MISSISSIPPI SOYBEAN PROMOTION BOARD
PROJECT NO. 22-2018
2018 ANNUAL REPORT

Title: Development of Fertilization Practices for Sustaining Mississippi Soybean Production

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BACKGROUND AND OBJECTIVES

Limited recent research exists in Mississippi regarding correlation of soil test indices to plant nutrient concentration and/or yield. Mississippi currently employs the Lancaster method to determine soil nutrient availability. Limited research investigating Lancaster extracted P and K correlation to soybean tissue concentration and yield suggests that differences may exist between Lancaster and Mehlich -3 extractable soil test P and K and soybean yield. Current data suggests that establishment of differing soil test critical levels among the two extraction procedures may be warranted, especially for P. Future research will maintain the current database and add new data points to allow for a more robust model to identify what soil test level soybean will respond positively to fertilization.

As Mississippi producers have shifted to a more grain-based system, sulfur (S)-deficient soybean fields have routinely been observed in Mississippi over the last several years. Currently, most producers apply sulfur to corn and rice, but very few apply sulfur to soybean. Research is needed to determine the appropriate sulfur source and application rate and timing for fields that require sulfur fertilization in Mississippi to produce maximal yield. Currently very little information exists on crop response to soil test-based S recommendations. Mississippi State University currently employs a differing soil test S index than most private and public laboratories in the Midsouth. Therefore, correlation and calibration attempts for S are required, and research will take a similar path as with recent and continuing work with P and K.

In recent years, producer concern has risen over differences in soil test results when crop rotation has changed. Mississippi has soils that support many cropping systems, and this allows altering the crop mix as commodity prices change. Soybean is the backbone of most rotational cropping systems in Mississippi. Little recent research has described differences in soil test variability when soybean rotation partners shift. Numerous research has described the positive benefit of rotating soybean with corn on both crops' potential in Mississippi, but limited data are available describing the impact of rotating soybean and rice on soil test properties.

OBJECTIVE(S)

Objective 1. Evaluate crop response to P and K fertilization and continue to build the Miss. soil test responsiveness database used to update soil test recommendations for both Lancaster and Mehlich-3 extractants.

Objective 2. Determine the appropriate S source and application rate and timing for Mississippi soybean production. Initiate database to generate soil test recommendations for S responsiveness used

to develop Mehlich-3 recommendations and update current modified combustion recommendations.

Objective 3. Evaluate the soil test variability among different soybean rotational partners and determine if soil test recommendations need to be altered based on rotational cropping history.

REPORT OF PROGRESS/ACTIVITY

During 2018, research was established on numerous sites; however, multiple sites were lost due to the periods of extended rainfall during harvest season. We concluded the season with two harvestable sites for P research, three harvestable sites for K research, and four harvestable sites for sulfur research. Overall, in all trials, yields were down from previous years of testing with soybean yields generally ranging somewhere between 50 to 65 bu/acre on low CEC-textured soils and less than 50 bu/acre on the high-CEC soils.

The extended period of rainfall during the harvest season led to some yield loss from beans shattering before it was dry enough to get the combines back in the field, especially on the clay soils. This may explain the lower soybean yields observed as well as the lack of response on soil where soil test would have been marginal.

For the P research, we observed one site with a yield response. Soil test P was 31 mg/kg at the Washington county site where we observed the response. This level is very near established critical levels in many states and would represent the first triggered application rate of P in Mississippi. Across the range of P_2O_5 application rates, soybean yields ranged from 54 to 61 bu/acre, with the greatest yield occurring when 90 lb P_2O_5/acre was applied (**Fig 1**).

The second site (off-station) in south Washington county had a soil test value of 45 mg/kg and yields ranged from 51 to 52 bu/acre across the range of P_2O_5 application rates. The soil test values at these two harvestable sites were only 14 ppm apart and each field showed a differential response to P fertilization. Data obtained in this range that is near the currently established critical value is a great asset in determining a new or updated soil test critical value.

