randomized complete block design with five blocks.
- Differences were interpreted as significant when Pr≤0.10 using LSD means comparison.

Fertilizer-K application times, R2 leaf-K concentration, and yield response to fertilizer-K

Grain Yield

- Grain yield for soybean grown on the Calloway soil is not reported due to severe lodging.
- Grain yield was significantly increased on the Calhoun soil by K fertilization. Yields of soybean receiving 112 kg K ha^{-1} preplant thru the R2 stage produced 4302-4323 kg ha^{-1}, which was equivalent to 90% of maximum yield produced by soybean receiving 168 kg K ha^{-1}. Soybean receiving K at the R5 stage (3676 kg ha^{-1}) or no fertilizer-K (2839 kg ha^{-1}) produced significantly lower yields than soybean fertilized with K before R2 stage.

Whole Plant-K Concentration

- Soybean receiving K, at each location and regardless of K application time, had greater plant-K concentrations than soybean receiving no fertilizer K (Table 1).
- Whole-plant K concentration at both sites was numerically greatest when K was applied at the R2-R3 stage.

Dry Matter

- Plant biomass was not affected by K application time on the Calloway soil (Table 1).
- For the Calhoun soil, dry matter accumulation declined linearly as K application was delayed (Table 1). The reduced biomass of soybean receiving mid- to late-season K may have contributed to their greater numerical K concentrations during late reproductive growth.

K Content and Recovery

- The lowest K content occurred for soybean grown with no fertilizer K (Table 1).
- On the Calloway soil, severe lodging (before sampling) may have caused variability in biomass and K uptake.
- Despite differences in biomass and plant-K concentrations, total K uptake and fertilizer recovery were not different among K application times on the Calhoun soil (Table 1). For both soils, the highest fertilizer-K recovery percentage occurred for K applied during the R2-R3 stage.

Conclusions

- Fertilizer K applied to irrigated soybean grown on K-deficient soil is recovered very efficiently (60-80%) when applied preplant or during reproductive growth.
- Potassium-deficient soybean fertilized with granular K after the onset of pod development (R3 stage) may experience biomass and yield loss compared to soybean receiving K fertilizer from before planting to early reproductive growth.
- Agronomic yield increases from late-season K fertilization are possible..
- Incorporation of fertilizer K with irrigation water and the shallow root system of soybean grown on these alluvial soils likely contribute to the rapid and efficient uptake of fertilizer K.

Upcoming Results

- Two additional sites were established in 2017 and results will be reported at a later date. This project is also evaluating objectives related to K application time.

Table 1. Dates of application, soybean growth stage, whole plant-K concentration, dry matter, K content and fertilizer recovery as calculated by the difference method for two field trials conducted in 2016.

Soil	DAP†	Rate	K Applied	Stage	Whole Plant K	Dry Matter	K Content	Recovery
	d	kg K ha^{-1}	d-mo		%K	kg ha^{-1}	kg ha^{-1}	%
Calloway	0	112	7 May	Preplant	1.81 ab	11,506 a	209 a	102 a
	37	112	14 Jun	V4	1.60 b	10,713 a	171 b	68 b
	64	112	11 July	R3	1.97 a	10,690 a	209 a	102 a
	86	112	3 Aug	R5	1.34 c	10,270 a	137 c	38 c
	138	0		--	0.99 d	9,607 a	95 d	--
				Pr > F	<0.0001	0.5509	<0.0001	0.0068
Calhoun	0	112	5 May	Preplant	1.16 ab	12,123 ab	141 a	75 a
	39	112	14 Jun	V6	1.30 ab	10,853 ab	142 a	76 a
	66	112	11 July	R2	1.44 a	9,952 b	146 a	80 a
	88	112	3 Aug	R5	1.31 ab	9,578 bc	125 a	61 a
	140	0	--	--	0.69 c	8,204 c	56 b	--
				Pr > F	0.0059	0.0105	0.0044	0.7662

† DAP, days after planting

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References

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