Partners in Progress
SOYBEANS

Soybean Research at OSU 2010

Supported by the

Oklahoma Soybean Board

and the

United Soybean Board

Oklahoma State University
Division of Agricultural Sciences and Natural Resources
Oklahoma Agricultural Experiment Station
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P-1030

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Foreword

This *Partners in Progress—Soybean* publication is the fifth in a series of annual reports from the Oklahoma State University's Division of Agricultural Sciences and Natural Resources summarizing work supported by the Oklahoma Soybean Commission (OSC) and the United Soybean Board (USB).

As partners, we have a history of cooperation that began when the first furrows were turned in Oklahoma soil. This collaboration continues to this day. In keeping with this spirit of cooperation, it is our intention that soybean research be directed as closely as possible to the needs of our state's producers.

Although this report focuses on soybean research progress of the past year, it is the continued support of a project over time that leads to successes such as variety releases and development of new technology.

History has proven that a united effort between soybean producers and Oklahoma Agricultural Experiment Station (OAES) agricultural scientists is beneficial to Oklahoma agriculture. Progress in OAES soybean research means progress for Oklahoma soybean producers.

Clarence Watson, Associate Director
Oklahoma Agricultural Experiment Station
Division of Agricultural Sciences and Natural Resources
Oklahoma State University

Oklahoma State University Division of Agricultural Sciences and Natural Resources Mission Statement

The Mission of the Oklahoma State University Division of Agricultural Sciences and Natural Resources is to discover, develop, disseminate, and preserve knowledge needed to enhance the productivity, profitability, and sustainability of agriculture; conserve and improve natural resources; improve the health and well-being of all segments of our society; and to instill in its students the intellectual curiosity, discernment, knowledge, and skills needed for their individual development and contribution to society.

Research and Producer Partnerships

As the name suggests, the OSB and OSU have enjoyed a partnership designed to help Oklahoma soybean producers to produce at a profit. The Soybean Check Off Board is proud to continue the symbiotic relationship with the researchers at OSU. Research priorities have changed over the course of time, but the partnership has been cultivated to produce the objective data needed by soybean producers to make informed decisions.

The proof is in the production, and soybean production has improved as a direct result of the research projects conducted by the university staff. In addition, the university effectively utilizes their mission of Extension that is a part of the land grant university, to disseminate the research results to the growers. Their use of grower meetings and their involvement in the annual soybean meeting produced by the soybean board has extended the reach of their research results.

With the assistance of the Soybean Check Off monies from the OSB, the university can conduct research that is practical, objective and timely. This productive partnership will continue to benefit an increasing number of Oklahoma soybean farmers.

Rick Reimer, Secretary
Oklahoma Soybean Board

Development of an NIR Calibration Model for Compositional Analysis of Soybean Cultivars

Nurhan T. Dunford
Biosystems and Agricultural Engineering

Chad Godsey
Department of Plant and Soil Sciences

2010 progress made possible through OSB/USB support

- **Thirty soybean samples grown at different locations in Oklahoma were analyzed for their protein, oil, ash and moisture contents using standard wet chemistry protocols.**
- **Protein contents of the samples were high, larger than 37 percent. Soybean cultivars Rev4.5R10MG4.5 and S51-T8MG5 grown in Pauls Valley had the highest oil content, larger than 16 percent, among the samples analyzed.**
- **The soybean compositional data obtained in this study is being used to develop a calibration model for a Near Infrared (NIR) instrument available at OSU. Successful completion of this study will significantly reduce the cost and time (to less than 1 minute per sample) required for soybean compositional analysis.**

Soybean variety enhancement and improvement research requires knowledge of seed chemical composition to verify the effects of agronomic practices on seed composition and quality and variations among genotypes. Although conventional analytical methods are accurate to analyze samples with varying chemical composition, they are cumbersome, time consuming, costly and require use of hazardous chemicals. Because of these reasons, the sample put through an analytical laboratory using wet chemistry techniques is constrained to only a handful of samples per day. Infrared spectroscopy based techniques has been used to replace wet chemistry in quantifying many compositional parameters in crops using a very small sample size (as small as one seed per kernel). A typical NIR spectroscopic analysis requires less than 1 minute. However, NIR measurements are scarcely selective, so wet chemistry must be used to model data (develop calibrations) from which relevant information can be extracted.

Major NIR spectrophotometer manufacturers usually have a calibration for whole soybean analysis. However, the calibration received from the instrument supplier needs to be attuned for each instrument to be used in the laboratory. Furthermore, the number and the chemical composition of the samples used for calibration model development greatly affect the validity of the calibration for the soybean varieties of interest. Hence, the accuracy of the chemical composition data obtained from an NIR spectrophotometer is as good as the calibration model used. The current calibration model used on the NIR instrument available at OSU does not include data from Oklahoma grown soybean samples. Furthermore, the instrument is not tuned for the soybean analysis.

The objective of this study is to standardize the current soybean calibration for the NIR spectrophotometer available at OSU using wet chemistry data obtained from soybean samples collected from OSU soybean variety field trials.

Material and Methods

Thirty samples were collected from OSU soybean variety field trials. These samples were analyzed for their protein, oil, ash, moisture and fatty acid composition using standard wet chemistry protocols. The soybean oil extracted from the samples was analyzed for its palmitic, stearic, oleic, linoleic and linolenic acid content.

Results

Table 1 shows the wet chemistry test results for protein, ash, moisture and oil content of Oklahoma grown soybean cultivars.

Table 1. Chemical composition of soybean varieties grown at different locations in Oklahoma.

*Sample Name**	*Protein (%)*	*Oil (%)*	*Moisture (%)*	*Ash (%)*
24WE	37.62±0.37	12.77±0.05	7.08±0.02	5.26±0.02
35WE	38.28±0.04	14.03±0.25	6.84±0.07	5.43±0.03
16NE	38.98±0.08	13.59±0.02	6.35±0.03	5.32±0.08
24NE	39.41±0.14	14.88±0.15	6.40±0.09	5.78±0.03
24PA	40.10±0.24	13.45±0.15	7.21±0.00	4.92±0.00
35NE	37.43±0.15	14.23±0.17	6.58±0.03	5.34±0.05
2NE	38.96±1.12	13.07±0.08	6.58±0.08	4.80±0.01
35PA	39.16±0.12	14.35±0.52	6.83±0.00	4.85±0.01
42PA	39.34±0.02	15.04±0.37	6.56±0.02	4.89±0.05
16PA	38.61±0.47	14.74±0.03	6.77±0.02	5.11±0.02
15NE	37.82±0.11	14.12±0.02	6.83±0.02	5.06±0.07
42NE	39.14±1.04	13.10±0.06	6.59±0.02	4.77±0.09
42WE	38.25±0.27	15.60±0.52	6.80±0.02	5.44±0.03
2WE	40.02±0.14	15.38±0.48	7.44±0.03	5.39±0.00
15PA	37.68±0.08	16.88±0.27	6.74±0.09	5.11±0.02
16WE	38.76±0.02	14.71±0.13	7.24±0.10	5.33±0.04
2PA	39.50±0.44	16.77±0.40	6.92±0.09	4.85±0.05
15WE	38.50±0.20	15.19±0.37	7.32±0.04	5.46±0.01
2FT	39.28±0.30	15.32±0.10	6.54±0.19	5.57±0.07
15CH	40.44±0.39	13.50±0.19	6.73±0.01	5.05±0.02
16CH	38.29±0.13	14.09±0.12	5.86±0.14	5.22±0.02
35CH	37.56±0.18	14.85±0.10	5.92±0.07	5.01±0.00
2CH	40.29±0.60	13.02±0.14	6.00±0.14	5.14±0.02
24CH	37.74±0.44	13.01±0.13	6.42±0.03	5.42±0.11
42FT	39.99±0.10	13.50±0.00	6.77±0.04	5.47±0.05
16FT	39.69±0.16	13.38±0.14	6.82±0.02	5.37±0.01
42CH	37.12±0.14	13.99±0.05	6.38±0.05	5.06±0.08
24FT	37.96±0.10	12.28±0.01	6.77±0.02	5.61±0.05
15FT	40.12±0.60	14.35±0.14	6.94±0.00	5.56±0.09
35FT	40.78±0.43	12.65±0.22	6.75±0.00	5.08±0.02

