MISSISSIPPI SOYBEAN PROMOTION BOARD
PROJECT NO. 22-2016 (YEAR 5)
2016 FINAL REPORT

Title: Soil P/K Correlations with Plant Tissue/Yield

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BACKGROUND AND OBJECTIVES

The adoption of grid soil sampling by producers in the Mississippi Delta has increased. In general, producers who employ grid sampling on their farms do so through consultant services, which utilize private laboratories for soil sample analysis. Private laboratories and numerous surrounding states utilize the Mehlich-3 soil test extractant. Currently, Mississippi utilizes the Lancaster extractant to determine soil nutrient availability. Producers and consultants have expressed concerns over different soil-test-based fertilizer recommendations between Lancaster and Mehlich-3 extracted samples. Little to no data are available that correlates Mehlich-3 extractable nutrients to soybean yield in Mississippi. Also, it is unclear when Lancaster soil test phosphorus (P) or potassium (K) was correlated with soybean yield in Mississippi (Lancaster 1980), or when fertilizer recommendations were last updated since Lancaster's attempts. Most of the author's work utilized cotton to set soil test ranges and fertilization recommendations.

Field trials were conducted at numerous locations within the state of Mississippi, both on research stations and on producer fields, to evaluate soybean response to P and K fertilization. Attempts will be made to identify sites that have a range of soil test P and K values (i.e. low to high) prior to crop establishment. Each experiment will be arranged as a randomized complete block design with no less than 6 replications of each P or K rate plus an unfertilized control.

Plant tissue will be collected at the R1 to R2 stage of soybean growth and development from one of the top three nodes with fully expanded leaves from no less than 20 plants within each plot, followed by analysis for elemental concentration. Soybean yield will be harvested with a small plot combine at maturity and reported at a standard moisture content of 13.0%. To determine if sites are responsive to K fertilization, single degree of freedom contrasts comparing the mean yield of soybean receiving any rate of K fertilization against the mean yield of the untreated control. Each site year will be analyzed independently.

Following identification of yield responsiveness, soybean yield data will be transformed into a relative yield. Relative soybean yield and tissue concentrations will be subjected to both Proc REG and Proc NLIN of SAS to attempt to identify a soil test critical value for both the Lancaster and Mehlich-3 soil test extractants, using a multiple model approach to determine best fits.

The overall objectives of the project are:

1. Evaluate soybean yield response to K fertilization rate
2. Evaluate soybean yield response to P fertilization rate
3. Correlate Lancaster and Mehlich-3 soil test P and K with Plant indices (tissue concentration and relative soybean yield)

REPORT OF PROGRESS/ACTIVITY

Potassium

To address objective one and three for potassium, beginning in 2012 growers were solicited to participate in the on-farm nutrient correlation/calibration trials. These trials were targeted to specific farms that had nutrient issues in the past and or current soil test values that were near currently established critical values. We strived to place at least 5 trials each year with hopes of ending the year with at least three harvestable sites. Only in the first year of testing were we able to harvest all five preplanned sites. In subsequent years, misapplication of fertilizer and/or combine operators ignoring the flagged area resulted in less than five trials harvested each year. During the course of the funding cycle for K research, approximately 19 trials were harvestable for intended data collection. Each site and its corresponding location and level of responsiveness are presented in table 1.

Collectively across all sites that responded to potash application, grain yield increased until reaching a plateau and could be described with a quadratic function (grain yield = 60.9 + 0.1212x-0.004x^2; R2 0.991; P=0.0008). Figure 1 represents mean data from all site years for both responsive and non-responsive sites. Mean soybean yield from the untreated control was 61 bu/acre, while the greatest soybean yield produced with potash fertilization was obtained when soybean received 160 lb K_2O/acre. However, soybean grain yield from plots receiving 160 lb K_2O/acre did not differ from yield from plots that received 80 lb K_2O/acre. Based on the quadratic function, grain yield was maximized with application rates of 150 lb K_2O/acre.

The current trend described by the quadratic equation will change with more data and/or by evaluating differing regression techniques (i.e. plateau type models). The quadratic-based model tends to overestimate the amount of fertilizer required to produce optimal yield and is an example of a risk aversion model to incurring a yield penalty. The quadratic model, however, may incur an economic burden if a producer elected to apply an amount of K_2O to achieve 100 % yield without taking into account a soil test. Based solely on the data shown in Fig 1, it appears that if a producer with no soil test or one wanting to reduce fertilizer expense, would be safe with a blanket application of 80-120 lb K_2O/acre.

Figures 2 and 3 represent the relationship between relative soybean yield and soil-test K extracted with the Lancaster (Fig. 2) and the Mehlich-3 (Fig. 3) extraction procedures. I have not attempted to fit a complex model to the data because I feel like more site-years are needed to obtain a critical level of K in the soil or a join point for complex plateau type modeling. Work will continue to achieve enough site-years to attempt complex modeling. However, taking a simple cate nelson approach, it appears that a critical level describing the response of relative soybean yield to soil-test K parameters is beginning to evolve. The soil test critical level regardless of extractant appears to be forming north of 150 mg K/kg. More response sites are needed to confirm this hypothesis, but inspection of Figures 2 and 3 suggests that chances of observing a soybean response to K fertilization at soil test levels above 150 mg K/kg is very marginal at best. The lowest soil test K associated with a non-responsive site was 168 mg K/kg (Table 1). Grain yield responses to K fertilization of soybean seeded to soil with a soil test K > 150 mg/kg only occurred at one site-year (site 6).

Due to the way soil sampling is conducted in MS, and the differing extractants utilized by private and state labs, it is imperative to correlate soil test K measured by both the Lancaster and Mehlich-3 extraction methods to soybean yield. It appears that there is very little difference between K extractability between the two methods (Fig. 4). The relationship between Mehlich-3 and Lancaster soil extraction methods proved to be positive and linear (Fig. 4). The linear function describing the difference between Mehlich-3 and Lancaster extractable K was almost 1:1, with Lancasater extractable K = 30.33+0.92*Mehlich-3 extractable K. The soil test values used to establish the relationship ranged from 35 to 502 mg K/kg. With the great range in soil test values represented and number of samples (n=696), I feel very confident that we could make determinations on soil test K from one extractant to the next once a definitive critical value is established via field correlation.