Due to a leaky greenhouse we lost a many of our tissue samples due to wetness causing a mold problem. Some samples were salvageable, but the full complement of samples was not sufficient to conduct statistical analysis on. In general, tissue samples from the Washington County site where a yield response occurred ranged from 0.39 to 0.56% P. At the off-station site in south Washington County, tissue P ranged from 0.36 to 0.48% P. At each site, the lowest tissue P levels would have been deemed sufficient by current set critical tissue P levels.

Unlike the P sites, in the K research trials we observed no yield response at any of the three testing locations. Mean soil test K was 160 at the DREC, 180 at the Leflore County site, and 147 mg/kg at the Washington County site. These soil test ranges are in a very narrow window around what we feel may be the new critical concentration, 150 mg/kg. Having sites this close to the critical concentration will allow us to strengthen our model. At the DREC, across the range of K_2O application rates, soybean yields ranged from 52 to 56 bu/acre (**Fig 2**). At the Leflore County site, soybean yield ranged from 62 to 65 bu/acre, and similar to the DREC data, did not increase with increasing K application rates.

Likewise, no yield increase was observed at the south Washington County site where soybean yields ranged from 59 to 62 bu/acre across the range of K application rates. This is the first year we have failed to observe a response to K fertilization in any of the harvested trials.

Similar to soybean tissue P, tissue K samples were also impacted by the leaky greenhouse. We had more viable K samples than P samples, but we still elected not to run statistics on them since it was unequal sample size across the rate structure (**Fig 4**). In general, soybean tissue K was in the range of sufficiency for all samples and ranged from 2.1 to 3.4%. Soybean Tissue K did not follow a trend for any testing site, with no increase in tissue K as K_2O application rate increased.

Four trials were established to evaluate soybean response to S rate and/or S product, application time, and source. All four trials were harvestable. The two trials evaluating S rate did not indicate a response to S fertilization (**Fig 5**). This was unexpected at the very fine sandy loam (VFSL) site as soil test S was within the range that a sulfur recommendation would have been suggested. Soil test sulfur at this site was 63 as evaluated by combustion methods, which would be considered low by Mississippi State Soil Testing Laboratory standards. The clay site (187 S) would have been considered in the medium category with a 50% chance of response.

Similar to the S rate trials, the two trials evaluating S source and application resulted in no positive response to S applications (**Fig. 6 and 7**). Soil test S level on the VFSL site was 72 (considered low by MSU labs) and for the clay site was 200 (medium). Last year on sites where responses occurred, soil test values were less than 50, which would be considered very low. These first two years of data underscore the importance of reevaluating S recommendations in Miss. to ensure that we have a firm understanding of when S is required by developing new robust models that develop new critical concentrations for soil test S.

Initial rotations were established for objective three during 2017. First year baseline data from 2018 resulted in soybean yields following corn ranging for 67 to 70 bu/acre, with mean soil test values of 47 and 175 mg/kg for P and K, respectively, and a sulfur soil test value of 54. For soybean following rice, soybean yields ranged from 54 to 62 bu/acre, with mean soil test values of 46 and 179 mg/kg for P and K, respectively, and a S soil test value of 183. By having a site with very similar soil test P and K levels across the rotation, we can track nutrient drawdown across rotation partners to determine if soil test recommendations need to be altered based on cropping history.

IMPACTS AND BENEFITS TO MISSISSIPPI SOYBEAN PRODUCERS

USDA-NASS estimates that approximately 17 and 19% of soybean acres in Mississippi receive P and K fertilization annually. The most recent Miss. soybean board surveys reported approximately 61% of respondent's soil sample every 3 years, with nearly 70 % of respondents suggesting they apply nutrients based on soil test results. These data would immediately affect those producers who annually apply P and K and perhaps bring heightened awareness to those who do not, or provide economic balance for those producers who are over-applying nutrients. If successfully correlated, the data could provide a university-based prescription equation for variable rate nutrient application based on grid sampling. No data are available describing S use trends in MS.