* Sample label abbreviations are as follows: 2=Rev4.5R10MG4.5; 15=S51-T8MG5.1; 16= MORSOYRTS4824MG4.8; 24= RC5007SMG5.0; 35=570RRSMG5.7; 42=HBKR5425MG5.4
MG refers to soybean maturity group.
FT=FORT COBB; CH=CHEROKEE; NE=NEWKIRK; PA=PAULS VALLEY; WE=WEBBERS FALLS

Ongoing Work

Currently, fatty acid compositions of oil extracted from soybean samples are being analyzed. After the completion of fatty acid tests, a calibration model will be developed and the NIR instrument will be tuned. Then, the NIR instrument will be ready for analyzing soybean samples from OSU field trials and growers in the state.

Evaluation of Preemergence Herbicides to Improve Weed Control in Soybean

Joe Armstrong
Department of Plant and Soil Sciences

2010 progress made possible through OSB/USB support

- **In no-till trials, preemergence herbicides applied with the burndown treatment improved early-season control of marestail, Palmer amaranth and morningglory compared to using glyphosate + 2,4-D alone for preplant weed control.**
- **In the conventional till trial, several preemergence herbicides provided excellent control of annual grass weeds and Palmer amaranth for at least 35 days after planting.**
- **Preemergence herbicides are important to improve weed control and prevent the development and spread of herbicide-resistant weeds in Oklahoma.**

Introduction

Weed control is a continual issue facing soybean producers in Oklahoma. Evaluation of herbicide options is essential for producers to make informed decisions for weed management in soybean and other crops in rotation. Preemergence herbicides, such as Valor® SX, Prowl H_2O or Canopy, provide a valuable tool for early-season weed control; however, many producers have shifted to using only postemergence applications for weed control in soybean, especially when growing glyphosate-resistant varieties. In no-till production, many producers apply glyphosate and/or 2,4-D as a burndown treatment to control weeds prior to planting, but do not include any additional herbicides to provide residual weed control.

The use of postemergence-only weed control programs presents several potential problems. First, by not using a soil-applied herbicide at planting or included with a burndown treatment, soybean yields may suffer due to early-season weed competition. Preemergence herbicides work through activity in the soil that controls weeds prior to or shortly after their emergence. As a result of improved early-season weed control, preemergence herbicides can also lengthen the window of time during which postemergence applications need to be made to prevent yield loss during the growing season. This cushion can be very important if weather conditions or workload prevent timely application of postemergence treatments. Finally, most producers who use a postemergence-only program are using only a single herbicide (glyphosate) for weed control. To prevent or delay the development of herbicide-resistant weeds, it is necessary to use additional herbicides from other modes of action to diversify the chemical weed control program. The easiest way to include additional herbicides is by using a preemergence herbicide that will provide soil residual weed control during the growing season. Therefore, the objective of these studies was to evaluate several preemergence herbicides for weed control in no-till and conventional till soybean production in Oklahoma.

Materials and Methods

No-till field trials were established near Enid and Vinita during 2010. Burndown and preemergence treatments were applied on April 15, two weeks before planting at the Enid location. At the Vinita location, treatments were applied on April 20, six weeks before planting. All treatments included glyphosate + 2,4-D + ammonium sulfate (AMS) at rates of 32 fl oz + 1 pt + 17 pounds per 100 gal per acre. Marestail and Palmer amaranth were the most prevalent weed species at the Enid location and Palmer amaranth and ivyleaf morningglory were the most prevalent weed species at the Vinita location.

A conventional-till trial also was established near Webbers Falls during 2010. Preemergence treatments were applied on May 28, immediately after planting. Annual grasses (barnyardgrass and large crabgrass) and Palmer amaranth were the most common weed species at this location.

At all trial locations, each treatment was replicated four times and visual estimates of weed control were collected by comparing herbicide treatments to the untreated control at multiple times during the growing season.

Results and Discussion

At the Enid no-till location, all herbicide treatments provided at least 91 percent control of marestail at 28 days after application (Table 2). At 49 days after application, only Valor® XLT, Authority® First, Authority® XL and Boundary® provided greater than 80 percent control of marestail. However, at 49 days after application, all preemergence treatments, with the exception of Prowl® H_2O, provided greater control of marestail than glyphosate + 2,4-D + AMS alone. Additionally, all preemergence treatments provided greater control of Palmer amaranth than glyphosate + 2,4-D + AMS alone at 28 days and 49 days after application.

At the no-till trial near Vinita, all preemergence herbicides provided at least 84 percent control of ivyleaf morningglory at 36 days after application, while glyphosate + 2,4-D + AMS alone provided only 64 percent control (Table 3). At 63 days after application, control of ivyleaf morningglory ranged from 25 percent to 83 percent with preemergence herbicides, while control with glyphosate + 2,4-D + AMS alone was only 25 percent. All preemergence treatments, with the exception of Prowl® H_2O, provided greater control of Palmer amaranth than glyphosate + 2,4-D + AMS alone at 63 days after application.

Preemergence herbicides also provided excellent control of annual grass weeds and Palmer amaranth in the conventional till trial near Webbers Falls. At 20 days after application, all preemergence herbicides provided at least 75 percent control of annual grass weeds and at least 91 percent control of Palmer amaranth (Table 4). Control of annual grass weeds also was excellent for many of the preemergence herbicides at 35 days after application, where all herbicides continued to provide at least 75 percent control of annual grass weeds. Palmer amaranth control decreased for some treatments at 35 days after application and ranged from 51 percent to 99

Table 2. Marestail and Palmer amaranth control 28 days and 49 days after application with various preemergence herbicides at no-till trial near Enid. Burndown and preemergence treatments were applied on April 15, two weeks before planting.

Herbicide treatment	*Rate/A*	*28 days after application*		*49 days after application*	
		Marestail	*Palmer amaranth*	*Marestail*	*Palmer amaranth*
		— — — — — — — % control — — — — — — —			
glyphosate + 2,4-D + ammonium sulfate	32 fl oz + 1 pt + 17 lbs/100 gal	95	74	40	20
+ Valor® XLT[a]	2.5 oz	99	99	83	87
+ Valor® XLT	3.5 oz	99	99	90	96
+ Fierce™[b]	3.0 oz	96	99	70	97
+ Fierce™	3.75 oz	99	99	70	98
+ Authority® MTZ	14 oz	99	99	73	70
+ Authority® First	3.2 oz	99	99	93	80
+ Authority® XL	3.2 oz	99	99	86	84
+ Authority® XL	4.0 oz	99	99	88	95
+ Boundary®	2.5 pt	99	99	99	91
+ Prowl® H_2O	2 pt	80	99	55	86
+ Valor® SX + Prowl H_2O	2 oz + 2 pt	91	99	72	99
Untreated		0	0	0	0
LSD[c]		13	23	19	17

[a] All treatments included glyphosate + 2,4-D + ammonium sulfate at rates of 32 fl oz + 1 pt + 17 pounds per 100 gallons per acre.
[b] Fierce™ is not currently registered for use in Oklahoma. Registration is expected during 2011.
[c] LSD: least significant difference.

percent with preemergence herbicides, indicating that some of the herbicides may provide season-long control of Palmer amaranth. For all treatments that required a postemergence application, glyphosate successfully controlled any weed escapes (data not shown).

