Project Number: (20-104-P) Final Report

Total 2020 Funds Granted: $36,900

Area: Agronomy

Project Areas: (1) GoBeans on-farm ($3,000)
(2) Cultural Practices for Optimizing Soybean Yield ($6,500)
(3) Fertility Evaluations for Optimizing Soybean Yield ($27,400)

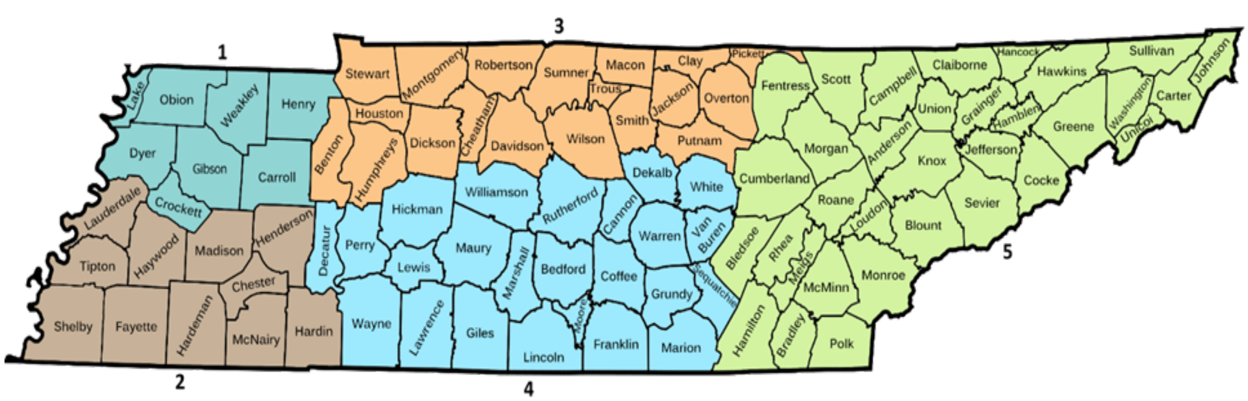
Due to 2020 funding cuts, less work was conducted under the GoBeans area in order to retain budget for Cultural practices and Fertility evaluations.

Project Area 1: GoBeans--A Soybean Verification Program for Tennessee

The GoBeans verification program allows producers to test university research and recommendations in an on-farm setting. During 2020, we collected data as part of the Top Bean high yield contest to recognize high yield soybean producers across the state of Tennessee.

Top Bean Soybean Yield Contest

The purpose of the Top Bean Tennessee Soybean Yield Contest is to recognize those producers in five contest districts who grow high-yielding soybeans, and to gather data on the production practices utilized by these outstanding producers in order to promote the use of sound cultural practices to increase soybean profitability. Sixty-two producers entered the 2020 contest, 32 contest fields were cut, and 22 completed contests were received. Mr. Justin Woodall (Grundy county) was the state Irrigated contest winner at 102. 59 bushels, and Mr. Josh Watson (Loudon county) was state Dryland contest winner at 92.54 bushels. District winners and their county representation are included in the table following:



Contest District	District Winners and Counties		District Winners and Counties	
	1st place Dryland	2nd place Dryland	Irrigated 1st Place	Irrigated 2nd place
Northwest TN	Kenneth Moore (92.11 bu) Weakley county	Kenneth Barnes (89.19 bu) Obion county	Keith Fowler (82.52 bu) Weakley county	Larry Fowler (80.22 bu) Weakley county
Southwest TN	Matt & Kelly Griggs (81.64 bu) Madison county	Wesley Evans (75.56 bu) Haywood county	Keith Sullivan (78.49 bu) Haywood county	
Northcentral TN	John Russell (75.34 bu) Macon county	Ben Wilson (46.94 bu) Benton county	No entries	
Southcentral TN	Justin Woodall (90.43 bu) Grundy county	Mark Davis (90.35) White county	Justin Woodall (102.59 bu) Grundy county	
East TN	Josh Watson (92.54 bu) Loudon county	David & Jacob Richesin (75.37 bu) Rhea county	No entries	

Project Area 2: Cultural Practices for Optimizing Soybean Yields

Cultural practices can influence soybean yield and profitability. In 2020, our focus was on completing a multi-year planting date and maturity group study to identify a) best maturity group fit for early, optimal or late planting, b) best time to plant by maturity group, and c) impact of planting date on soybean development and seed quality in a dryland environment.

In 2020, a break in cold wet weather allowed for an April planting opportunity, however, continued rains during May interfered with late May planting. Milan received excellent rain in June, July and August. A Wintersteiger cone planter planted all plots (4 rows wide by 30 ft) on 30" rows with each treatment replicated 4 times. Weed control, insects and diseases were managed using UT recommended practices.