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END PRODUCTS–COMPLETED OR FORTHCOMING

(first two publications are from my program and were sponsored by a previous grant from MSPB evaluating nitrogen additions to soybean and have recently been published)

McCoy, J.M., G. Kaur, B.R. Golden, J.M. Orlowski, D. Cook, J.A. Bond, and M.S. Cox. (2018). Nitrogen fertilization of soybean affects root growth and nodulation on two soil types in Mississippi. Communication in Soil Science and Plant Analysis 49(2) 181-187.

McCoy, J.M., G. Kaur, B.R. Golden, J.M. Orlowski, D. Cook, J.A. Bond, and M.S. Cox. 2018. Nitrogen fertilization of soybeans in Mississippi increases seed yield but not profitability. Agronomy Journal 110 (4) 1505-1512.

Assefa, Yared, L.C. Purcell, M. Salmeron, S. Naeve, S. N. Casteel, P. Kovacs, S. Archontoulis, M. Licht, F. Below, H. Kandel, L.E. Lindsey, J. Gaska, S. Conley, C. Shapiro, J.M. Orlowski, B.R. Golden, G. Kaur, M. Singh, K. Thelen, R. Laurenz, D. Davidson, and I.A. Ciampitti. (2019) Assessing variation in US soybean seed compostion (protein and oil). Frontiers in Plant Science. (*Accepted* Feb 25 2019)

Falconer, L., J.T. Irby, J. Orlowski, T.W. Allen, J.A. Bond, N.W. Buehring, A.L. Catchot, D. Cook, B.R. Golden, J. Gore, L.J. Krutz, and H.C. Pringle. 2018. Soybeans 2019 Planning Budgets. Mississippi State University Extension Service Publication P-3166.

Bryant, C., L.J. Krutz, M.A. Locke, W. Steinriede, D.B. Reynolds, B.R. Golden, and T. Irby. 2018. In-field best management practices for Mid-South irrigated soybean production. [Online]. ASA, CSSA, and SSSA, Madison, WI. Baltimore, MD. Nov. 4-7, 2018. Available at: https://scisoc.confex.com/scisoc/2018am/meetingapp.cgi/Paper/113869

Kaur, G., B. R. Golden, K. K. Crouse, J. L. Oldham, and J. A. Bond. 2018. Comparison of Lancaster, Mehlich 1, and Mehlich 3 soil test methods. [Online]. ASA, CSSA, and SSSA, Madison, WI. Baltimore, MD. Nov. 4-7, 2018. Available at: https://scisoc.confex.com/scisoc/2018am/meetingapp.cgi/Paper/112106

McCoy, J., B.R. Golden, L.T. Bell, B. Pieralisi, and J. Mansour. 2018. Management options for high-yielding soybean and corn in Midsouthern irrigated environments. [Online]. ASA, CSSA, and SSSA, Madison, WI. Baltimore, MD. Nov. 4-7, 2018. Available at: https://scisoc.confex.com/scisoc/2018am/meetingapp.cgi/Paper/113857

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Radio:

RFDTV Radio Spot October 10, 2018 soybean fertility programs
RFDTV Radio Spot January 5, 2018; Soil Sampling Techniques

Grower Meetings:

Grenada County Grower Meeting – Fertilizer strategies for 2018; Grenada, MS (March 8, 2018)
Sunflower County Grower Meeting – Fertilizer strategies for 2018; Indianola, MS (February 26, 2018)

Leflore County Grower Meeting – Fertilizer strategies for 2018; Greenwood, MS (February 26, 2018)

Lee County Grower Meeting – Fertilizer strategies for 2018; Baldwyn, MS (February 14, 2018)
Humphreys County Grower Meeting – Fertilizer strategies for 2018; Belzoni, MS (February 13, 2018)

Coahoma County Grower Meeting – Fertilizer strategies for 2018; Clarksdale, MS (February 12, 2018)