Phosphorus

Identical to the potassium trial (to address objectives two and three for phosphorus), beginning in 2012 growers were solicited to participate in the on-farm nutrient correlation/calibration trials. These trials were targeted to specific farms that had nutrient issues in the past and or current soil test values that were near currently established critical values. We strived to place at least five trials each year with hopes of ending the year with at least three harvestable sites. Only in the first year of testing were we able to harvest all five preplanned sites. In subsequent years, misapplication of fertilizer and/or combine operators ignoring the flagged area resulted in less than five trials harvested each year. During the course of the funding cycle for P research, approximately 17 trials were harvested for data. Each site and its corresponding location and level of responsiveness are presented in table 2.

Of the 17 testing locations for P, eight site-years were responsive to P fertilization while nine s did not respond positively to fertilization (Table 2). Mean grain yield across the responsive sites was 62 bu/acre, with a corresponding Lancaster extractable soil test P of 44 mg/kg and a Mehlich-3 extactable P level of 37 mg/kg (Figs 5). Alternatively, on non-responsive sites mean soybean yield was 70 bu/acre, Lancaster soil test extractable P was 56 mg/kg, and Mehlich-3 extractable P averaged 49 mg/kg. At responsive sites, the response to P fertilization differed dramatically when compared to K research. On average, the initial application of P_2O_5 maximized soybean grain yield. Single degree of freedom contrasts suggested that P_2O_5 application rates of 30, 60, 90, and 120 lb P_2O_5/acre produced less soybean yield than soybean receiving 150 lb P_2O_5/acre, but all produced greater yields than the untreated control.

Figures 6 and 7 show the beginning stages of development of a correlation curve. Similar to research investigating K, more site-years are needed to utilize complex modeling procedures to develop a critical level and/or join point between responsive and non-responsive sites. Unlike K research results where scatter plots for both Lancaster and Mehlich-3 extractants looked similar, for P research they contrasted greatly.

For both Lancaster and Mehlich-3, there is no clear discernable critical value that aids in diagnosing responsive and non-responsive sites. This is not uncommon for P research with any soil test extractant. It appears that a great deal of work will be needed to delineate a soil test critical level for each extractant, and perhaps other soil property values will be needed to aid in identifying a critical level. For now and based on yield response work, it appears that approximately 100 lb/acre of triple super phosphate or diammonium phosphate will fix a P problem if one exists. However, it will be very difficult in predetermine where and when a P deficiency will occur based on these data.

Fig. 8 represents the relationship between Lancaster and Mehlich-3 extractable P. Similar to K results, the relationship was positive and linear. However, it appears that the relationship between Lancaster and Mehlich-3 P is more erratic than that observed with K. The spread of data points around the regression line suggests that one soil test extractant was more likely to overestimate the P value obtained with the other. However, based on the previous figures suggesting that no clear critical level is currently identifiable, the under- or over-estimating is not as critical, being that soil testing for P does not have high a high degree of accuracy. Work will continue in the future to establish a critical P value further refine prediction models by addition of other soil properties to aid in describing crop response to P.

IMPACTS AND BENEFITS TO MISSISSIPPI SOYBEAN PRODUCERS

This research will directly influence the Mississippi soybean industry by providing a set of Mississippi soil test recommendations that could be applied to soil test data from laboratories that utilize Mehlich-3 as an extractant. The research will also be valuable in updating current P and K fertilizer recommendations based on the Lancaster extraction method currently utilized by Mississippi State University's Soil Test Laboratory. The research will also provide data based on newer high-yielding cultivars, the ESPS, and new and evolving production practices. USDA-NASS estimates that approximately 17 and 19% of soybean acres in Mississippi receive P and K fertilization annually. 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 over-apply nutrients. If successfully correlated, the data could provide a university-based prescription equation for variable rate nutrient application based on grid sampling.

END PRODUCTS- COMPLETED AND FORTHCOMING

Publications

MBJ 2015. States "Big 4" row crops post record yields in 2014. Mississippi Business Journal (May 29,2015)

Floyd, A. 2015. Experts give tips to prevent yield loss in soybeans. Growing Georgia. [On-Line] Available at: http://growinggeorgia.com/features/2015/02/experts-give-tips-prevent-yield-loss-soybeans/

Soybeans 2016 Planning Budgets. 2015. Mississippi State University Extension Service Publication P-2921.

Golden, B.R. 2015. Fertilizing soybean in Mississippi. Mississippi soybean promotion board fact sheet. Osborn-Barr, St. Louis, Mo.

Mississippi soybean, 2015. Soil Sampling – the first step toward a profitable growing season. Mississippi soybean promotion board fact sheet. Osborn-Barr, St. Louis, Mo.

Mississippi soybean, 2015. Mississippi soybean production best management practices guide. Mississippi soybean promotion board production guide. Osborn-Barr, St. Louis, Mo.

Catchot, A., D. M. Dodds, J. Gore, B. R. Golden, J. A. Bond, T. Irby, D. Cook, and T. W. Allen. 2015. Reminder: Scout schools start next week. [Online] Available at http://www.mississippi-crops.com/2015/05/23/reminder-scout-schools-start-next-week/
Catchot, A., D. M. Dodds, T. Irby, J. A. Bond, T. W. Allen, B. R. Golden, J. Gore, and D. Cook. 2015. 2015 scout schools set for Mississippi. [Online] Available at http://www.mississippi-crops.com/2015/04/08/2015-scout-schools-set-for-mississippi/

Golden, B.R. 2014. Diagnosing nutrient deficiencies in Mississippi soybeans. [Online]. Available at: http://www.mississippi-crops.com/2014/06/14/diagnosing-nutrient-deficiencies-in-mississippi-soybeans/

Irby, J.T., and B.R. Golden. 2014. Soybean crop update and replant decisions. [Online]. Available at: http://www.mississippi-crops.com/2014/06/13/soybean-crop-update-and-replant-decisions/

Print Article United Soybean Board. 2014. Using Post Harvest Soil sampling as part of your soybean nutrient management program. [On-Line] Available at http://unitedsoybean.org/article/using-post-harvest-soil-sampling-as-part-of-your-soybean-nutrient-management-program/

Print Article MBJ. 2014. MSU scientists evaluating soil-testing recommendations. Mississippi Business Journal. Sept 25, 2014.