This study included 32 total treatments:

- Four maturity groups (MG) : Late 2, Late 3, Late 4, Early 5 with 2 varieties per maturity group from commercially available seed
- Four 2020 plant dates: April 22, May 11, June 4, June 18
- During the season data such as flowering and development notes, stand counts and end of season plant height, node, pod, seed weight, seed oil and protein and yield were collected.

2020 Results Dryland Maturity Group x Plant Date:

Weather patterns at Milan REC were wet and cold into May, warm mid-season with excellent rainfall, with a wet fall.

- Optimal Time to Plant each MG: MG 2 and MG 3 varieties yielded best planted in early May followed by late April. MG 4 and MG 5 varieties yielded best planted at any date before late June.
- Optimal MG choice for Plant Date: For early planting into cold, wet conditions MG4 and MG 5 varieties yielded best, probably due to higher pod load compared to MG 2 and 3 varieties. All MG yielded well at optimal planting time of early May. Since Milan received excellent rainfall during the growing season (similar to irrigated conditions), MG 3, 4 and 5 were good choices for June planting, setting similar pod numbers.
- Soybean seed size: Over all maturities, there was a trend for June planted soybeans to produce larger/heavier seed.
- Seed Protein and Oil: When seed percent protein and oil were measured, we noted very uniform, higher seed protein levels with late April planting, and slightly lower seed protein with June planting, particularly for MG 5 varieties. Seed oil content did not appear to be affected by planting date.
- Our intent is to summarize across our 4 year dataset and use this information to update the Tennessee Soybean Quick Facts publication, create a new Extension soybean publication, include in presentations for 2021 winter producer meetings and as part of virtual grain conference.
- The multi-year support of the TSPB for this project is gratefully acknowledged.

Project Area 3: Fertility Practices for Optimizing Soybean Yields

Three studies were conducted to determine impact of broiler litter to yield of soybeans 1) from prior applications to corn, 2) applied directly to soybeans, and 3) the liming effect of poulty litter in soybean production. Poultry litter, commercial fertilizer, and/or lime were hand spread at planting to simulate mechanical application into no-till systems, therefore these materials were not incorporated in any of the studies.

Study 1: Rotational Benefit to Soybean of Corn-applied litter (project led by and summary written by Dr Shawn Hawkins)

This study examines soybean produced in rotation with corn, wherein the prior year corn crop had been fertilized with different rates of poultry litter. The plots included four replicates of six treatments at two University of Tennessee Research and Education Centers at Milan and Spring Hill, TN:

Milan	Spring Hill
1. Negative Control	1. Negative Control
2. Positive Control	2. Positive Control
3. 2-tons broiler litter/acre	3. 2-tons broiler litter/acre
4. 3-tons broiler litter/acre	4. 3-tons broiler litter/acre
5. 4-tons broiler litter/acre	5. 4-tons broiler litter/acre
6. 7-tons broiler litter/acre	6. 5-tons broiler litter/acre

Positive control plots received nitrogen, phosphorus and potassium commercial fertilizers per soil test recommendations in corn and phosphorus and potassium in soybean, while negative controls received phosphorus and potassium in corn but no nitrogen fertilizer and no fertilizer in soybean. At Milan, sulfur (12 lbs/ac) was added to the positive and negative control treatments to produce the corn and positive control only treatment for the rotational soybean crop. For the prior year corn crop, split nitrogen application rates were used at UT Extension recommended application rates (210 lbs-N/ac at Milan; 180 lbs-N/ac at Spring Hill) for the positive control; the negative controls plots did not receive any supplemental nitrogen. Treatments that received litter did not receive any chemical nitrogen or P, K or S fertilizers for either crop. None of the plots received nitrogen to produce soybean.

At planting, **soil minerals analyses** were conducted to determine whether mineral nutrients were enriched in the soils are a result of the litter applications. Also at planting, **soil nitrate tests** were conducted to determine whether carryover nitrogen was present as a result of the prior year litter applications. Soybean trifoliate leaf samples were collected to determine whether deficiencies or enrichments of nitrogen or mineral nutrients resulted from the treatments. Nitrogen deficiency was determined with spectrometric trifoliate leaf chlorophyll content. Soybean grain mineral nutrient concentrations were analyzed to detect whether the litter provided and thus enriched the grain with mineral nutrients. Crop removal rates of phosphorus, potassium, and sulfur were calculated to establish the scale and value of crop mineral removal rates. Finally, yields were examined to determine whether the prior year litter application resulted in an increase in soybean yield.

Soil Minerals

Broiler litter contains primary plant mineral nutrients (P-K), mineral macronutrients (e.g. S), and mineral micronutrients (e.g. Zn, Cu, B), which can enrich soil in these nutrients resulting in improved soybean yield and/or reduced fertilizer costs. Composite soil samples (6”) were collected at soybean planting to test whether litter applied to prior year corn at planting resulted in an increase in plant available soil mineral concentrations.

At Milan, the prior year litter applications clearly increased soil phosphorus, potassium, and zinc concentrations (Figure 1).