Noxubee County Grower Meeting – Fertilizer strategies for 2018; Macon, MS (February 5, 2018)

Tunica County Grower Meeting – Fertilizer strategies for 2018; Tunica, MS (January 10, 2018)

Madison County Grower Meeting – Fertilizer strategies for 2018; Canton, MS (January 9, 2018)

Hinds County Grower Meeting – Fertilizer strategies for 2018; Raymond, MS (January 9, 2018)

Warren County Grower Meeting – Fertilizer strategies for 2018; Vicksburg, MS (January 8, 2018)

Technical Presentations:

Nutrient Fall Meeting – How to maximize fertilizer benefit on minimal budgets, Eagle Lake, MS (September 26, 2018)

Pursell Technologies PCU Field Tour – PCU performance and Issues in Mid South. Stoneville, MS (Aug 17, 2018)

Greenpoint Ag Ag Summit – How to soil test and sustainable fertilization for maximum net return. Memphis, TN (July 18-19, 2018)

Ag explore Plot Tour – Fertilizer micronutrient use in Mississippi. Stoneville, MS (July 16, 2018)
Farm Bureau YFR – Controversial issues in Mid-South Agriculture. Stoneville, MS (July 13, 2018)

MSPB site visit – Soybean nutrient portioning research update. Stoneville, MS (July 11, 2018)
Thad Cochran Leadership Group – Controversial issues in Agriculture. Stoneville, MS (June 19, 2018)

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MSU Scout School – Know your nutrient deficiencies and how to address them. Verona, MS (May 29, 2018)

MSU Commodity Specialist Retreat – Changes in the retail fertilizer world. West Point, MS (March 22-23, 2018)

Farm Bureau YFR Conf. – How to best use fertilizer recommendations for net return. Biloxi, MS (Feb 23-24, 2018)

MS Ag Consultants Assoc – Making the most out of your fertilizer dollar. Starkville, MS (Feb 6-7, 2018)

Cotton and Rice Conference – Optimal fertilization of soybeans in Midsouth. Memphis, TN (Jan 11-12, 2018)

Tri State Soybean Meeting – Nutrient Uptake and Portioning in Mid South Soybeans. Oak, Grove, LA (Jan 5, 2018)

Soybean Specific Podcasts:

Bald pathologist takes on seed quality. Mississippi Crop Situation Podcast (November 1, 2018)

All about potash. Mississippi Crop Situation Podcast (October 25, 2018)

Late-season soybean diseases. Mississippi Crop Situation Podcast (September 20, 2018)

Things to think about postharvest. Mississippi Crop Situation Podcast (September 12, 2018)

Tropical storm Gordon effects. Mississippi Crop Situation Podcast (September 4, 2018)

Management of sting bugs in soybeans. Mississippi Crop Situation Podcast (August 9, 2018)

Rice and soybeans. Mississippi Crop Situation Podcast (August 8, 2018)

Soybean: July 24 2018. Mississippi Crop Situation Podcast (July 24, 2018)

Best management practices for weed control. Mississippi Soybean Promotion Board (July 1, 2015)

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Graphics/Tables

Figure 1. Soybean yield increase as a function of phosphorus fertilizer rate at all sites managed for correlation calibration trials during 2018.