Presentations at Conferences

Oldham, J.L., K.K. Crouse, B. Macoon, M.W. Shankle, M.W. Ebelhar, and B.R. Golden. 2015. Four years and counting: An update on seasonal soil testing variation. . In Annual meetings abstracts

[Online]. ASA, CSSA, and SSSA, Madison, Minneapolis, MN. Nov 15-18, 2015. Available at: https://scisoc.confex.com/scisoc/2015am/webprogram/Paper93802.html (Volunteered)

Ross, W.J., B.R. Golden, M.D.Furhman, T. Irby, G. Stevens, J. Lofton, C.B. Neely, R.W. Schnell, L. Falconer, D. Hathcoat. M. Rhine, and L. Bell. 2015. An evaluation of crop rotation and soil nutrients in the Midsouth. In Annual meetings abstracts [Online]. ASA, CSSA, and SSSA, Madison, WI. Minneapolis, MN. Nov 15-18, 2015. Available at: https://scisoc.confex.com/scisoc/2015am/webprogram/Paper93703.html (Volunteered)

Mississippi Agricultural Consultants Association – Soybean and Corn Fertility Management; Starkville, MS (Feb 5-6, 2014)

Kraus, N and B.R. Golden. 2014. Late soybean planting doesn't mean change in variety. USB/MSSB Update. May 19, 2014.

Agronomic crops extension retreat – 2014 soil fertility update for soybeans, corn and rice; Hamilton, MS (June 26, 2014)

Lowndes county crop update – 2014 fertilizer considerations for soybean and corn; Hamilton, MS (July 8, 2014)

Mississippi Agriculture Industries Council; Certified Crop Advisor Training – 2014 fertility challenges for rice, corn and soybean; Orange Beach, AL (July 30, 2014)

Mosaic Fertilizer Composite plots field tour – Maximizing Nutrient use in Corn and soybean; Stoneville MS (August 21, 2014)

Farm Bureau Commodity Directors Tour – Soybean and corn fertilizer management; Stoneville, MS (August 6, 2014)

Mid-South Soybean Board - Soybean and corn rotation sulfur balances; Portageville, MO (August 12, 2014)

Farm Bureau young farmers and ranchers field tour – Row Crop Research at the DREC; Stoneville, MS (August 15, 2014)

Bell, L., B.R. Golden, J.L. Oldham and M.W. Ebelhar. 2014. Soybean response to potassium and phosphorus fertilization in Mississippi. . In Annual meetings abstracts [CD-ROM]. ASA, CSSA, and SSSA, Madison, WI. Long Beach, CA. Nov 2-5, 2014. (Volunteered)

B.R. Golden. 2014. Updating current soil test recommendations for MSU planning and implementation; Stoneville MS (Sept 2, 2014)

B.R. Golden. 2014. Pillow Planting Company; Nutrient Management Plans for Corn and Soybean; Stoneville, MS (Sept 30, 2014)

Golden, B.R. 2014. Soil Sampling for Fertility Management. MSSPB Video. Oct 7, 2014. [On-Line] Available at: https://www.youtube.com/watch?v=_Z-jPblhJNU&list=UUe2_hAnfIGf2eQSBPGSptpg

B.R. Golden. 2014. Silent Shade Plantation; Nutrient Management planning for whole farm with emphasis on Corn, Soybean, and Rice. Belzoni, MS (Oct 1, 2014)

Mississippi ASA Meeting – Soil fertility Concerns for Soybean and Corn; Grenada MS. (Nov 12, 2014)

Mosaic Fertilizer Information Exchange – Soil Fertility Status in Mississippi; Plymouth, MN (November 10, 2014)

Mississippi Agriculture Consultants Information Exchange; What's going on in the Fertility world; Stoneville, MS (Oct 2, 2014)

Beck Ag Soybean Educational Session – Early season issues impacting Soybean yield; National call in radio show (Dec 10, 2014)

Golden,B.R. and J. Nichols. 2013. Fertility needs for maximizing soybean yield. In Proc. Consev. Cotton and Rice Conf. Mid America Farm Pub. Baton Rouge, La. Jan 31- Feb 1.

Golden, B.R. 2013. Current soil test correlation and calibration research in Mississippi. Southeast Regional Information Exchange Group-6. Baton Rouge, LA June 16-18, 2013.

Montgomery, G.B., B.R. Golden, S.A. Shinkle, and T.W. Allen. 2013. Management Considerations for Mid-Southern Soybean Production. In Annual meetings abstracts [CD-ROM]. ASA, CSSA, and SSSA, Madison, WI. Tampa, FL. Nov 3-6, 2013.

Mississippi Agricultural Consultants Association – Soil test correlation and calibration for soybean and corn; Starkville, MS (Feb 5-6, 2013)

Tri State Soybean Grower Meeting – Fertility needs for maximizing soybean yield; Stoneville, MS (Jan 4, 2013)

United Soybean Board – Optimal Rotation Intervals for Soybean and Corn; Little Rock, AR. (Feb 3, 2014)

Mississippi Agricultural Consultants Association – Soybean and Corn Fertility Management; Starkville, MS (Feb 5-6, 2014)

Mississippi Row Crop Short Course – Precision Agriculture Technologies for Soil Fertility; Starkville, MS (Dec 4, 2013)

Mississippi Agricultural Consultants' Association Research Exchange – Update on upland row crop fertility; Cleveland, MS (October 23, 2013)

Technical Presentation; Mississippi Agricultural Consultants Association. Soil Fertility for cotton and soybean. Starkville, MS (February 14-15)

Technical Presentation; Pioneer Consultants Conference. Soil Fertility for corn and soybean in the Midsouth. Tunica, MS (February 23-24, 2012)

Technical Presentation; Mississippi Agricultural Consultants Association. Fall Soil Fertility Update. Cleveland, MS (September 13, 2012)

Production Meeting Presentation; Mississippi ASA, Optimizing soybean and corn rotations with soil testing. Grenada, MS (November 13, 2012)

Production Meeting Presentation; Mississippi Row Crop Short Course; Corn and soybean fertility programs; Starkville, MS (December 4, 2012)

Field Days

Delta Research and Extension Center Early-season field day – Corn and Soybean Fertility; Stoneville, MS (April 30, 2014)

Verona Field Day – Update on Cotton OVT, What's on the Horizon and mid-season fertilizer management; Verona, MS (August 7, 2014)

Delta Research and Extension Center Irrigation management turn row tour; Soybean growth stages and identification; Stoneville, MS (August 30, 2013)

Field Day Presentation; Delta Research and Extension Center Agronomic Crops Field Day, Soybean phenology and soil test correlation/calibration . Stoneville, MS (July 19, 2012)