At Spring Hill, significant differences were not detectable in any of the soil mineral concentrations. For P and K, the soil test variability was high, possibly due to past dairy manure applications in the chosen plot area, resulting in low statistical power. Plots that received higher litter application rates (3, 4, and 5 tons/ac) displayed P and K concentrations that exceeded the positive/negative controls.

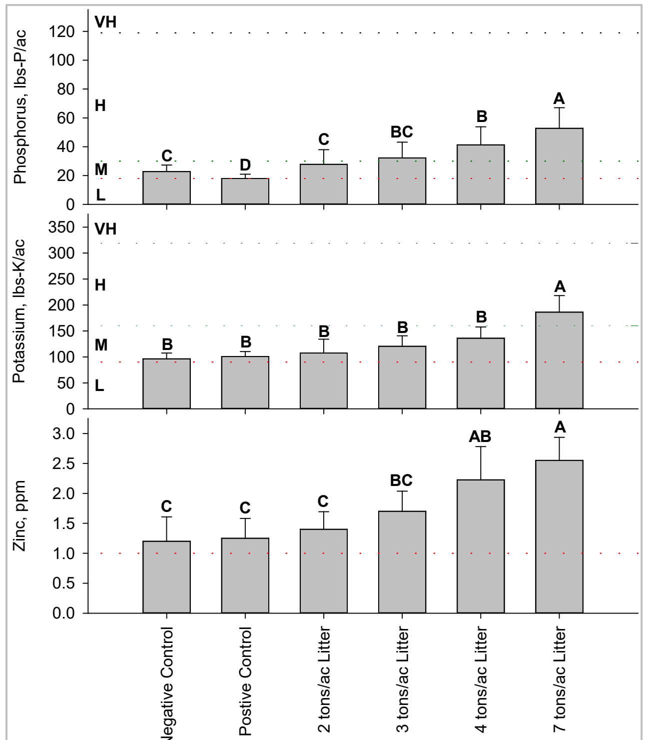


Figure 1. Soil test phosphorus (P-top), potassium (K-middle) and zinc (Zn-bottom) concentrations at Milan at soybean planting. Soil test P and K calibration levels are indicated by dashed threshold lines (L=Low, M=Medium, H=High, VH=Very High); the zinc sufficiency threshold for corn is indicated. Prior year corn treatments that don’t share a common letter display P, K, or Zn concentrations that are significantly different.

Results indicate that a soybean producer may apply the litter at planting to the corn for benefit in soybean crop. This allows the corn to take full advantage of starter nitrogen in boiler litter using relatively high application rates every other year. Phosphorus and potassium, and likely micronutrients, will have a durable soil presence and will be available to replace crop removal during corn and soybean grain harvest in subsequent crop years.

Soil Nitrate

Composite soil samples (12”) were collected at soybean planting to test the hypothesis that soil nitrate concentrations would be higher in the plots that had received litter for the prior year corn crop. At Milan, treatments had low soil nitrate concentrations (< 2.5 lbs-N/ac) that were not significantly different. At Spring Hill, treatments had higher soil nitrate concentrations 10.5 $\pm$ 3.4 lbs-N/ac) that were not significantly different.

R1-R3 Leaf Analysis

No significant treatment differences were observed at Milan or Spring Hill for the leaf nitrogen, macronutrient (P, K, Ca, Mg), or micronutrient concentrations (Fe, Mn, Zn, Cu, B). The measured concentrations easily exceeded lower sufficiency threshold values.

Leaf sulfur concentrations were near or below the lower sufficiency threshold at Milan and Spring Hill. No significant treatment differences were observed at Milan, but the controls at Milan received 12 lbs-S/ac in both 2019 and 2020. At Spring Hill, plots than had received higher prior year litter application rates versus the positive control tended to yield leaves with higher sulfur concentrations (Figure 2). Harvested leaves were also subject to a leaf chlorophyll content (SPAD) analysis but no treatment differences were observed.

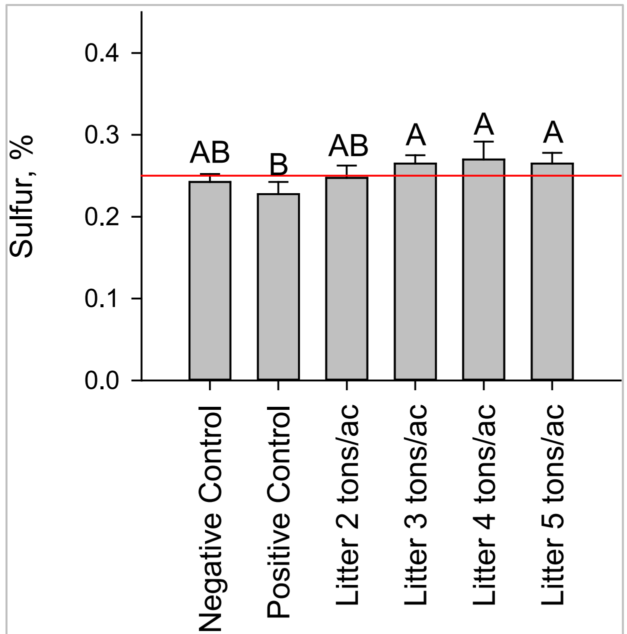


Figure 2. Soybean leaf sulfur concentrations at Spring Hill REC. The red line indicates a lower sufficiency threshold value. Treatments that don't share a common letter display sulfur concentrations that are significantly different.

