Do Your Soybeans Have the Right Stuff?

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Introduction

Phosphorus (P) is a key limiting nutrient for soybean production in South Dakota. Soil tests have been used as a baseline indicator for fertilizer recommendations for over a century. However, plant tissue analysis may be used to complement a soil test as a way to validate fertilizer and management practices. Soybean plant tissue nutrition sufficiency ranges were first published in the 1960's and need to be reevaluated.

Objectives

1. Test the validity of soil P recommendations in South Dakota with respect to soybean yield response.
2. Nutritional sufficiency ranges must be updated for trifoliolates.
3. Recognize implications of improper plant sampling methods.
4. Determine guidelines for correct growth stages and specific plant parts to collect soybean plant biomass for nutritional sufficiency analysis.

Materials and Methods

Field research was conducted at five locations in Eastern South Dakota in 2013. A randomized complete block design with four replications with five broadcast P fertilizer rates were applied at planting: 0, 20, 40, 60, 80 lbs P_2O_5 per acre using 0-46-0 (TSP).

Data collected:

1. Pre-plant soil samples (0-6 inches).
2. Nutrient analysis of trifoliolate (leaf) and petiole (leaf stem) at the following growth stages (Picture 1):V3-V4 & R1-R2.
3. Total plant P uptake at full seed, R6 (Picture 2).
4. Seed yield, moisture, oil, protein, height, yield components, and seed nutrient concentrations.
5. Yield was subjected to a mixed-model analysis using PROC MIXED procedure in SAS.

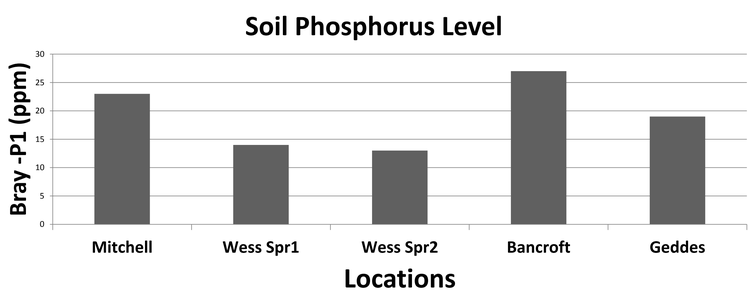
Picture 1: Separation of trifoliolate and petiole

Picture 2: Collection of whole-plant biomass for total P uptake at full seed (R6)

Soils

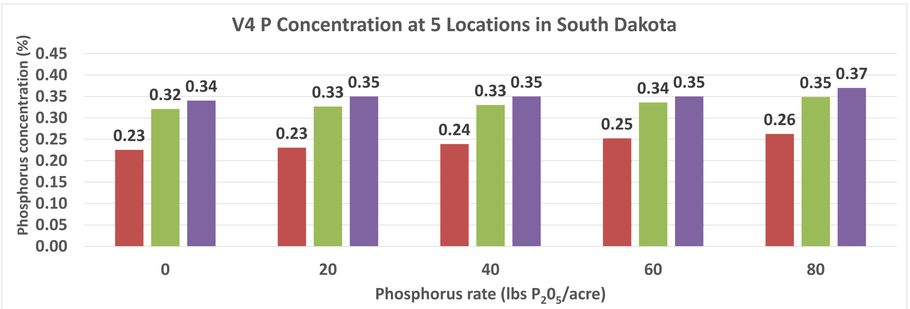
Figure 1. Analysis of soil test phosphorus level before planting. Categories or interpretation for Bray-P1 extraction (ppm):

Very Low	0-5
Low	6-10
Medium	11-15
High	16-20
Very High	21+

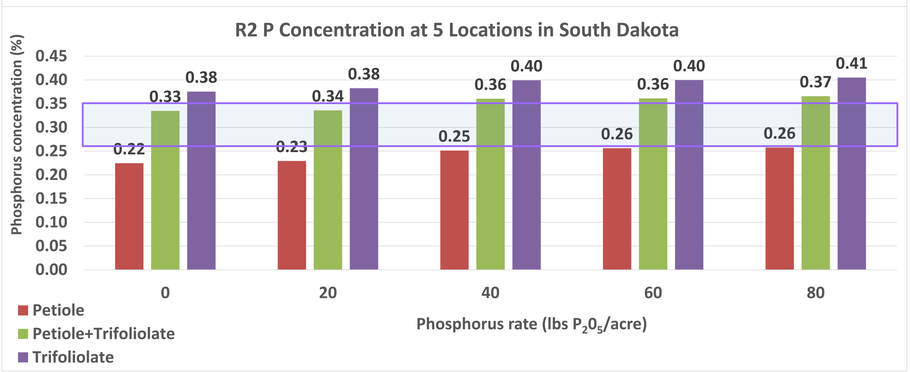


Plant Tissue Nutrient Analysis

Figures 2 and 3: P concentration in soybean plant tissues sampled in response to P2O5 fertilizer rates.



Range in the low end of the P sufficiency range for soybean trifoliolate without petiole at R1-R2 is shown in rectangle (0.26-0.35%).



Yield Data/Analysis

Table 1: Analysis in yield data across all sites. LSD (0.05) = 3.23 bu/acre difference required to be considered significant.

P rate (lbs/ac)	bu/acre
0	48.4
20	47.5
40	47.7
60	48.4
80	47.0

Conclusions

1. P concentration in the petiole and trifoliolate increased with P rates up to 40 lbs P_2O_5 per acre without a corresponding increase in seed yield.
2. Improper plant sampling methods result in inaccurate interpretations of nutrient sufficiency.
3. No significant yield response from different P_2O_5 treatments, which was attributed to medium/high soil P at locations.
4. Nutritional sufficiency ranges need to be updated after data collection/analysis is complete.

Future Research

1. Replication of this project will include sites testing low for P, to potentially validate any plant/yield response.
2. Soybean varietal influence on P uptake.
3. Influence of P fertilization on yield components and seed P.
4. Understand the variation of trifoliolate nutrient concentrations across landscapes of entire fields.
5. Management decisions affecting P uptake.

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