Field Day Presentation; Main campus Mississippi State University; Corn zinc fertility and soybean phenology; Starkville, MS (July 19, 2012)

Workshops

GFK Data – Common Soil fertility practices in MS; National Call in show (December 21, 2015)

Ayers Delta Group - Soil Fertility and its importance; Yazoo City, MS (November 10, 2015)

Ayers Delta Group – Soil Fertility and its importance; Rolling Fork, MS (November 9, 2015)
IHL Tour – Importance of Fertilizer BMPS for Mississippi Delta; Stoneville, MS (October 8, 2015)

MACA information exchange – What's new in the fertility world; Stoneville, MS (October 1, 2015)

Jimmy Sanders Agronomic Training – BMPS for Rice, Corn and Soybean; Rayville, LA (September 24 2015)

Monsanto Educational – Soil testing and its importance for corn and soybean; Memphis, TN (September 9, 2015)

Mosaic field tour – Fertilizer products for corn and soybean; Stoneville, MS (August 13, 2015)
Agronomic Crops Agent Training – Soil fertility Primer; Hamilton, MS (June 18, 2015)
BASF agronomic crops tour – Soybean and corn soil fertility to maximize production, Leland MS (June 24, 2015)

MSU Scout School – Know your fertilizers, Fertilizer ID; Starkville, MS (June 4, 2015)

MSU Scout School – Know your fertilizers, Fertilizer ID; Verona, MS (June 2, 2015)

MSU Scout School – Know your fertilizers, Fertilizer ID; Clarksdale, MS (May 28, 2015)

Farm Bureau Spring Tour – Row crop update for Rice and Soybean; Stoneville, MS (May 15, 2015)

Beck Ag Soybean Educational Session – Late season issues impacting Soybean yield; National call in radio show (Feb 20, 2015)

MSSPB/USB Soybean Management Seminar Series – Digging Deeper to Protect your Soybean Yield – Soil Fertility; Rolling Fork MS (February 11, 2015)

MSSPB/USB Soybean Management Seminar Series – Digging Deeper to Protect your Soybean Yield – Soil Fertility; Stoneville MS (February 10, 2015)

Mississippi Agricultural Consultants Conference – Soil Sampling Methodologies in Mississippi; Starkville, MS (February 4, 2015)

MSSPB/USB Soybean Management Seminar Series – Digging Deeper to Protect your Soybean Yield – Soil Fertility; Cleveland MS (January 22, 2015)

Monsanto Consultants Conference – Optimal fertility programs for corn and soybean; Memphis, TN (January 9, 2015)

Jimmy Sanders Agronomic Training – Fertilizer needs assement for corn, soybean, and rice; Stoneville MS (January 6, 2015)

Delta Research and Extension Center ANR row crops workshop – Know your fertilizers; identification and use; Stoneville, MS (April 30, 2014)

Agronomic crops extension retreat – 2014 soil fertility update for soybeans, corn and rice; Hamilton, MS (June 26, 2014)

MSU Row Crop Short Course – Fertility concerns headed into 2015. Starkville, MS (Dec 2, 0214)

Delta Ag Expo Soybean Roundtable – Potassium deficiency in soybean; Cleveland, MS (Jan 16-17, 2013)

Lowdes county crop update – 2013 Soybean soil fertility update on correlation calibration; Hamilton, MS (Jan 14, 2014)

Itawamba county mid-season crop update – 2013 soil fertility update on correlation calibration; Baldwyn, MS (July 16, 2013)

Agronomic crops extension retreat – 2013 soil fertility update on current corn and soybean issues; Hamilton, MS (June 6, 2013)

Jimmy Sanders/Pinnacle Ag Inc., Certified Crop Advisor Training – Current issues in row crop fertility; Monroe, LA (Aug 7, 2013)

Jimmy Sanders/Pinnacle Ag Inc., Certified Crop Advisor Training – Current issues in row crop fertility; Birmingham, AL (Aug 1, 2013)

Jimmy Sanders/Pinnacle Ag Inc., Certified Crop Advisor Training – Current issues in row crop fertility; Stoneville, MS (July 31, 2013)

Mississippi Agriculture Industries Council; Certified Crop Advisor Training – Fertilization programs for corn and soybean; Orange Beach, AL (July 24, 2013)

Production Meeting Presentation; Delta Ag Expo, Current issues in soybean fertility. Cleveland, MS (January 17-18, 2012)

Production Meeting Presentation; County Meeting. Soil fertility questions with changing production practices. Yazoo City, MS (February 22, 2012)

Industry Update; Mississippi Agriculture Industry Association. Soil fertility update. Orange Beach, AL (July 23-27, 2012)

Production Meeting Presentation; Delta Crop Summit, Soybean and Corn Fertility Programs, Stoneville, MS (November 14, 2012)

Graphics/Tables

Table 1. Harvestable experimental locations for potassium research during the 2012-2016 seasons. Sites were deemed responsive to fertilization at Alpha levels < 0.10 by ANOVA and single degree of freedom contrasts.

Site No	Year	Location	Mean Soil Test K (ppm) from UTC	Responsive to Fertilization
1	2011	Washington	311	No
2	2012	Washington	285	No
3	2012	Washington	236	No
4	2012	Humphreys	90	Yes
5	2012	Bolivar	151	Yes
6	2012	Bolivar	212	Yes
7	2013	Leflore	382	No
8	2013	Tunica	257	No
9	2013	Washington	387	No
10	2013	Carrol	249	No
11	2014	Washington	225	No
12	2014	Washington	183	No
13	2014	Washington	223	No
14	2015	Washington	271	No
15	2015	Bolivar	135	Yes
16	2015	Bolivar	123	Yes
17	2016	Washington	168	No
18	2016	Bolivar	115	Yes
19	2016	Washington	215	No

Figure 1. Mean response of soybean grain yield to potash fertilization across 19 experiments conducted during 2012-2016 in the Miss. Delta region.