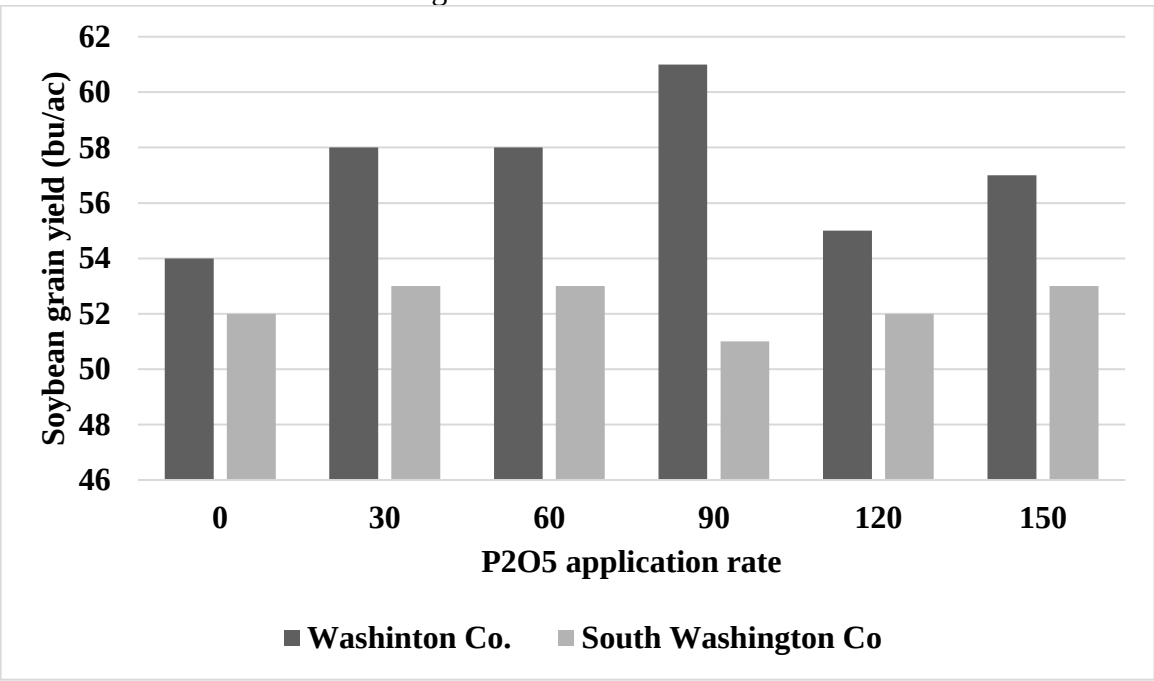

Figure 2. Soybean tissue P concentration as a function of phosphorus fertilizer rate at two responsive sites managed for correlation calibration trials during 2018. (limited data due to greenhouse leak, unequal sample sizes)