Grain Mineral Analysis

Grain nitrogen, macronutrient (P, K, Ca, Mg, S) and all but one of the tested micronutrients (Fe, Mn, Zn, Cu) concentrations were similar for all treatments at Spring Hill and Milan. The concentration of boron at Spring Hill also did not vary but were higher than the concentration measured at Milan

At Milan, boron concentrations tended to be higher in grain harvested from plots that received prior year broiler litter (Figure 3). In fact, grain harvested from all of the plots that had received any amount of prior year litter contained higher boron concentration than in the grain harvested from the positive control (Figure 3). Although soil boron concentrations

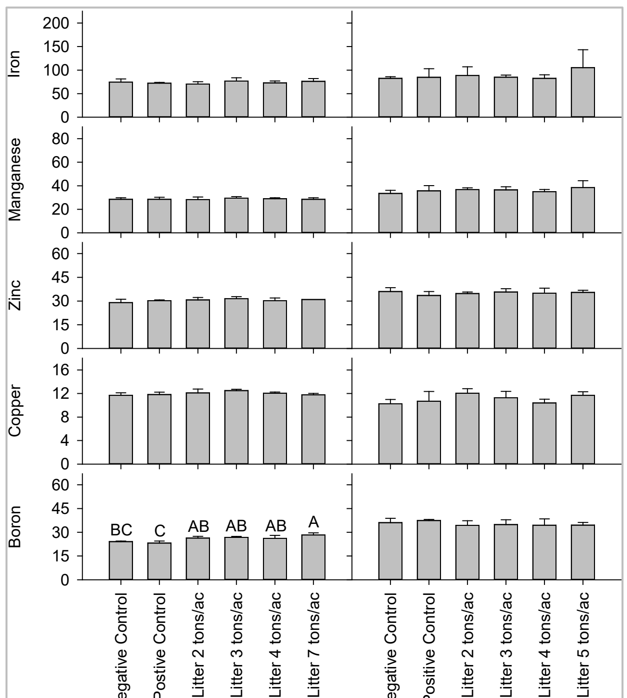


Figure 3. Grain micronutrient concentrations (ppm). Treatments not sharing a common letter have significantly different B concentrations.

did not vary by treatment, these data do indicate that litter may be provisioning plant available boron to soybean.

Plant/Grain Harvest Analysis

At Milan, the plant population (92,000 ± 9,800 pl/ac), height (48.6 ± 1.5”), node count (22 ± 1 n/pl), pods density (59 ± 7), and the grain protein (35.0 ± 0.4%), oil (18.5 ± 0.3%), and seed weight (19.1 ± 0.3 grams/100 ct) were consistent between treatments. Yields varied significantly, with yield for the 2 ton-litter/ac treatment (84 ± 5 bu/ac) being significantly higher than the positive control yield (74 ± 5 bu/ac) (Figure 3). Notably, all of the litter treatment plots had small but consistently higher yields than the positive and negative controls. At Spring Hill, yield (67 ± 5 bu/ac), the plant height (44 ± 2.7”), node count (18 ± 1 n/pl), pods density (72 ± 17), and the grain protein (38.0 ± 0.3%), oil (18.6 ± 0.2%), fiber (4.8 ± 0.1%) and 100 seed weight (17.2 ± 1.1 grams) were all consistent.

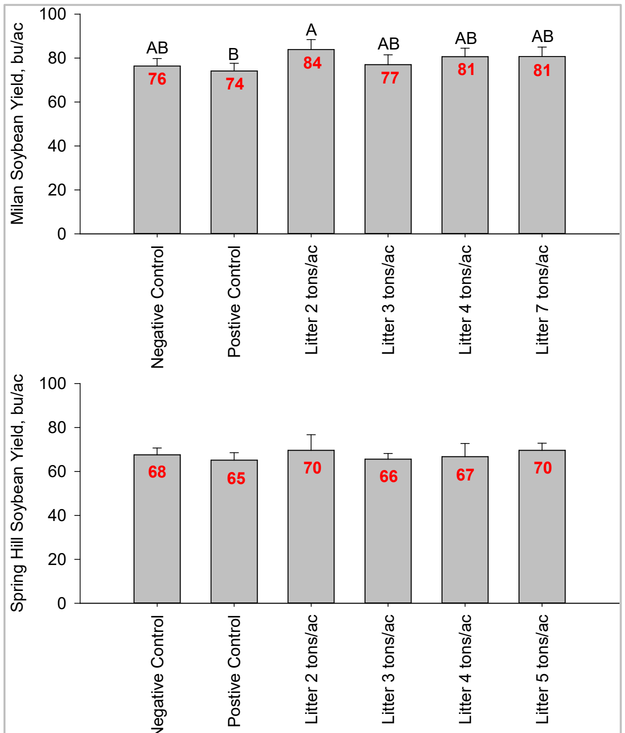


Figure 4. Milan (top) and Spring Hill (bottom) soybean yield data.