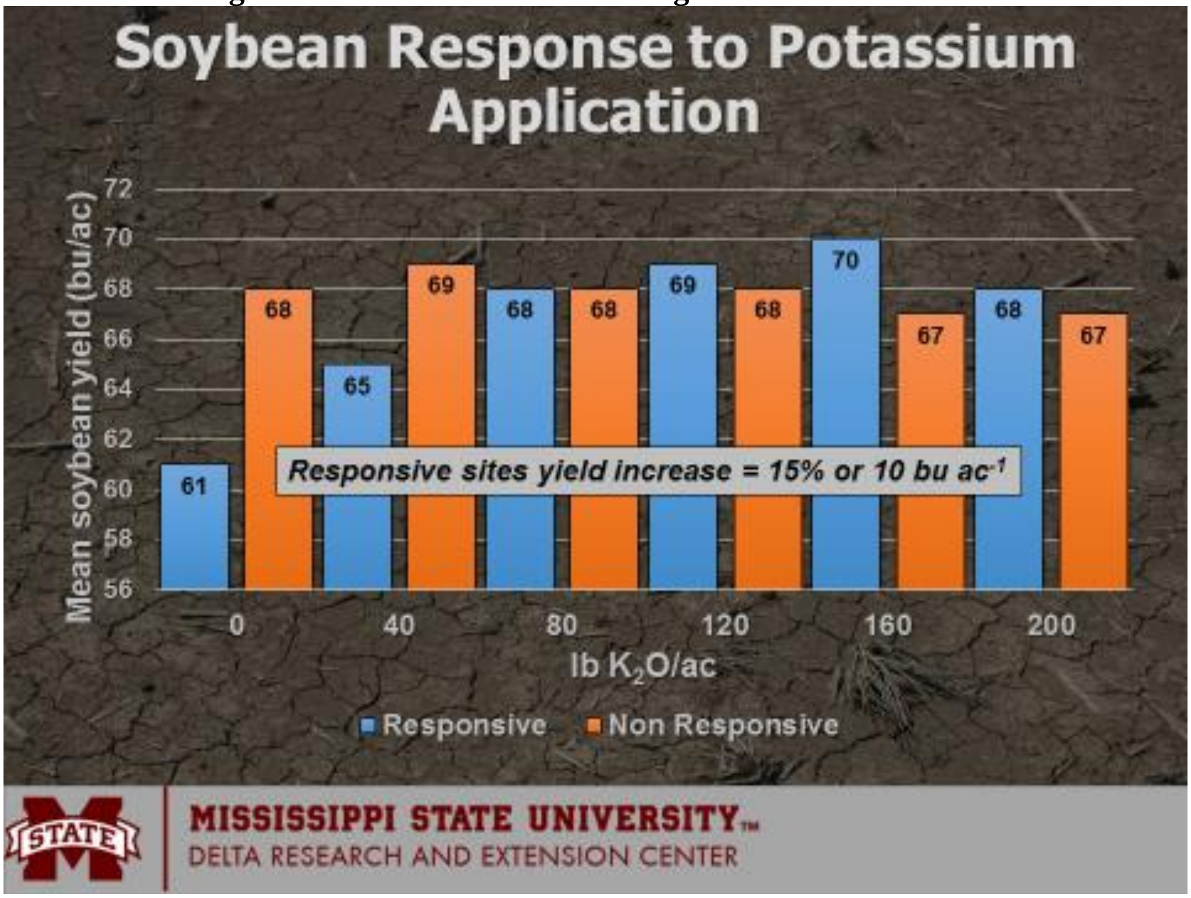

Figure 2. Relationship between Lancaster Extractable K and relative soybean yield. Circles represent the mean (n=5 or 10) soil test value from each untreated control plot and the corresponding relative yield. Black circles represent sites that positively responded to fertilizer at Alpha = 0.10.

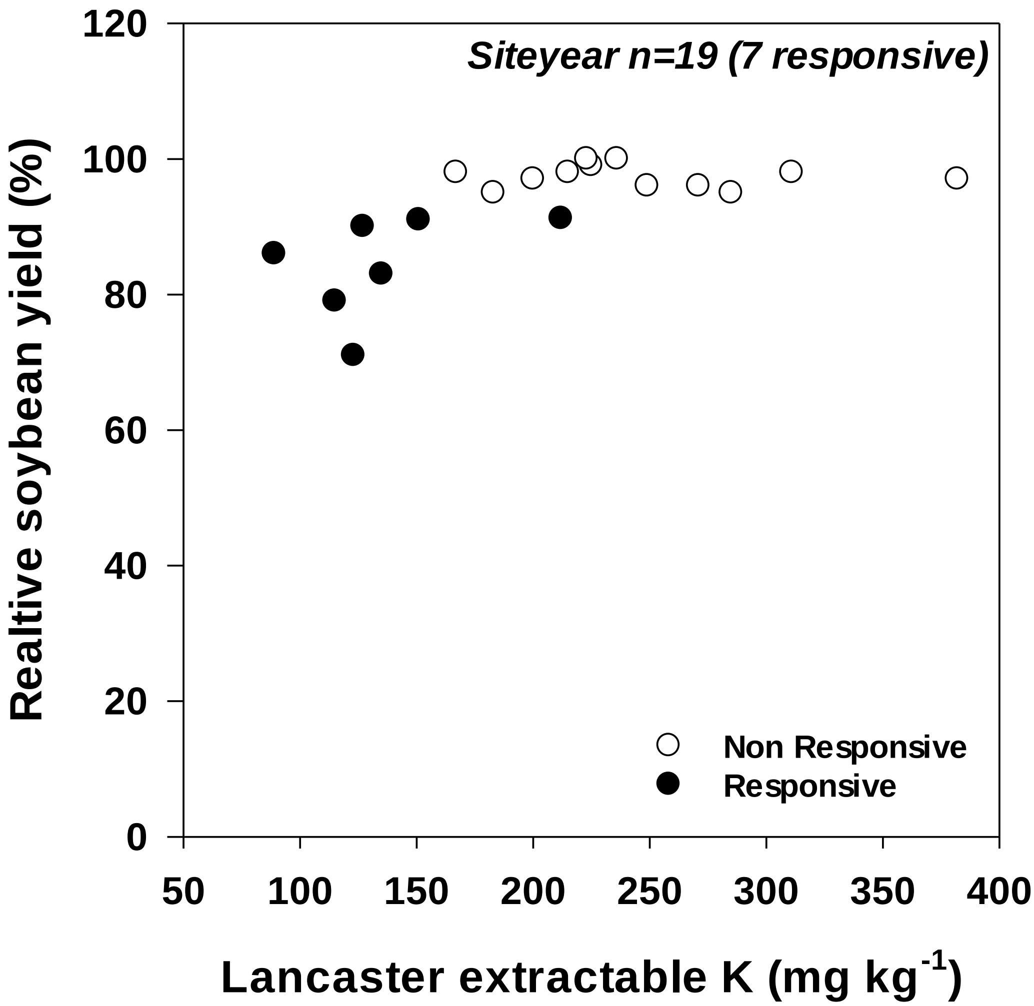

Figure 3. Relationship between Mehlich-3 Extractable K and relative soybean yield. Circles represent the mean (n=5 or 10) soil test value from each untreated control plot and the corresponding relative yield. Black circles represent sites that positively responded to fertilizer at Alpha = 0.10.