Conclusions

Using a preemergence herbicide with the burndown application in no-till soybean, improved early-season control of marestail, Palmer amaranth and ivyleaf morningglory compared with using glyphosate + 2,4-D alone in trials conducted during 2010. Preemergence herbicides also provided excellent early-season control of grass weeds and Palmer amaranth in the conventional till soybean trial. Furthermore, several herbicides provided season-long weed control and did not require postemergence treatments to control weed escapes. Preemergence herbicides will not usually eliminate the need for postemergence applications, but will reduce weed populations present during the growing season and may reduce the number of treatments required for satisfactory weed control. Additionally, the use of preemergence herbicides will improve control popula-

Table 3. Marestail and ivyleaf morningglory control 36 and 63 days after application with various preemergence herbicides at no-till trial near Vinita. Burndown and preemergence treatments were applied on April 20, six weeks before planting.

		36 days after application	*63 days after application*	
Herbicide treatment	*Rate/A*	*Ivyleaf morningglory*	*Ivyleaf morningglory*	*Palmer amaranth*
		——— % control ———		
glyphosate + 2,4-D + ammonium sulfate	32 fl oz + 1 pt + 17 lbs/100 gal	64	25	35
+ Valor® SX[a]	2 oz	85	48	92
+ Valor® XLT	2.5 oz	96	76	87
+ Valor® XLT	3.5 oz	99	66	91
+ Fierce™[b]	3.0 oz	95	61	68
+ Fierce™	3.75 oz	95	43	71
+ Authority® MTZ	14 oz	90	71	66
+ Authority® First	3.2 oz	98	81	75
+ Boundary®	2.5 pt	94	43	72
+ Envive®	3.5 oz	--	83	97
+ Canopy® EX	1.5 oz	97	66	74
+ Prefix™	2 pt	84	25	84
+ Prowl® H_2O	2 pt	84	50	60
Untreated		0	0	0
LSD[c]		18	28	30

[a] All treatments included glyphosate + 2,4-D + ammonium sulfate at rates of 32 fl oz + 1 pt + 17 pounds per 100 gallons per acre.
[b] Fierce™ is not currently registered for use in Oklahoma. Registration is expected during 2011.
[c] LSD: least significant difference.

tions of marestail, Palmer amaranth, or other weeds that are resistant or tolerant to glyphosate. The decision to use a preemergence herbicide should be made based on the weed species present and the size of the weed populations in each individual field.

Evaluations of preemergence herbicides will continue in 2011.

Acknowledgements

Thank you to our cooperators, Linden Baker (Enid), Jay Franklin (Vinita) and Bob Ross (Webbers Falls), for allowing us to conduct these trials in their fields and to the OSB for providing funding to conduct these trials.

Table 4. Annual grass and Palmer amaranth control 20 days after application with various preemergence herbicides at conventional-till trial near Webbers Falls. Preemergence treatments were applied immediately after planting on May 29.

Herbicide treatment	*Rate/A*	*20 days after application*		*35 days after application*	
		Annual grasses	*Palmer amaranth*	*Annual grasses*	*Palmer amaranth*
		——— % control ———			
Valor® SX	2 oz	83	98	80	83
Valor® XLT	2.5 oz	95	99	90	92
Fierce™[a]	3.0 oz	94	99	99	99
Fierce™	3.75 oz	98	99	99	99
Envive®	3.5 oz	95	99	90	94
Prefix™	2 pt	87	97	94	84
Authority® XL	3.2 oz	93	84	87	72
Authority® XL	4.0 oz	91	91	90	72
Authority® MTZ	8 oz	75	91	75	51
Boundary®	2.5 pt	86	98	98	92
Linex® + Dual Magnum®	1 pt + 1.33 pt	96	99	96	86
glyphosate + ammonium sulfate (early POST)[b]	32 fl oz + 17 lbs/100 gal	--	--	99	88
Untreated		0	0	0	0
LSD[c]		18	7	12	16

[a] Fierce™ is not currently registered for use in Oklahoma. Registration is expected during 2011.

[b] Glyphosate + ammonium sulfate was applied as an early postemergence treatment on June 16.

[c] LSD: least significant difference.

Soybean Disease Management

John Damicone, Tyler Pierson and J.J. Stoekel
OSU Department of Entomology and Plant Pathology

2010 progress made possible through OSB/USB support

- **In the absence of soybean rust and frogeye leaf spot, fungicide programs did not increase yield of soybean.**
- **Seed treatments did not increase plant stand or yield at various planting dates under a low-yielding environment in 2010.**
- **In a field infested with soybean cyst nematode, planting a resistant variety increased yield by 18 percent over a susceptible variety.**
- **A seed treatment developed for control of soybean cyst nematode did not increase yields of either a susceptible or resistant soybean variety.**

Foliar Diseases

Soybean rust is a new threat to soybean production in the U.S. Since 2004, rust has been a yearly problem in the southeastern U.S. and was found in Oklahoma each year from 2007 to 2009. However, rust was only a significant problem in 2007, when it was first detected in July. The sentinel plot program and rust monitoring activities by soybean growers and crop advisers in the state have increased the awareness of the presence of other foliar diseases in addition to soybean rust. In Oklahoma, Septoria brown spot is present in most old soybean fields and causes noticeable premature defoliation. Other diseases found in the state include frogeye leaf spot, bacterial blight, Cercospora blight and downy mildew. Frogeye leaf spot is generally accepted to reduce soybean yields when severe.

Fungicides registered for use on soybean to control rust and other foliar diseases include strobilurins (Headline, Quadris) and triazoles (Alto, Domark, Folicur, Laredo, Tilt) and pre-mixtures of triazoles and strobilurins (Quilt, QuadrisXtra, Stratego). All of these fungicides act as protectants and have some degree of systemic activity. Triazoles are being promoted as having excellent activity in situations where rust is already present in the field. Strobilurin fungicides such as Headline are being promoted for plant health benefits that claim increases in yield in the absence of disease.

Fungicide programs recommended for soybean rust were evaluated on the variety AG5605 at the Oklahoma Vegetable Research Station in Bixby and at the Cimarron Valley Research Station in Perkins. Treatments were applied at the R3 (beginning pod) growth stage or at the R3 and R5 (beginning seed) growth stages.

At Bixby, rainfall was 4.71 inches below normal (30-year average) from June through October but was above normal in September during pod fill. Average daily temperature was above normal from June through August and was near normal for September and October. Soybean rust did not develop in this trial, but foliar diseases reached high levels by R7 (beginning maturity). Brown spot was the primary disease, but bacterial blight and Cercospora blight also were present. Disease incidence did not differ among treatments (Table 5). All treatments except Stratego at R3 and Topguard at R3 and R5 reduced defoliation compared to the control. Yields were high compared to previous trials with nonirrigated soybean at this site but did not differ among treatments.

At Perkins, rainfall was 1.23 inches below normal (30-year average) from June through October. Average daily temperature was above normal for June, August and September and near normal for the remainder of the cropping period. The crop was under moderate drought stress during 14-day periods with little or no rain that occurred in each month from June through October. Soybean rust did not develop in this trial and incidence of brown spot was low at the R5 growth stage. Levels of brown spot did not differ among treatments. Yields were average compared to previous trials with nonirrigated soybean and did not differ among treatments.