Harvest Mineral Removal Rates

Milan soybean harvest removal of phosphorus (61 ± 5 lbs-P_2O_5/ac), potassium (93 ± 7 lbs-K_2O/ac), and sulfur (25 ± 2 lbs-S/ac) did not vary significantly by treatment. Removal rates (0.78-P_2O_5/bu; 1.17 lbs-K_2O/bu; and 0.18 lbs-S/bu) were similar to published reference values.

Spring Hill soybean harvest removal of phosphorus (52 ± 5 lbs-P_2O_5/ac), potassium (86 ± 9 lbs-K_2O/ac), and sulfur (11 ± 1 lbs-S/ac) did not vary significantly by treatment. Removal rates (0.78-P_2O_5/bu; 1.28 lbs-K_2O/bu; and 0.16 lbs-S/bu) were similar to published reference values.

Summary

Single applications of litter to prior year corn can be expected to increase plant available soil phosphorus and potassium concentrations for a rotational soybean crop (Figure 1). Other plant available macronutrients (sulfur - Figure 2) and micronutrients (zinc and boron, Figure 1 and Figure 3, respectively) are likely present in litter and may benefit the soil nutrient profile. There is some indication that prior year litter applications improve soybean yield (Figure 4). Depending on the cost of litter, these soil and production benefits could be obtained at reduced cost and perhaps in fewer trips over a field versus commercial fertilizers. Litter application to corn could increase soil organic matter, releasing nitrogen and other nutrients to soybean crop.

Study 2: Direct Application of Rates of Broiler Litter to Soybeans (project led by and summary written by Dr. McClure)

The objective of this project was to evaluate the benefit to soybean of direct broiler litter application at planting in no-tillage dryland soybean. Application of litter to soybean may release "starter" nitrogen and micronutrients that could provide a yield advantage to the bean crop.

The field study was conducted at the UT Research and Education Center Milan. Asgrow 46X6 variety was planted on May 21 at a rate of 145,000 seeds/acre, and weeds, insects and diseases were managed using UT recommended practices. The field was planted in corn the previous year, and at-planting soil analysis indicated Medium to High phosphorus and potassium levels across the plots. An analysis of broiler litter obtained for this test indicated each ton provided approximately 30-60-60-12S.

Treatments in 2020 included a positive control that included N, P, K, S at rates equivalent to a 2 ton rate of broiler litter, a no N check with P, K, and S at rates equivalent to 2 ton rate of litter minus nitrogen, a no-fertilizer check, and broiler litter at 3 rates. All materials were hand-spread at planting, and incorporated into soil with rainfall into a no-tillage system.

Treatment	Sources used	Rate Applied
1. N, P, K, S	Ammonium nitrate 34-0-0 Phosphorus 0-45-0 Muriate of potash 0-0-60 Sulfate of potash 0-0-50-18S	60-120-120-24S
2. P, K, S	Phosphorus 0-45-0 Muriate of Potash 0-0-60 Sulfate of Potash 0-0-50-18S	120-120-24S
3. No fertilizer check		
4. Poultry litter 1 Ton/Ac	Broiler litter	30-60-60-12S
5. Poultry litter 2 Ton/Ac	Broiler litter	60-120-120-24S
6. Poultry litter 3 Ton/Ac	Broiler litter	90-180-180-36S

The intent of this study was to evaluate effect of broiler litter on the growth and development, and seed quality, composition and yield of soybeans. Data collected included stand, root nodule count at R2, R2 and R8 height, pod number, R2 and R8 node count, harvested seed weight, seed protein, oil, and yield. In order to identify impact of litter on soybean nutrient level, soybean trifoliates were collected and analyzed at R1, and a seed sample analyzed for nutrient concentration after harvest.

Plant Measurement Results

Soybean stand differed slightly with treatment, with the no fertilizer check having lowest stand (102K/ac) and the 2 T/Ac broiler litter treatment with highest final population (116K/Ac). Generally, application of litter did not reduce soybean stand, and was similar to the commercial fertilizer checks. Soybean plants were taller (Figure 1) and visually greener at R2 when nitrogen was included in the fertilizer program (P=0.0034), and at 2 T/Ac or higher rates of broiler litter, indicating some 'starter' nitrogen effect on early season soybean growth. Late season (R8) soybean height also trended higher as broiler rate increased, and where N was applied at planting as commercial fertilizer.