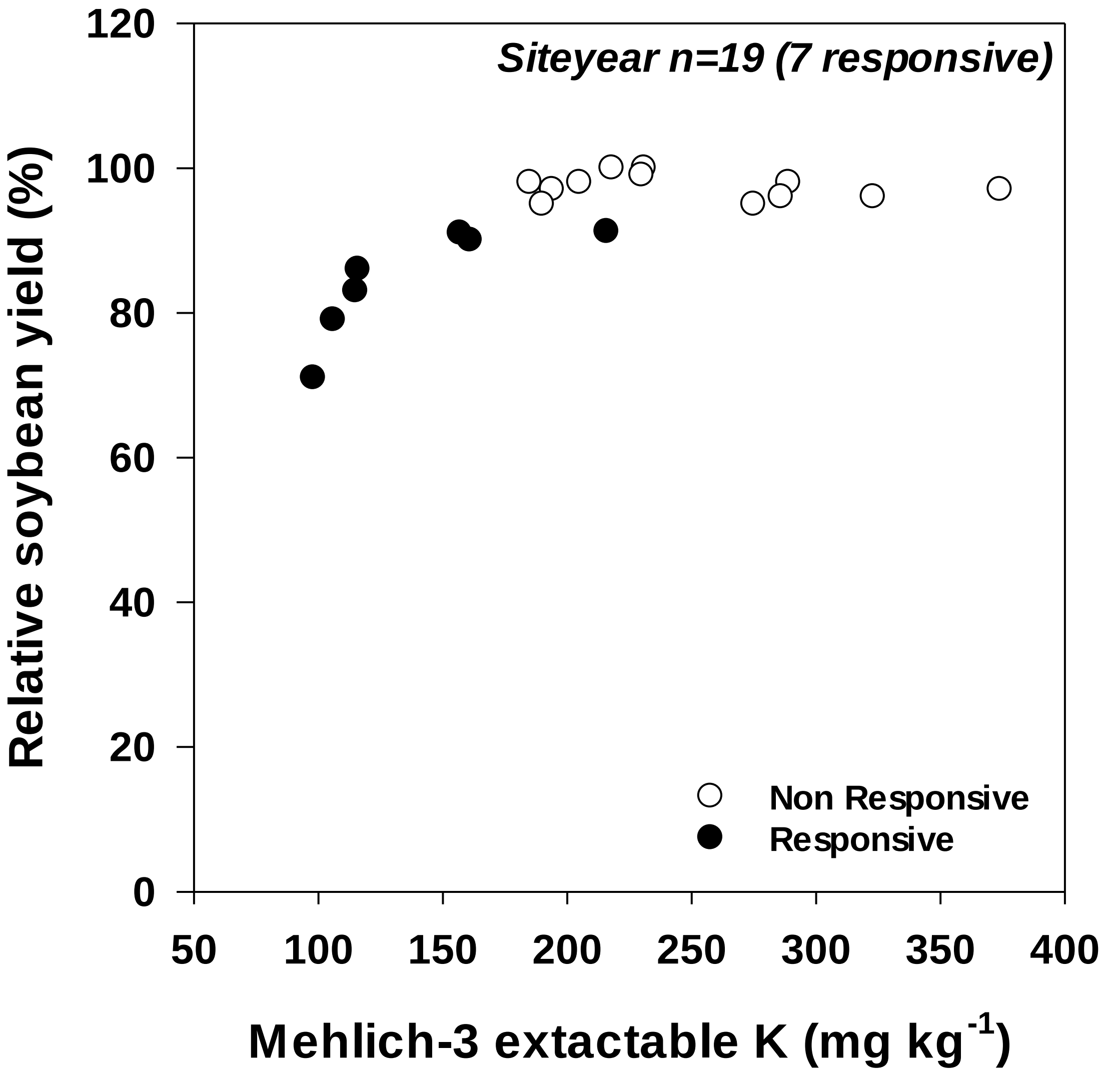

Figure 4. Relationship between Lancaster extractable soil K and Mehlich-3 extractable soil K. Each circle represents soil collected from an untreated control (0 K_2O/acre) at research locations throughout MS.