Table 5. Disease and yield response of soybeans (AG5605) to fungicide programs at the Oklahoma Vegetable Research Station in Bixby.

Treatment and rate/A (timing[z])	*Disease incidence (%)*	*Defoliation (%)*	*Yield (bu/A)*
Check	96.7 a[y]	65.8 a	55.2 a
Headline® 2.08E 6 fl oz (R3)	94.6 a	52.5 bc	51.5 a
Topguard® 1.04F 7 fl oz (R3)	95.4 a	49.2 bc	55.2 a
Stratego 2.08E 8 fl oz (R3)	95.8 a	54.2 abc	62.6 a
Headline® 2.08E 6 fl oz (R3, R5)	95.0 a	47.5 bc	62.3 a
Headline® 2.08E 6 fl oz (R3) Topguard® 1.04F 7 fl oz (R5)	88.3 a	43.3 c	57.5 a
Topguard® 1.04F 7 fl oz (R3, R5)	98.3 a	56.2 ab	55.7 a
Domark® 230ME 4 fl oz (R3, R5)	95.0 a	49.2 bc	52.8 a
Stratego 2.08E 8 fl oz (R3, R5)	93.7 a	42.5 c	62.1 a
Quadris® Xtra 2.34F 5 fl oz (R3)	87.9 a	46.7 bc	59.6 a
LSD P=0.05[x]	NS[w]	12.2	NS

z Application timing was at growth stage R3 on Aug. 18 and R5 on Sept. 7.
y Values in a column followed by the same letter are not significantly different at P=0.05.
x Fisher's least significant difference.
w Treatment effect not significant at P=0.05.

Table 6. Disease and yield response of soybean (AG5605) to fungicide programs at the Cimarron Valley Research Station in Perkins.

Treatment and rate/A (timing[z])	*Brown spot (%)*	*Yield (bu/A)*
Check	3.7 a[y]	37.8 a
Headline® 2.08E 6 fl oz (R3)	5.8 a	38.3 a
Topguard® 1.04F 7 fl oz (R3)	2.9 a	40.5 a
Stratego 2.08E 8 fl oz (R3)	4.6 a	35.0 a
Headline® 2.08E 6 fl oz (R3, R5)	3.7 a	40.6 a
Headline® 2.08E 6 fl oz (R3) Topguard® 1.04F 7 fl oz (R5)	5.8 a	40.9 a
Topguard® 1.04F 7 fl oz (R3, R5)	6.2 a	41.1 a
Domark® 230ME 4 fl oz (R3, R5)	5.4 a	37.1 a
Stratego 2.08E 8 fl oz (R3, R5)	5.0 a	38.7 a
Quadris® Xtra 2.34F 5 fl oz (R3)	2.9 a	37.3 a
LSD P=0.05[x]	NS[w]	NS

[z] Application timing was at growth stage R3 on Aug. 20 and R5 on Sept. 7.
[y] Values in a column followed by the same letter are not significantly different at P=0.05.
[x] Fisher's least significant difference.
[w] Treatment effect not significant at P=0.05.

Fungicide programs did not provide statistically significant yield increases in either trial. Results in 2010 were similar to those observed in previous years where soybean rust and frogeye leaf spot were not problems. Increases in yield from plant health benefits also do not appear to be consistent and warrant fungicide use for this purpose.

Seedling Diseases and Stand Establishment

Soybean and wheat are about the only crops grown that do not normally include seed treatment with fungicide to control seedling disease (seed rot and damping off). Recent observations are that stand establishment is a problem in many soybean fields. In particular, stands appear to be more erratic in the production of full-season soybean planted in June and July. Seedling diseases caused by the fungi *Fusarium*, *Rhizoctonia* and *Pythium* may be involved in stand establishment when conditions are not ideal for germination and emergence. There are species of *Pythium* that are most damaging at high soil temperatures. The evaluation of seed treatments at various planting dates may provide growers useful information for maximizing stand establishment and yield potential.

Stand establishment and yield responses from seed treatments were evaluated at various planting dates at the Cimarron Valley Research Station in Perkins. Seed treatments included an old broad-spectrum protectant fungicide (Thiram 42S), a new protectant + systemic fungicide (Trilex® 2000), and a combination of Trilex® 2000 and a systemic insecticide (Gaucho) control of insects such as the threecornered alfalfa hopper. The three treatments (old fungicide, new fungicide and new fungicide + insecticide) were compared to untreated seed planted in replicated plots in April, May, June and July. The variety AG3101 was planted on April 27 and the variety Stine 5482-4 was planted on the remaining planting dates from May 10 to July 14 at a rate of 8.6 seeds per foot on a 36-inch row spacing with a vacuum planter. Stand counts were made from 14 days to 21 days after each planting date. AG3101 was harvested on Sept. 3, and Stine 5482-4 was harvested on Nov. 4.

Rainfall was above normal (30-year average) from May through July but was below normal from August through October. Average daily temperature was above normal each month except May, which was below normal, and July, which was near normal. The crop was under moderate drought stress during 14-day periods with little or no rain that occurred in each month from June through October. Planting date effects were significant for stand establishment and yield. Emergence was more than 50 percent for all planting dates except May 10 and June 11 (Table 7). Yields also differed among planting dates and was correlated with stand counts (r=0.47, P<0.01). Yields were highest for planting dates with emergence exceeding 50 percent and were lowest for the May 10 and June 11 planting dates when emergence was poor (Table 8). The effect of seed treatment was not significant for either stand count (Table 7) or yield (Table 8). Yields were generally poor and plots of Stine 5482-4 never properly matured and retained green foliage at harvest.

Table 7. Soybean stand establishment in response to planting date and seed treatment.

Treatment and rate/cwt seed	*Planting date* Apr 27	May 10	May 27	Jun 11	Jul 14	average[z]
			Stand (plants/ft)			
Check	7.2	3.1	5.2	2.0	4.6	4.4 a[y]
Thiram 42S 2 fl oz	7.2	3.0	5.3	4.0	4.7	4.9 a
Trilex® 2000 1 fl oz	7.3	4.3	5.1	3.1	5.1	5.0 a
Trilex® 2000 1 fl oz + Gaucho® 1.6 fl oz	6.9	3.6	5.2	1.3	5.0	4.4 a
average[x]	7.2 a[y]	3.5 c	5.2 b	2.6 d	4.8 b	
Treatment LSD P=0.05[w]						NS[u]
Planting date LSD P=0.05						2.8

[z] Averaged over planting dates.
[y] Values in a column or row followed by the same letter are not significantly different at P=0.05.
[x] Averaged over treatment.
[w] Fisher's least significant difference.

Table 8. Soybean yield response to planting date and seed treatment.

Treatment and rate/cwt seed	Planting date Apr 27	May 10	May 27	Jun 11	Jul 14	average[z]
	Yield (bu/A)					
Check	22.1	6.6	15.0	13.0	18.8	15.1 a[y]
Thiram 42S 2 fl oz	20.0	6.2	14.6	11.4	15.3	13.5 a
Trilex® 2000 1 fl oz	19.2	8.1	15.2	13.6	17.0	14.6 a
Trilex® 2000 1 fl oz + Gaucho® 1.6 fl oz	20.0	6.3	17.8	12.1	19.4	15.1 a
average[x]	20.3 a[y]	6.8 d	15.7 b	12.5 c	17.6 b	
Treatment LSD P=0.05[w]						NS
Planting date LSD P=0.05						2.2

[z] Averaged over planting dates.
[y] Values in a column or row followed by the same letter are not significantly different at P=0.05.
[x] Averaged over treatment.
[w] Fisher's least significant difference.