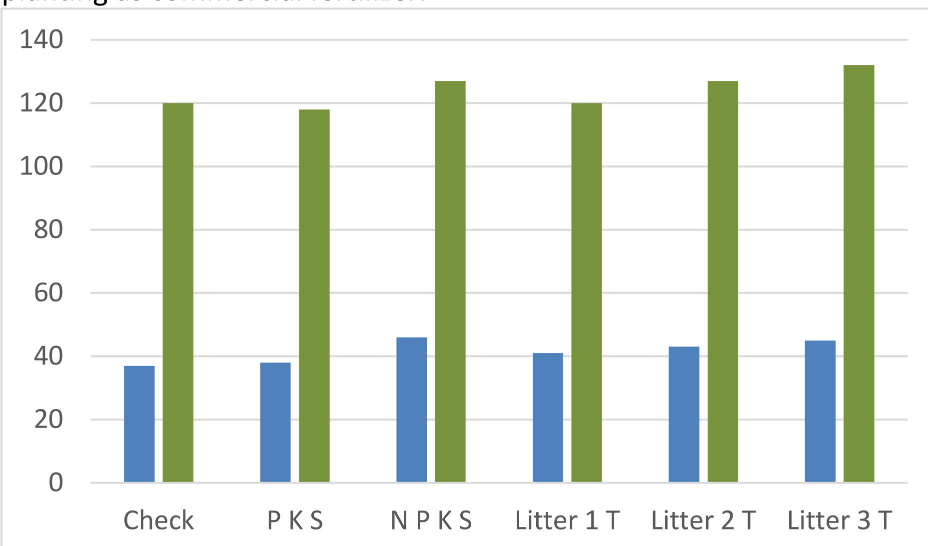


Figure 1. Soybean height in inches with each fertilizer treatment measured at early season (R2 blue bars), and late season (R8 green bars).

Early season stem nodes were similar across treatments (9.3 to 9.7 nodes/plant). Soybean root nodule numbers (Table 1) were noticeably reduced in all plots where fertilizer or litter were applied compared to the no fertilizer check although differences were not significant (P=0.148). It appeared that soybean nitrogen fixing nodules were reduced more with N containg fertilizers and the 2 T/Ac or higher rate of broiler litter, indicating soybean might be utilizing fertilizer N instead of ramping up development of nitrogen fixing nodules.

Table 1. Root Nodule Production

Fert Treatment	Nodules Per Plant
No Fertilizer	72
P K S	65
N P K S	58
Litter 1 T/Ac	65
Litter 2 T/Ac	52
Litter 3 T/Ac	56

Soybean roots with N fixing nodules

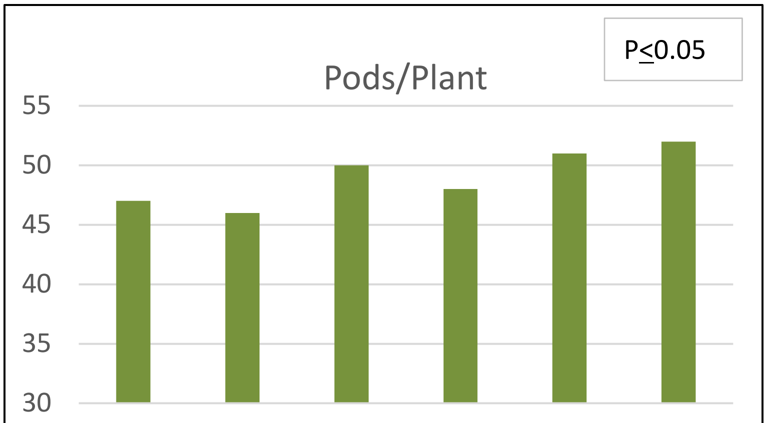


Figure 2. Average pods per plant at end of season.

Soybean plots that received some supplemental nitrogen at planting retained more pods per plant (Figure 2) than the no fertilizer check. Pod counts were highest behind broiler litter at 2 and 3 T/Ac, which was statistically similar to the N, P, K, S control, while the P, K, S control had lowest pod numbers.