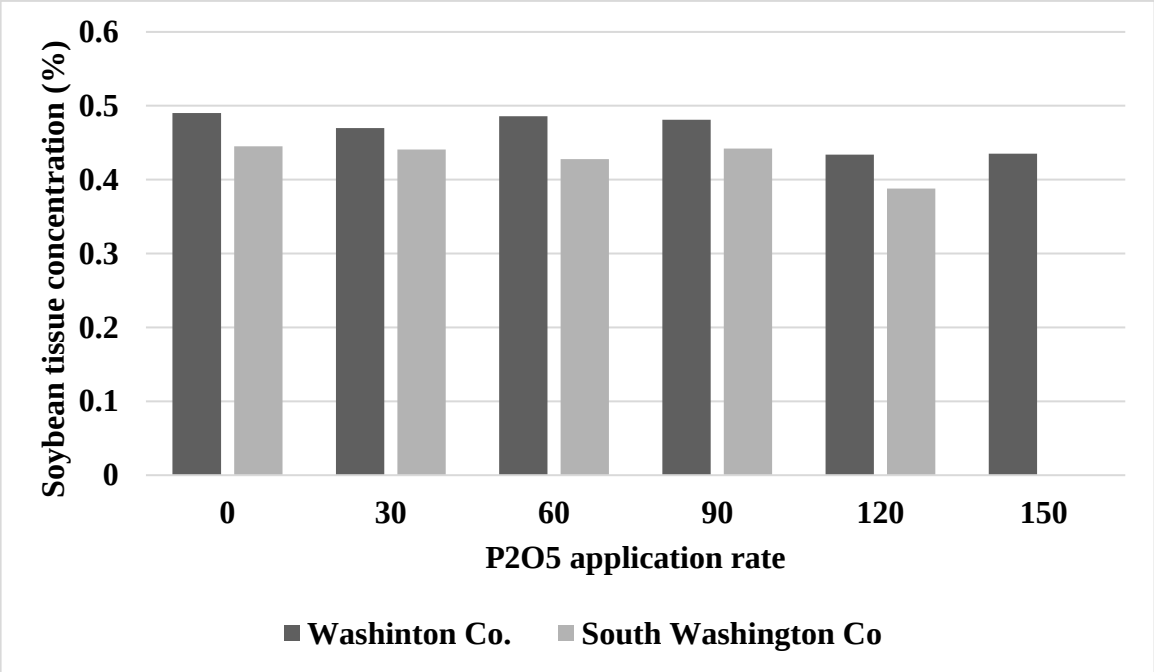

Figure 3. Soybean yield increase as a function of potassium fertilizer rate at all sites managed for correlation calibration trials during 2018.

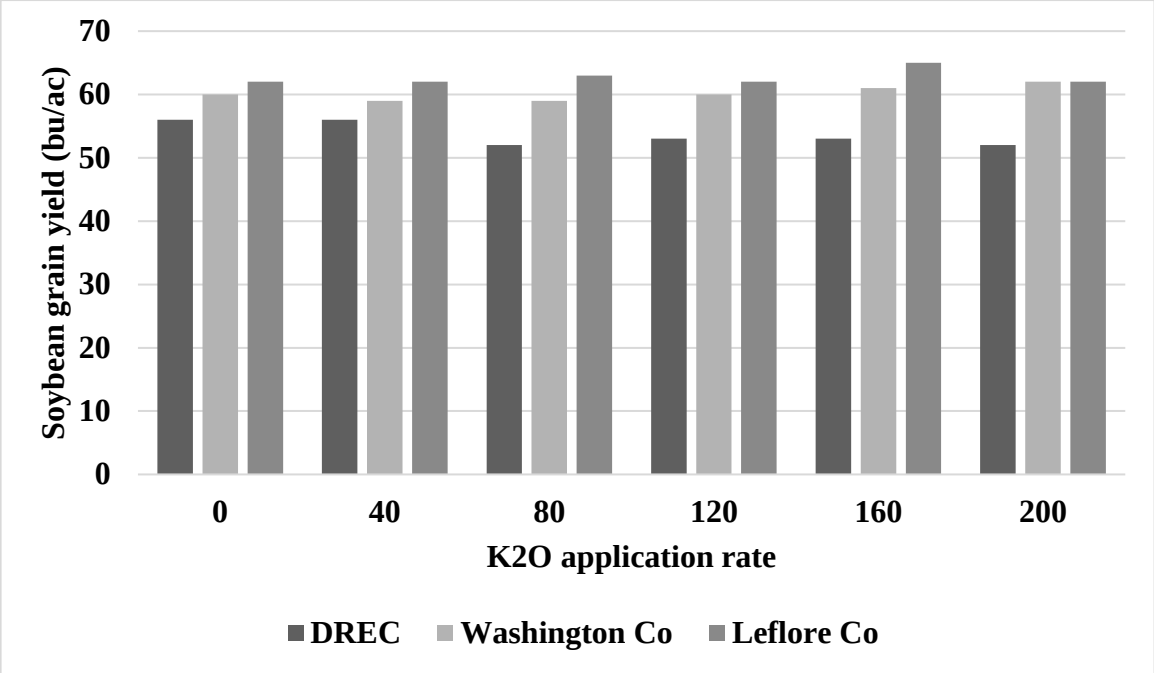

Figure 4. Soybean tissue K concentration as a function of potassium fertilizer rate at two responsive sites managed for correlation calibration trials during 2018.