Table 9. Response of soybean cyst nematode susceptible and resistant soybean cultivars to seed treatments for control of soybean cyst nematode.

Treatment and rate/cwt seed	SCN (no. eggs per 100 cc soil) 5400-4 (S)[z]	5420-4 (R)[y]	average[x]	Yield (bu/A) 5400-4 (S)	5420-4 (R)	average[x]
Check	676	1062	869 a[w]	33.0	41.8	37.4 a
Trilex® 2000 1 fl oz	317	612	465 a	35.0	39.7	37.4 a
Trilex® 2000 1 fl oz + Poncho Votivo 2 fl oz	304	748	526 a	35.0	40.1	37.5 a
average[v]	432 a[w]	808 a		34.4 b	40.5 a	
Treatment LSD P=0.05[u]			NS[t]			NS
Variety LSD P=0.05			NS			2.8

[z] S=susceptible to SCN.
[y] R=resistant to SCN
[x] Averaged over variety.
[w] Values in a column or row followed by the same letter are not significantly different at P=0.05.
[v] Averaged over treatment.
[u] Fisher's least significant difference.
[t] Treatment effect not significant at P=0.05.

Soybean Cyst Nematode

The soybean cyst nematode (SCN) is the most serious soybean pest in the U.S. While soybeans can be produced in SCN-infested fields, up to 30 percent yield losses can occur without obvious symptoms. Therefore, farmers usually do not know that their fields are infested with SCN. SCN is known to occur in 19 counties in Oklahoma.

In 2010, a trial was established in an SCN infested field at the Oklahoma Vegetable Research Station in Bixby evaluating resistant varieties and a new seed treatment (Poncho Votivo). Resistant (Stine 5420-4) and susceptible (Stine 5400-4) varieties were compared for response to a seed treatment (Poncho Votivo) for control of SCN in an infested field. Seed treatments were applied using a rotary drum in a total slurry volume of 8 oz per 100 pounds of seed. The experimental design was a split plot with seed treatment as the whole plot and variety as the sub plot. Soil samples (8 cores to 10 cores from the root zone of each sub plot) were taken after harvest. SCN eggs were extracted, stained and counted.

Rainfall was 4.71 inches below normal (30-year average) from June through October but was above normal in September during pod fill. Average daily temperature was above normal from June through August and was near normal for September and October. SCN egg counts were highly variable (cv=111) and did not differ among treatments or among the resistant and susceptible varieties (Table 9). Levels of SCN were not correlated with yield, which was average compared to previous dryland soybean trials at this site. Yields did not differ among seed treatments. However, yield for the resistant variety (Stine 5420-4) was greater than for the susceptible variety by an average of 6 bushels per acre.

Using Glycerol, a Byproduct of Biodiesel Creation from Soybean, to Increase the Energy Recovery from Anaerobic Digesters

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2010 progress made possible through OSB/USB support

- **When added to swine manure at ratios as low as 1:100, glycerol derived from biodiesel production can triple biogas production in anaerobic digesters.**
- **The simplest method of addition, mixing with manure prior to feeding, appears to be the most effective method of adding glycerol to digesters.**

The purpose of this project is to investigate the use of a high energy waste product, glycerol, to increase the electrical power output of farm anaerobic digester-generator sets. Using swine manure alone, anaerobic digestion rarely produces enough power to offset farm consumption—even when using a high rate digestion system such as an Anaerobic Sequencing Batch Reactor (ASBR). Glycerol has the potential to be the primary source of organic matter (and therefore, energy) driving the process. Swine manure serves as a source of microbial inoculants, essential nutrients and alkalinity to maintain steady ASBR performance.

Methods and Materials

Glycerol was donated by Murray Thibodeaux, a dealer for FUELmeister biodiesel equipment in Tulsa. Thibodeaux is a small-scale producer of biodiesel. His main source of raw materials is waste grease from fast food restaurants.

Three, 18-liter reactors were built using material purchased through another source. All three reactors began operating on a swine-manure-only diet at organic loading rates of 1.4 g VS/l-day (1.7 g COD/l-day). Biogas production and pH were monitored to determine when all three reactors had reached stable operation. On October 29, two reactors were converted to Treatment 1 and Treatment 2.

Treatment 1: Increased Organic Loading

Glycerol was mixed with manure in the reactor's daily feed. The amount of glycerol added was increased on a weekly basis starting at a rate of 14 ml of glycerol per day, or 1.0 g COD/l-day from glycerol. This, added to 1.7 g COD/l-day from swine manure, gave an initial combined loading rate of 2.7 g COD/l-day. Combined loading rates for the control and treatment reactors are given in Figure 1. Glycerol was steadily increased until combined loading rate on the treatment reactor reached 4.8 g COD/l-day on Nov. 11, 2010. At that time, biogas production began to decline and effluent organic matter concentration began to increase for the treatment reactor. Glycerol was decreased until operation began to stabilize at a combined organic matter loading rate of 3.8 g COD/l-day on Dec. 6, 2010. Increasing loading rates will begin at smaller increments until another point of decline in biogas production occurs.

Cumulative biogas production from both treatment and control reactors is given in Figure 2. Both overall production and rate of production (slope of lines) has increased with addition of glycerol. These are encouraging results. For instance, on November 11, combined loading rate on the treatment reactor was slightly less than twice that of the control reactor (4.8 vs 2.5 g COD/l-day), but gas production was nearly three times greater than the control (18 vs 6.3 liters of biogas per day).

Treatment 2: Glycerol Injection during React Phase

A single injection of 36 ml glycerol (2.8 g glycerol COD/l-day, 4.5 g combined COD/l-day) was made into the second treatment reactor on Oct.29, 2010. Gas production immediately dropped, and pH plummeted. The reactor has yet to return to stable operation. This is not totally unexpected, seeing how the loading rate is close to the first indication of glycerol toxicity in the stepped increase experiment (4.8 g COD/l-day). Once the reactor recovers, daily injections will begin at a much lower rate and will slowly increase the daily volume of glycerol introduced.

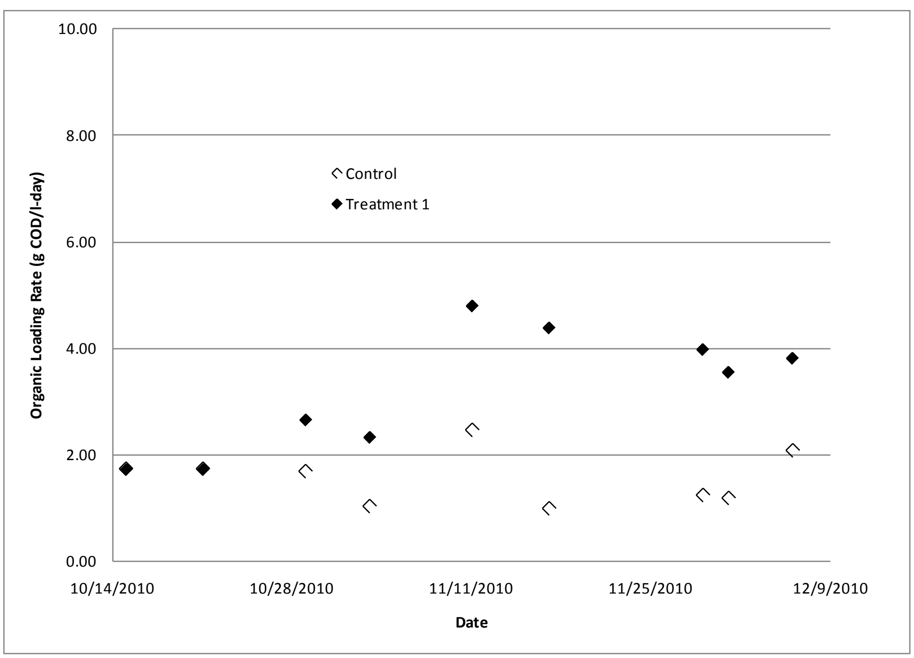

Figure 1. Combined (manure plus glycerol) organic matter loading rate on control and Treatment 1 reactors.