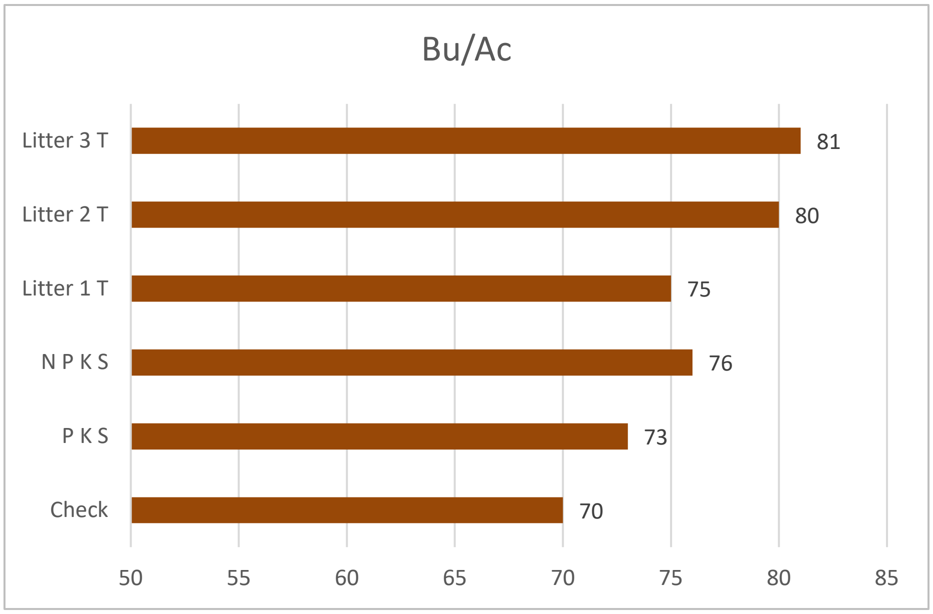
Tissue and Seed Nutrient Concentration

Soybean leaf concentrations were similar for macronutrients N, P, K, S, Mg and most micronutrients (Table 2) for all treatments. The only micronutrient that appeared to follow a response to broiler litter was Boron which was higher in concentration particularly behind 2 T and 3 T/Ac rate. Seed nutrient concentrations were similar across the treatments for macro and micronutrients, including Boron (data not included) indicating treatment did not alter seed nutrient composition.

Table 2. Leaf nutrient concentration in soybean at R2 stage.

Treatment	N	P	K	S	Mg	Bo	Cu	Fe	Mn	Zn
	%	%	%	%	%	ppm	ppm	ppm	ppm	ppm
Check	5.6	0.75	2.19	0.31	0.45	28.1bc	9.8 b	105	47.0ab	47.3
P K S	5.4	0.76	2.54	0.31	0.44	28.8bc	10.4ab	104	50.5a	46.7
N P K S	5.8	0.78	2.37	0.34	0.44	27.6c	13.8a	114	47.3ab	42.8
Litter 1 T	5.6	0.73	2.26	0.31	0.46	30.4b	11.1ab	117	49.3ab	46.7
Litter 2 T	5.8	0.78	2.58	0.32	0.45	32.9ab	10.9ab	107	44.8b	47.7
Litter 3 T	5.8	0.81	2.67	0.33	0.48	33.0a	12.1ab	114	54.5a	49.8
Statistical Significance	ns	ns	ns	ns	ns	*	**	ns	*	ns

‘*’ denotes statistical differences in treatment at P≤0.10, ‘’ denotes statistical differences in treatment at P≤0.05 level of signficance; ‘ns’ means no differences.**



Soybean yield increased 3 bu/Ac with N, P, K, S control over P, K, S control indicating nitrogen played some contribution to yield. Broiler litter at 2 to 3 T/Ac improved yield above the N, P, K, S control by 4 to 5 bushels, indicating another factor--possibly Boron related improvement to pod retention also contributed to yield.

Figure 3. Soybean yield following application of commercial fertilizer or broiler litter compared with no fertilizer check. Broiler litter at 2 or 3 T/Ac was significantly different from the check and P, K, S control at $P \leq 0.05$.

Summary:

Applying 2 to 3 T/Ac broiler litter to soybeans increased soybean height both early and late season, improved early leaf concentration of the micronutrient Boron, pod retention and yield, but did not affect seed nutrient concentration or the tissue levels of other macro and micronutrients in our study. The development of N fixing nodules on roots was delayed particularly in treatments that included ammonium nitrate or litter, but supplemental nitrogen from these sources offset any reduced N fixation in nodulation early season because yield was not reduced. Broiler litter at 2 T/Ac appeared to be as effective as the 3 T/Ac rate with respect to improved yields. Nitrogen uptake appeared to have some bearing on yield as the N, P, K, S control outyielded the P, K, S control. The additional increase in yield with litter is thought to be related to boron uptake and enhanced pod retention at higher (2 to 3 T/Ac) rates of broiler litter.

Study 3: Liming Potential of Broiler Litter Application in Soybeans (project led by and summary written by Dr. Nutifafa Adotey)

The objective of this project was to evaluate the liming potential of poultry litter application in an unirrigated No-till soybean field.