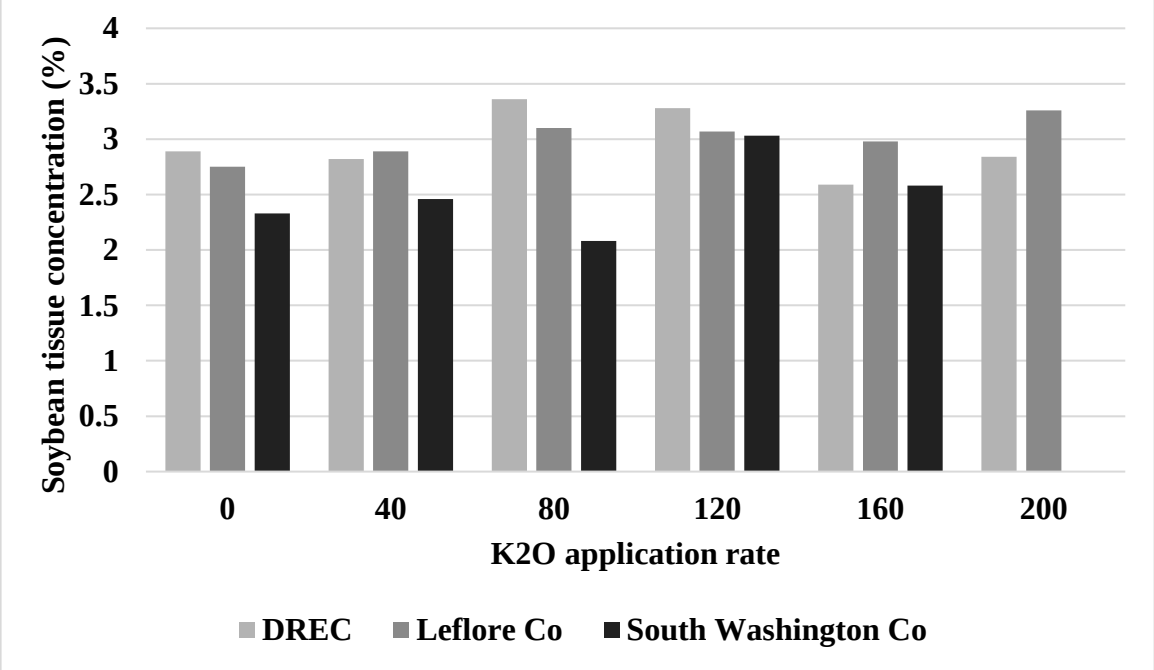

Figure 5 Soybean yield increase as a function of S fertilizer rate at all sites managed for correlation calibration trials during 2018. Site 1 = VFSL, Site 2 = Clay.

