Potassium Fertilizer Rate and Timing Effect on Recovering Yield Loss in Potassium Deficient Soybean

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Summary Statement: ***Seed yields of irrigated soybean [Glycine max (L.) Merr.] responded similarly (±5%) to granular fertilizer-K applied from preplant to the R2 stage with a quadratic model providing an accurate assessment of yield response across time expressed as days after planting. Yield response information will aid mid- to late-season fertilization decisions, especially when used with tissue analysis.***

Introduction

- Irrigated soybean grown on silt loam soils in Arkansas typically respond to K fertilization. Limited research has been conducted to determine how late in the soybean growth cycle granular fertilizer-K can be applied to prevent yield loss from K deficiency or obtain an economic yield response to fertilizer-K.
- The literature contains few examples describing soybean yield response to in-season K fertilization.

Objectives

- The primary objective was to evaluate soybean yield response to fertilizer-K application time on K-deficient silt loams.
- Secondary objectives included evaluating the effect of fertilizer-K application time on fertilizer-K recovery (by difference) and trifoliolate leaf-K concentration.

Hypothesis

- ✓ Soybean would respond positively and equally to fertilizer-K applied from preplant through vegetative growth and the benefit would gradually decline as fertilizer-K was delayed thru blooming and pod set. Fertilizer-K applied after R4 stage would not benefit yield.

Materials and Methods

- **2015 Trial**
  - 56 kg K ha^{-1} as muriate of potash (500 g K kg^{-1}) applied nine times during the season expressed as days after planting [DAP, preplant K was designed as at planting (9 June) and no fertilizer-K was labeled as harvest 121 DAP; Table 1]
  - Calloway silt loam (pH = 7.7)
  - 43 (dry) and 31 (moist) mg Mehlich-3 K kg^{-1} (0-10 cm)
  - Pioneer 47T36R (38-cm wide rows)
  - Randomized complete block design with each treatment replicated six times. Each replicate included three plots that received no fertilizer-K.
- **2016 Trial**
  - Calhoun silt loam (8.1 pH)
    - ✓ Armor 47-R70 planted 5 May (38-cm wide rows)
    - ✓ 23 (moist) or 46 (dry) mg Mehlich-3 K kg^{-1} (0-10 cm)
  - Similar design as 2015 trial, except treatments replicated five times each and fertilizer-K applied at 112 kg K ha^{-1} eight times during the season and compared to a high K standard of 168 kg K ha^{-1} (preplant).
  - Preplant K was designated as at planting (5 May) and no fertilizer-K was labeled as harvest 140 DAP (Table 2).

ANOVA and Regression Across Application Times

- Replicate yield data regressed across DAP using linear or quadratic models. Sites analyzed separately. ANOVA was performed on leaf-K concentration at the R2 stage.

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

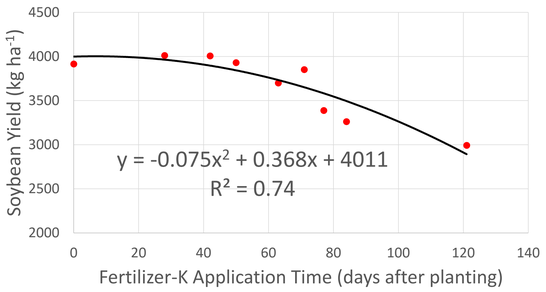
Leaf-K Concentration

- Leaf-K concentration shows soybean was K deficient in plots that had received no fertilizer-K by R2 at each site (Tables 1-2).
- Soybean that received fertilizer-K preplant or the V4 stage contained low (1.5%) to sufficient (>1.8%) leaf-K concentrations (Table 1) that were statistically equal to soybean that received an equal K rate preplant. Root uptake of soil surface-applied K appears to be quite rapid by irrigated soybean.

Table 1. Dates of application, soybean growth stage, and leaf-K concentration at R2 stage (samples collected on 29 July).