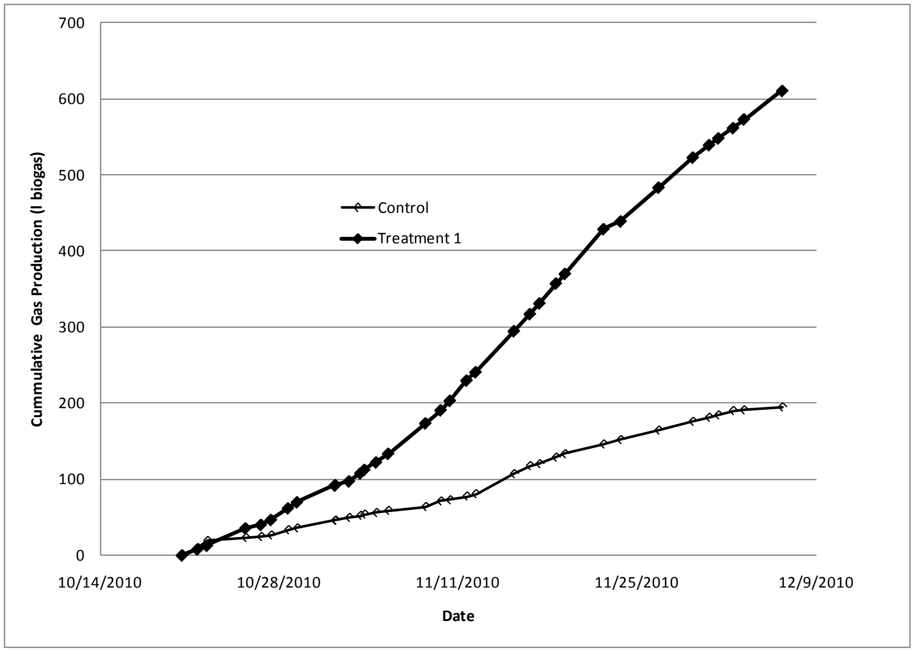

Figure 2. Cumulative biogas production from control and Treatment 1 reactors.

The Potential for more Intensive Management Strategies in Soybean – Management Zone and Grid Soil Sampling

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2010 progress made possible through OSB/USB support

- **Most fields sampled had a lot of variability in pH and phosphorus.**
- **In most fields in Oklahoma, variable rate technology would place lime and nutrients where they are needed the most.**
- **Electrical conductivity was not well correlated to yield in 2010.**

Introduction

Precision agriculture technologies related to crop production have had a slow adoption rate in Oklahoma. Many Oklahoma producers recognize the role of these technologies in the Midwestern corn and soybean belt but are concerned about their economic feasibility in this state. Automated or embedded technologies such as guidance systems and swath control are being adopted faster than management technologies such as yield monitors and variable rate controllers. It is easy for producers to get confused and discouraged with the enormous amount of data that can be collected. One challenge using data management technologies is the lack of a purpose for the data. One viable use of the data is to conduct on-farm research to assist farm management decisions.

On-farm research has always been utilized to some extent, but results have often been influenced by unnoticeable circumstances. This may lead producers to make quick judgments as to the outcome of on-farm trials without seeing true differences. On the other hand, researchers may be limited by making blanket recommendations based on a few small plot trial locations. However, if some of the causes of variability are measured or accounted for, the on-farm results may be more meaningful. A team based approach makes sense for determining site-specific recommendations for specific areas of Oklahoma. One potential area for this targeted research is intensive management practices such as foliar nitrogen (N) or fungicides on soybean.

The objective of this project is to demonstrate various precision ag technologies as they relate to soybean production on partnering farmers' fields and to identify economical intensive management strategies that make use of these technologies.

Methods

Five soybean fields near Hobart, Miami, Ponca City, Red Rock and Webbers Falls were identified for the study. Researchers collected all historical data that the producer partner had previously collected. Very little yield history was available due to the lack of yield monitors on combines. Data collected included soil electrical conductivity, centimeter level elevation and grid soil samples. Fields were sampled on a 2.5 acre grid. Soil samples were analyzed for pH, plant available N, phosphorus (P) and potassium (K), organic matter and micronutrients. Soil pH and nutrient maps will be generated based on grid soil sampling. Fields will be evaluated for potential variable rate application of lime, P and / or K fertilizers. Data collected in 2010 will be used to base variable rate treatments in following years.

Due to timing of funding, the only on-farm trial put out to evaluate the potential use of variable rate technology was at Miami. At this location we placed a P, K and a P+K rich strip in the field. These strips were placed to pass through low, medium and high soil test levels for each nutrient. Application rates of 60 pounds of P_2O_5 per acre and 80 pounds of K_2O per acre were used (Figure 3). These rates corresponded to the recommendations from the lowest P and K testing areas of the field.

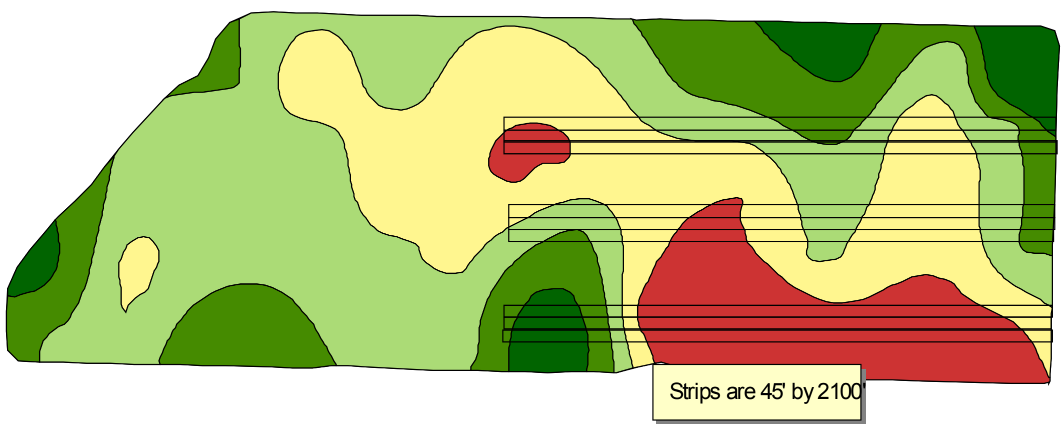

Figure 3. Phosphorus, potassium, and phosphorus + potassium rich strips across the Ottawa County soybean field.

Results

There were multiple lessons that could be learned from the Partners in Research Precision Ag Demonstration Fields project. Two great points taken from this project are 1: treating field variability can be economical; and 2: there are seldom relationships between two nutrients or soil properties. To illustrate the potential for variable rate technology and the possibility for more intensive management, each field should be examined.