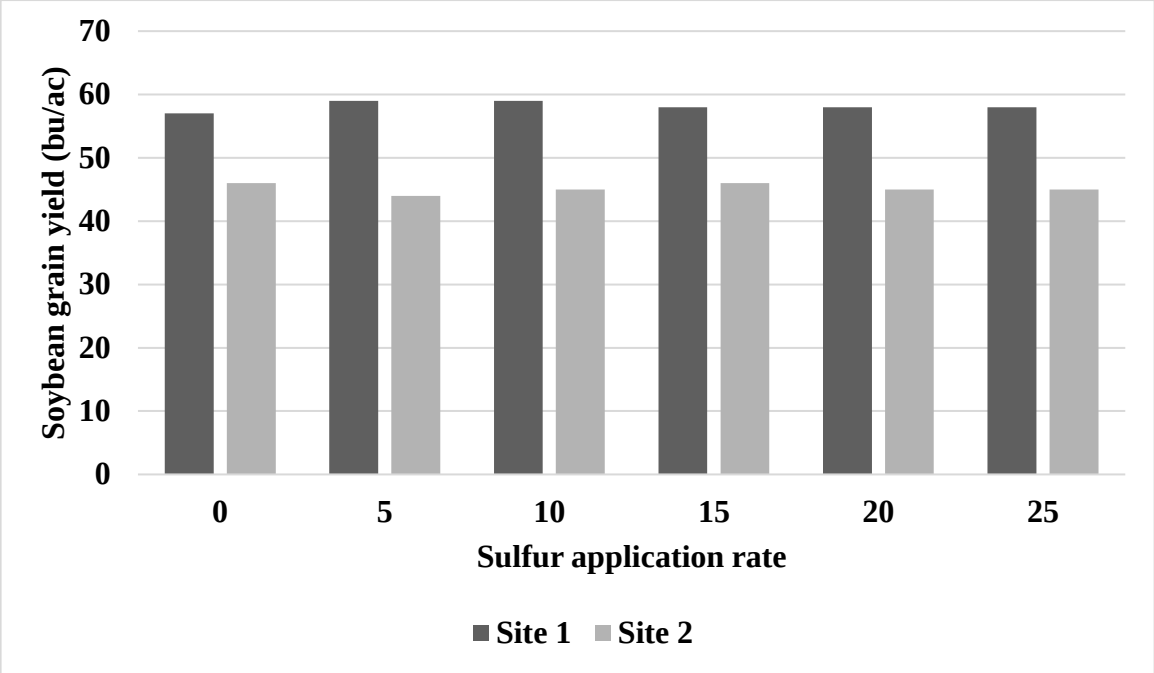

Figure 6. Soybean yield as influenced S fertilizer source and application time at a VFSL soil site at DREC (Site 1) managed for sulfur source response trials during 2018.

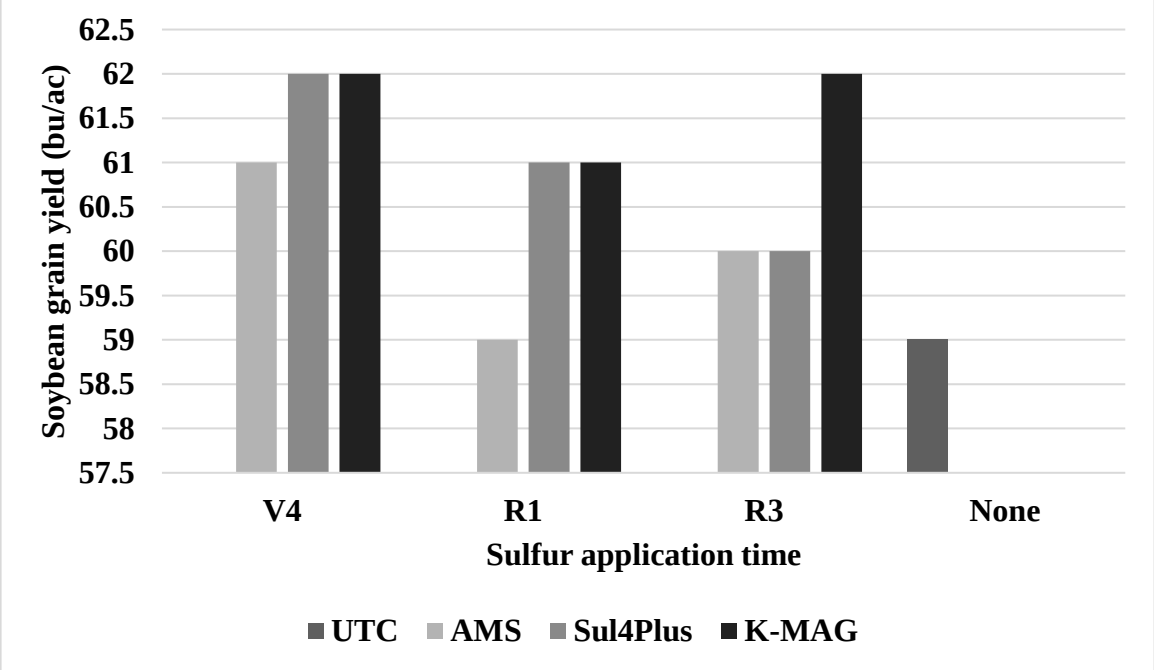

Figure 7. Soybean yield as influenced S fertilizer source and application time at a Clay soil site at DREC (Site 2) managed for sulfur source response trials during 2018.