DAP	Rate	K Applied	Stage	29-Jul Leaf-K
d	kg K ha^{-1}	d-mo		%K
0	56	22-Apr	--	1.26
0	112	22-Apr	--	1.53
28	56	21-Jul	V4	1.35
42	56	21-Jul	R1-2	1.36
50	56	29-Jul	R2.0	0.99
63	56	11-Aug	R4.0	1.01
71	56	19-Aug	R5.0	0.97
77	56	25-Aug	R5.5	1.01
84	56	1-Sep	R6.0	0.97
121	0	--	R8.0	0.97
			LSD0.10	0.08

Fig. 1. Soybean yield response to fertilizer-K application time in 2015 (see Table 1 for K application times).



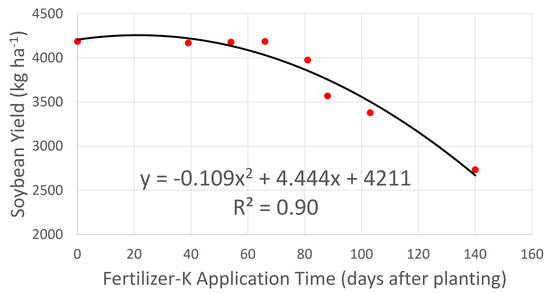
Grain Yield

- Leaf-tissue K concentration at the R2 stage indicated soybean was K deficient.
- Significant seed yield increases were obtained from preplant applied fertilizer-K at each site year (Figs. 1-2)
- Seed yield declined nonlinearly as fertilizer-K application time was delayed beyond the R2 growth stage.
- Seed yield declined quite rapidly when K application was delayed beyond the R3 to R4 growth stage.

Table 2. Dates of application, soybean growth stage, and leaf-K concentrations at R2 stage (samples collected 29 June).

DAP	Rate	K Applied	Stage	29-Jun Leaf-K
d	kg K ha^{-1}	d-mo		%K
0	56	5-May	--	1.62
0	112	5-May	--	1.88
0	168	5-May	--	2.00
39	112	14-Jun	V4	1.72
54	112	29-Jun	R1-2	1.06
66	112	11-Jul	R2.0	1.06
81	112	26-Jul	R4.0	1.06
88	112	Aug-3	R5.0	1.00
103	112	Aug-18	R6.0	1.00
140	0	--	R8.0	1.06
			LSD0.10	0.12

Fig. 2. Soybean yield response to fertilizer-K application time in 2016 (see Table 2 for K application times).



Conclusions

- Maximum (±5%) soybean yield was produced by fertilizer-K applied from before planting to the R2 stage each year (54 DAP in 2015 and 69 DAP in 2016).
- Yield increases may be obtained from fertilizer-K applied up to the R5 stage.
- In areas where soybean stand establishment is a risk, application of fertilizer-K may be delayed..
- Root uptake of the V4 to R1-2 stage fertilizer-K application was rapid as leaf-K concentrations at R2 were equal to (2015) or slightly less (2016) than leaf-K concentrations of plants receiving preplant fertilizer-K. In 2016, additional leaf and petiole (separate tissues) samples were collected 2 wk after each K application.
- In-season monitoring of soybean leaf-K concentrations and application of fertilizer-K when concentrations are deficient may be an effective management practice, especially for high yield situations.
- Results do not support or refute whether foliar-application of low fertilizer-K rates is an practice equally effective as soil-applied fertilizer-K.
- Each year maximal yield was produced by a fertilizer-K rate greater than the rate used for in-season application. Thus, the results do not indicate whether maximal yield can be produced by mid- to late-season K fertilization.

Preliminary and Upcoming Results

- Whole plant samples were collected at R6 from selected treatments in 2016 to evaluate aboveground-K content and fertilizer-K recovery for each K application. Analysis is not yet complete.
- Additional site-years will be added to develop a robust yield trend across several K deficient situations.

Acknowledgments

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