Ottawa County Field

In the 109-acre field located in Ottawa County, variability in soil test values were observed (Table 10). Soil pH ranged from 5.2 to 7.5, soil test P ranged from 9 pounds to 61 pounds of P per acre, and soil test K ranged from 78 pounds to 138 pounds of potassium per acre. In the case of pH, only 44 percent of the field requires lime application. Of the area that requires lime, the recommendation ranges from 1,000 pounds to 2,400 pounds per acre. Phosphorus recommendations range from 0 to 50 pounds of P_2O_5 per acre. If P was applied based on the field average of 32 pounds of P_2O_5 per acre, 41 percent of the field would receive an amount of P lower than what is recommended based on the grid soil sampling (Table 10). Potassium fertilizer recommendations range from 38 pounds to 50 pounds of K_2O per acre, which is not a big range. However, it is important to note that the entire field is deficient in K, and if fertilizer was applied based on the field average of 45 pounds of K_2O per acre, then 13 percent of the field has a greater chance of limiting yield potential due to K deficiency.

Table 10. Soil test P and potassium from a soybean field in Ottawa County.

	P		*K*	
	Soil Test	*P_2O_5 Rec.*	*Soil Test*	*K_2O Rec.*
	- - - - - lbs/A - - - - -		- - - - - lbs/A - - - - -	
Field Average	27	32	107	45
Range of Soil test	9 - 61	0 - 50	78 - 138	38 - 50
	% of field	P_2O_5 Rec.	% of field	K_2O Re.
Lowest soil test value	13	50	13	50
	28	40	31	45
	37	32	21	43
	16	25	20	42
Highest soil test value	5	0	14	38
% of field under field avg.	41		13	
% correct	37		31	
% of field over field avg.	21		55	

Yield data was collected by the producer using a yield monitor. Average yield was determined for 30 feet by 60 feet grids (Figure 4). This enabled us to make paired comparisons between the fertilizer rich strips and the farmer practice. When evaluating the data, a significant yield response was observed with the addition of P fertilizer in the lower testing P areas of the field. All other nutrient rich strips did not increase yield compared to the farmer practice. The overall lack of response to P and K, with the exception of extremely low soil test P areas (STP < 30), may have been a result of the slightly below average yield for the year due to environmental stresses. The response in the low testing P areas provides an argument for variable rate P application, targeting P to the areas that need it the most.

Figure 6 illustrates the weak relationship between yield and electrical conductivity (EC) at Ottawa County. Typically, the higher EC values would indicate higher amounts of clay in the soil and this means more water holding capacity. Therefore, you would expect higher yield in heavier textured soils, especially in a year like 2010. Caution should be used when using EC to delineate management zones. Sometimes EC may not correlate well with yield. In these instances, grid soil sampling is your best option.

Noble County Field

In the 125-acre field located in Noble County, variability in soil test values were observed (Table 11). Soil pH ranged from 5.2 to 6.0 and soil test P ranged from 15 pounds to 51 pounds of P per acre. Of the area that requires lime, the recommendation ranges from 1,400 pounds to 5,000 pounds per acre. Phosphorus recommendations range from 10 pounds to 50 pounds of P_2O_5 per acre. If P was applied based on the field average of 30 pounds of P_2O_5 per acre, 51 percent of the field would receive an amount of P lower than what is recommended based on the grid soil sampling (Table 11). Yield data was not collected on this field due to extremely low yields.

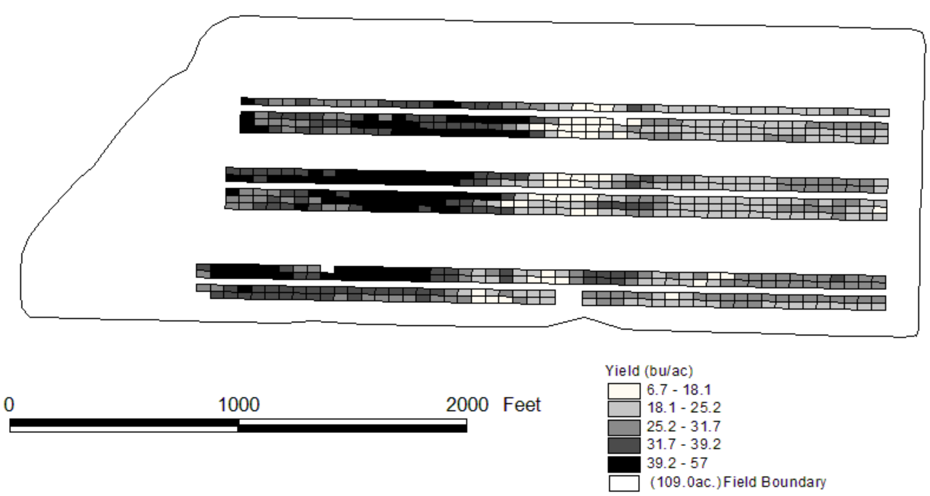

Figure 4. Yield analysis for phosphorus, potassium and farmer practice strips in Ottawa County in 2010.

Figure 5. Soybean yield along the farmer practice and phosphorus rich strips.

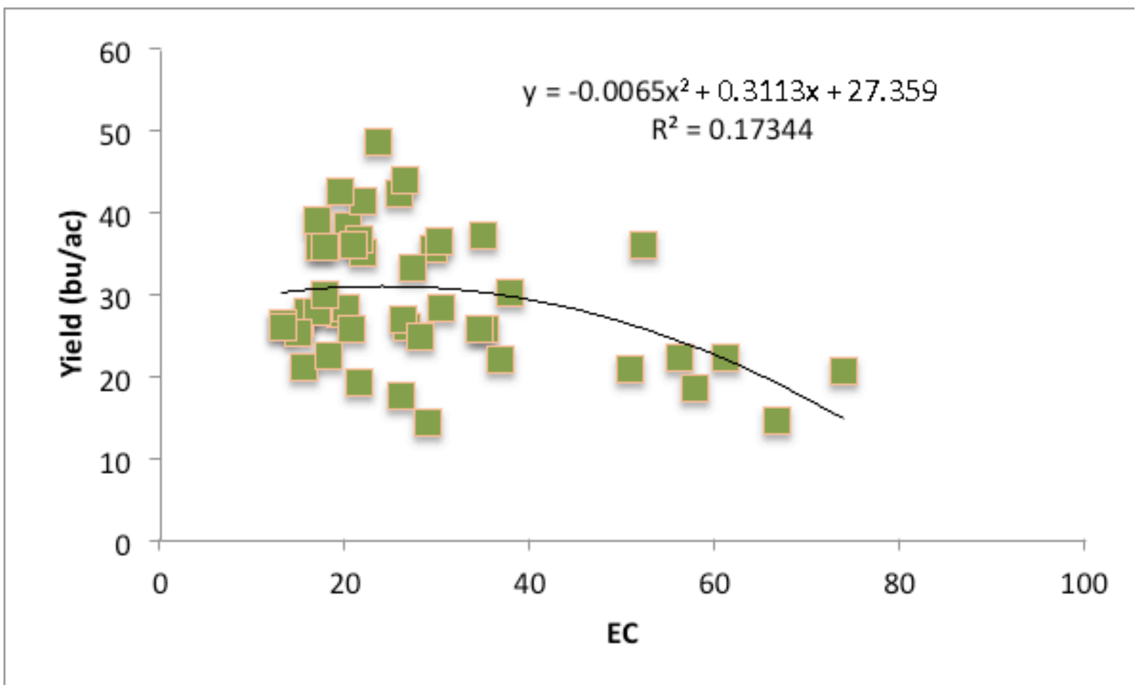

Figure 6. Yield versus electrical conductivity for the Ottawa County field.

Table 11. Soil test P, potassium and buffer index from a soybean field in Noble County.