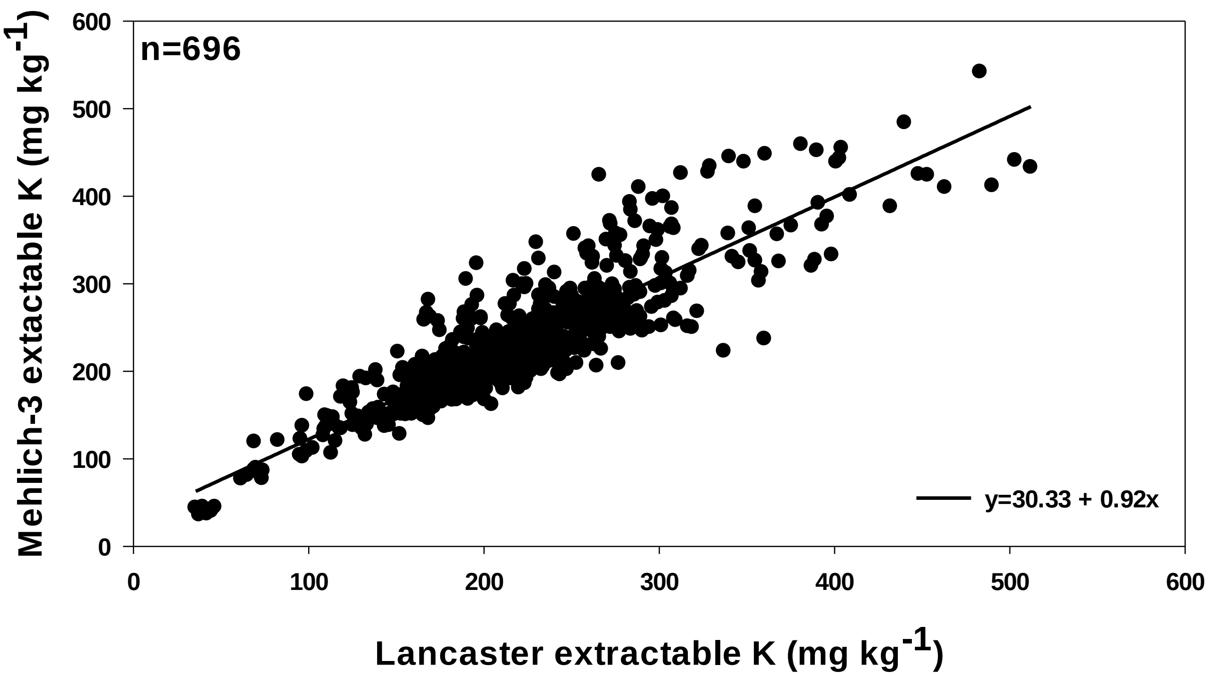

Table 2. Harvestable experimental locations for Phosphorus research during the 2012-2016 growing seasons. Sites were deemed responsive to fertilization at Alpha levels < 0.10 by ANOVA and single degree of freedom contrasts.

Site No	Year	Location	Mean Soil Test P (ppm) from UTC	Responsive to Fertilization
1	2012	Washington	55	No
2	2012	Humphreys	34	Yes
3	2012	Washington	55	No
4	2012	Bolivar	30	Yes
5	2013	Washington	35	Yes
6	2013	Tunica	47	Yes
7	2013	Carrol	85	Yes
8	2013	Leflore	56	No
9	2014	Washington	51	No
10	2014	Washington	27	No
11	2014	Washington	51	No
12	2015	Bolivar	72	No
13	2015	Washington	66	Yes
14	2015	Washington	51	No
15	2016	Bolivar	62	No
16	2016	Washington	42	Yes
17	2016	Washington	24	Yes

Figure 5. Mean response of soybean grain yield to phosphorus fertilization across 19 experiments conducted during 2012-2016 in the MS Delta region.

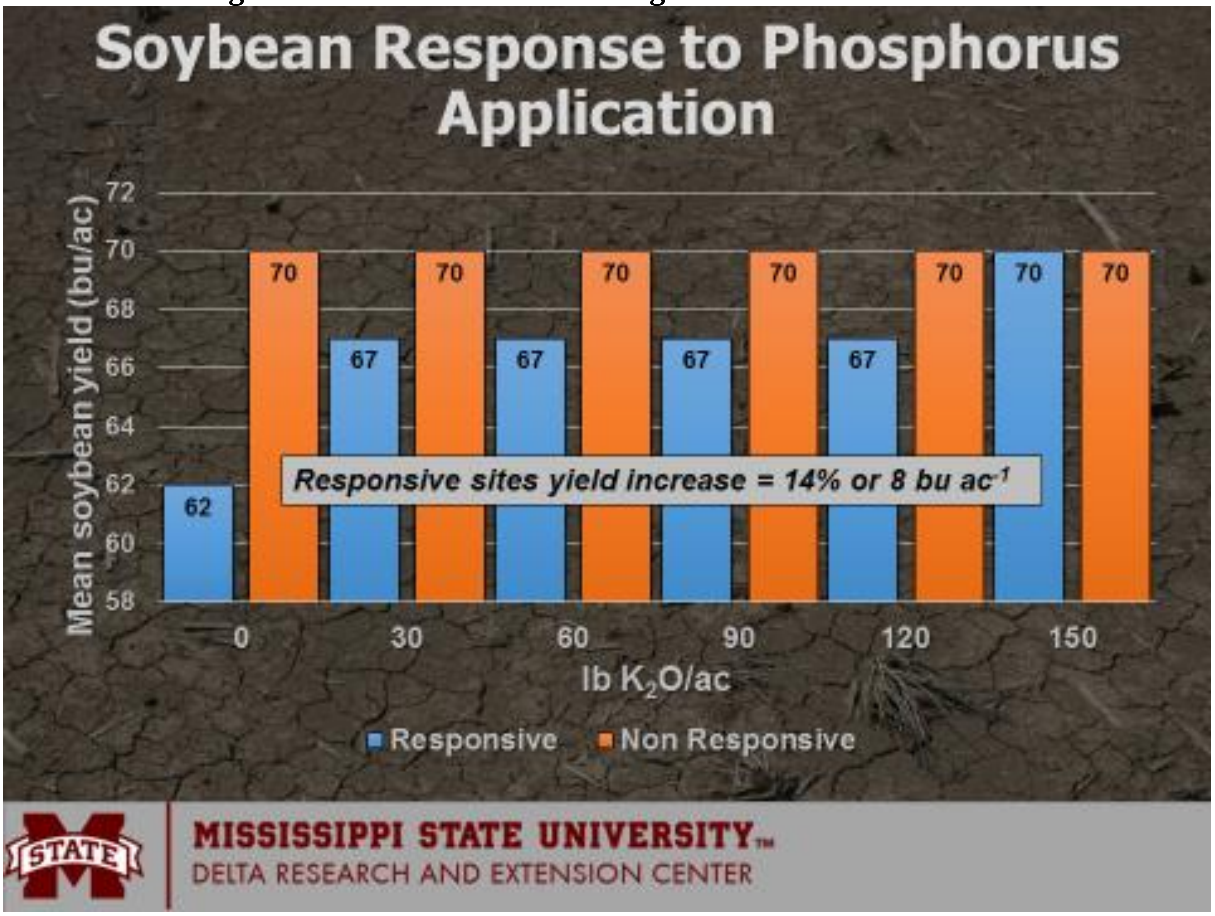

Figure 6. Relationship between Lancaster Extractable P and relative soybean yield. Circles represent the mean (n=5 or 10) soil test value from each untreated control plot and the corresponding relative yield. Black circles represent sites that positively responded to fertilizer at Alpha = 0.10.