	BI		P		K	
	Soil test	Lime rec	Soil Test	P_2O_5 rec	Soil Test	K_2O rec
	- - - - lbs/A - - - -		- - - - - lbs/A - - - - -		- - - - lbs/A - - - -	
Field Average	6.9	2,000	30	30	374	0
Range of Soil test	6.3 - 7.1	1,400 - 5,000	15 - 51	10 - 50	281 - 533	0
	% of field	Lime rec	% of field	P_2O_5 rec	% of field	K_2O rec
Lowest soil test value	5	5,000	16	50	21	0
	5	2,800	35	35	35	0
	18	2,400	27	30	20	0
	53	2,000	16	25	16	0
Highest soil test value	19	1,400	6	10	8	0
% under	26.5		51		0	
% correct	51		27		0	
% over	18		22		0	

Table 12. Soil test phosphorus and buffer index from a soybean field in Kay County.

	BI		*P*	
	Soil test	*Lime rec*	*Soil Test*	*P_2O_5 rec*
	- - - - - lbs/A - - - - -		- - - - - lbs/A - - - - -	
Field Average	6.8	2,400	41	20
Range of Soil test	6.5 - 7.1	1,400 - 3,800	10 - 204	0 - 50
	% of field	Lime rec	% of field	P_2O_5 rec
Lowest soil test value	13	3,800	3	50
	18	2,800	32	35
	27	2,400	34	25
	23	2,000	13	10
Highest soil test value	19	1,400	17	0
% under	31		70	
% correct	27		0	
% over	42		30	

Kay County Field

In the 145-acre field located in Kay County, variability in soil test values were observed (Table 12). Soil pH ranged from 5.0 to 7.5 and soil test P ranged from 10 pounds to 204 pounds of P per acre. Of the area that requires lime, the recommendation ranges from 1,400 pounds to 3,800 pounds per acre. Phosphorus recommendations range from 0 to 50 pounds of P_2O_5 per acre. If P was applied based on the field average of 30 pounds of P_2O_5 per acre, 70 percent of the field would receive an amount of P lower than what is recommended based on the grid soil sampling (Table 12).

Yield data collected with the producers yield monitor revealed that yield

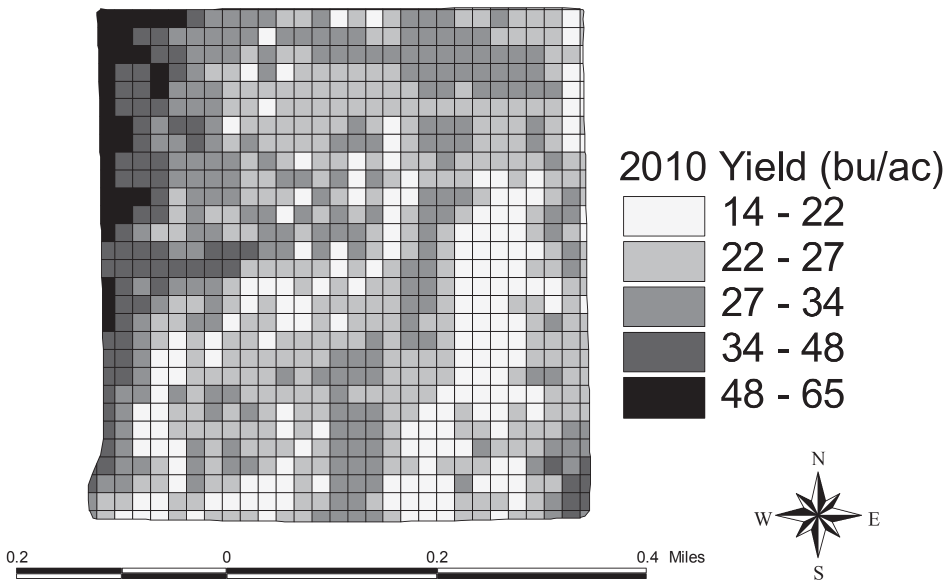

Figure 7. Soybean yield for the soybean field in Kay County.

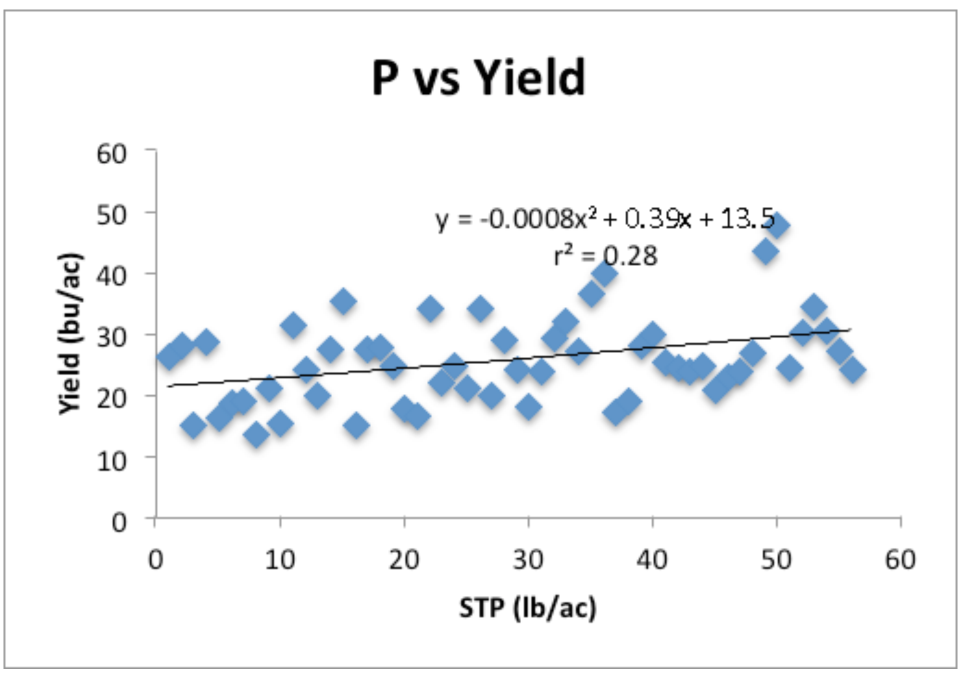

Figure 8. Soybean yield versus soil test P at Kay County.

was highly variable, ranging from 14 bushels to 65 bushels per acre (Figure 7). Yield appeared to be correlated with soil test P (Figure 8), as soil test P increased so did yield.

Muskogee County Field

The field sampled in Muskogee County resulted in very little variability (data not shown). No nutrient deficiencies were detected in the soil samples and elevation did not differ more than 5 meters across the entire field.

Summary

If researchers discuss the use of variable rate technologies (VRT), they can look at all four locations and see that the Muskogee County location VRT would not be economical as there are no nutrient deficiencies and very little variation across nutrient levels. However, at the other three locations, one could make the argument that VRT is economical. Take the Kay County location for example; the field average buffer index (index that determines lime rate) is 6.8. If this field were sampled as a composite, the soils lab would have recommended 1.2 ton of Effective Calcium Carbonate Equivalent (EECE) lime per acre. However, if the results from the grid of the soil sampling exercise are observed, it can be seen that of the 56 samples there were only a few that fell into that category.

The second noteworthy observation comes from looking at the correlation of the independent nutrients and other soil characteristics such as soil EC and slope. At each location there may be similarities between two or three such as slope, EC and buffer index. However, these correlations do not hold up from one field to the next. The greatest take home is that in most cases, a single nutrient or soil property cannot be used to describe the variability of others. Although EC was not discussed much, EC was not well correlated with yield data that was collected in 2010.

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RESEARCH