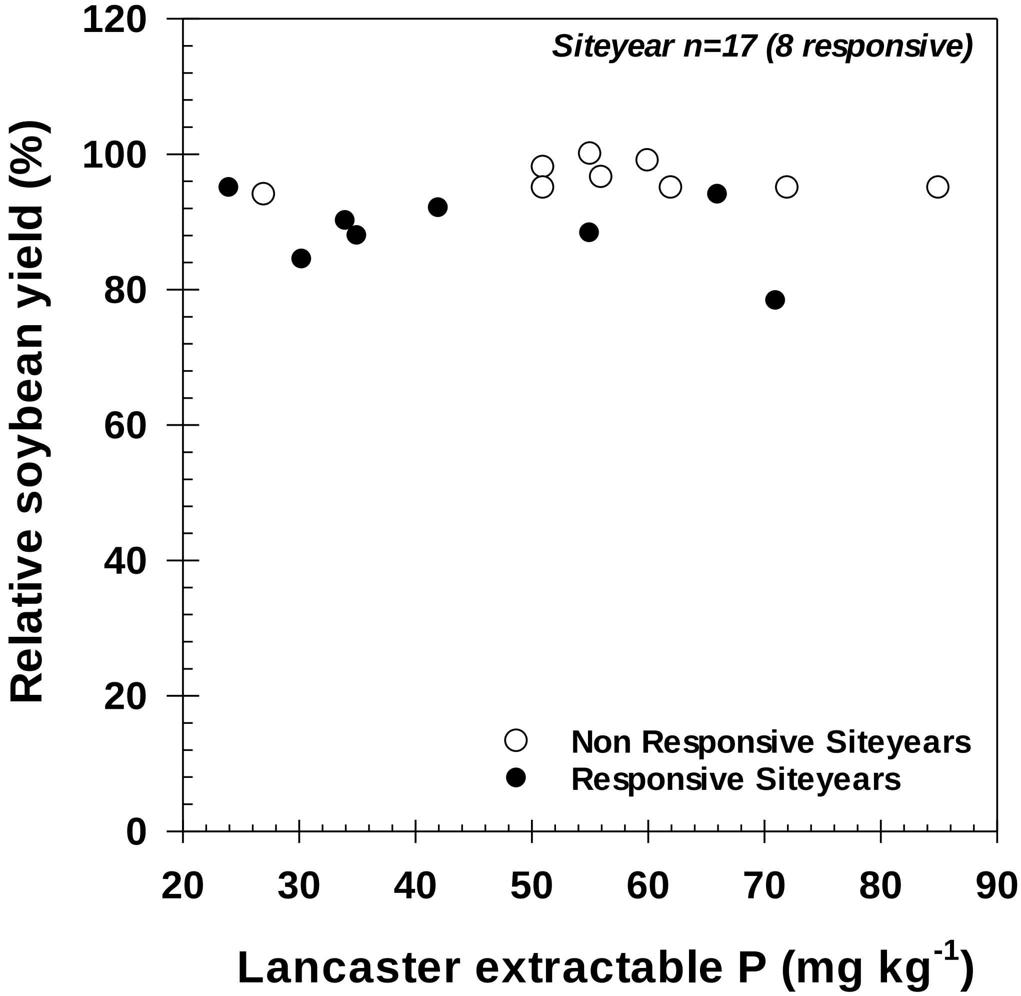

Figure 7. Relationship between Mehlich-3 Extractable P and relative soybean yield. Circles represent the mean (n=5 or 10) soil test value from each untreated control plot and the corresponding relative yield. Black circles represent sites that positively responded to fertilizer at Alpha = 0.10.

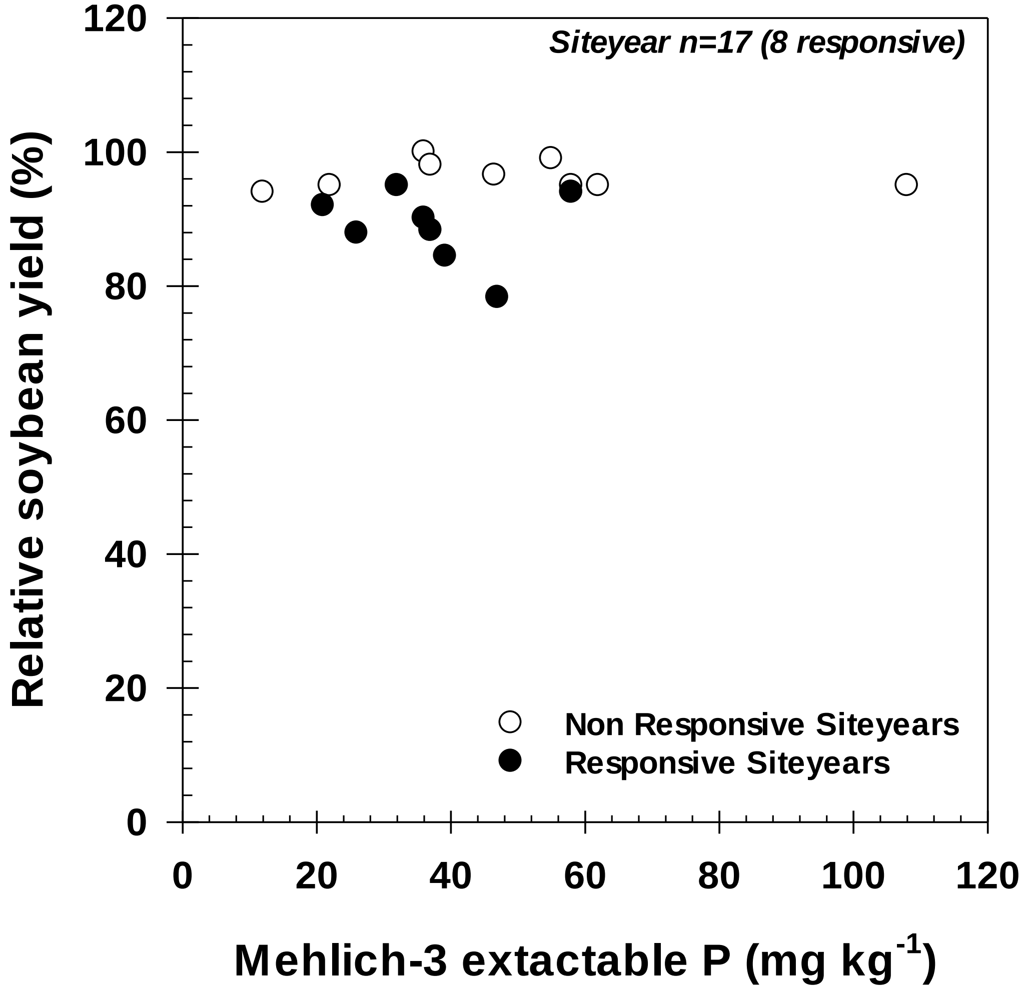

Figure 8. Relationship between Lancaster extractable soil P and Mehlich-3 extractable soil P. Each circle represents soil collected from an untreated control (0 P_2O_5/acre) at research locations throughout MS.