Materials and Methods

The field trial was conducted at the UT Research and Education Center Milan, TN (35°55'10.0"N

88°44'12.6"W) on a Loring Silt loam in 2020. The trial consists of 8 liming treatments using a completely randomized design with four replicates for a total of 32 plots. Each plot was 10 x 30 feet long consisting of four rows. Liming treatment consists of pelletized lime (DL), poultry litter (PL), liquid lime (LL) and their combinations (Table 1). Plots were fertilized according to UT recommendations with the exception of 100%PL treatment. Liming treatments were surface broadcast uniformly by hand on May 15, 2020 prior to planting. Soil samples, taken from each plot at the 6- and 12-inch depth before fertilizer application were air-dried, sieved, and analyzed for soil pH and Mehlich I extractable elements. Asgrow 46X6 soybean was drill-seed on June 2, 2020 and managed according to the UT recommendations. At the R1/R2 and R3/R4 growth stages, whole plant biomass (3.3-foot row) was collected from each plot, and partitioned into leaves, stem, and flower + pod for nutrient concentration and uptake. At maturity, the center two rows were harvested for grain yield. Soil samples collected at harvest were analyzed for soil pH and Mehlich I extractable elements.

Table 1. Liming treatment and their respective application rates

Treatment #	Treatment combination	Rate (lbs/acre)
1	No lime/control	0
2	20%PL	800
	80%DL	1600
3	50%PL	2000
	50%DL	1000
4	80%PL	3200
	20%DL	400
5	100%PL	4000
6	100%DL	2000
7	LL[a]	12.5
8	LL[b]	25

DL, Pelletized lime

PL, poultry litter

LL, liquid lime

Results

Soil pH and Mehlich-I-extractable nutrient elements

The pre-plant soil pH and Mehlich-I-extractable K, Mg, and Fe concentrations were not affected by liming treatments. Conversely, Mehlich-I-extractable phosphorus (P), calcium (Ca), sodium (Na) boron (B), manganese (Mn), and zinc (Zn) concentrations significantly increased following treatment application (Table 2). Soil pH and Mehlich-I-extractable nutrient elements were similar among the treatments with the exception of Na, which was significantly higher in treatment combination with at least 50% of poultry litter. It is worth noting that seasonal fluctuations in soil properties, particularly pH and soil K concentrations are not unusual. Generally, soil pH and K in the fall tends to be lower than spring measurement collected from the same field. In this trial, pre-plant and harvest samples were collected in the spring and fall, respectively. Thus, pre-plant sampling in the 2021 spring will present an accurate comparison of a change in soil properties.

Tissue analysis, nutrient uptake, and grain yield
Nutrient concentrations in the leaves were significantly greater compared to the stem with the exception of K at the R1/R2 and R3/R4 growth stages (Table 3). Also, the nutrient concentration in the flower+pod at R3/R4 growth stage was greater than in the stem. No significant difference in nutrient concentration was observed among treatment at the R1/R2 growth stages while differences in K, Fe, and Mn concentrations was evident among treatments at the R3/R4 growth stage (Table 3). The nutrient concentrations reported at all growth stage in this study were within the sufficiency level deemed adequate for plant growth and development. Higher N and P uptake by plants treated with at least 50% of poultry litter did not translate into higher soybean yield (data not shown). Soybean yield was not significantly influenced by treatment application, indicating that soil pH was not a yield-limiting factor. However, a 12%-yield loss was observed in plots treated with two times the recommended rate of liquid lime product (Figure1).

Summary

- Treatment did not influence soil pH. Seasonal fluctuation may partly explain the lack of significant difference among the treatments.
- Grain yield from un-limed plots were comparable to all of the limed plots except one, indicating that soil pH may not have been a yield-limiting factor.

Table 2. Effect of soil sampling time and liming treatment on soil pH and Mehlich-I extractable soil nutrients (0 – 6 inch).

Treatment effects	pH	P	K	Ca	Mg	B	Fe	Mn	Na	Zn
		---------------------------------lbs. per acre-------------------------------------								
Time										
Pre-plant	6.4	23	113	2435	205	0.5	26	23	14	1.1
Harvest	6.5	35	113	3419	191	0.7	25	28	18	1.6
Treatment										
Control	6.5	29	120	2892	184	0.7	26	28	15	1.4
20%PL+80%DL	6.6	30	120	3272	193	0.7	23	27	14	1.4
50%PL+50%DL	6.4	26	112	2701	197	0.6	27	24	18	1.3
80%PL+20%DL	6.5	33	120	2889	188	0.6	25	26	16	1.4
100%PL	6.5	27	95	2929	225	0.6	26	22	20	1.5
100% DL	6.6	33	119	3168	202	0.7	25	27	15	1.4
LL[a]	6.3	25	108	2640	199	0.6	27	24	15	1.3
LL[b]	-	-	-	-	-	-	-	-	-	-
Sig. (P≤0.05)										
Time	ns	****	ns	****	ns	***	ns	***	****	****
Treatment (Trt)	ns	ns	ns	ns	ns	ns	ns	ns	**	ns
Time*Trt	ns	ns	ns	ns	ns	ns	ns	ns	*	**

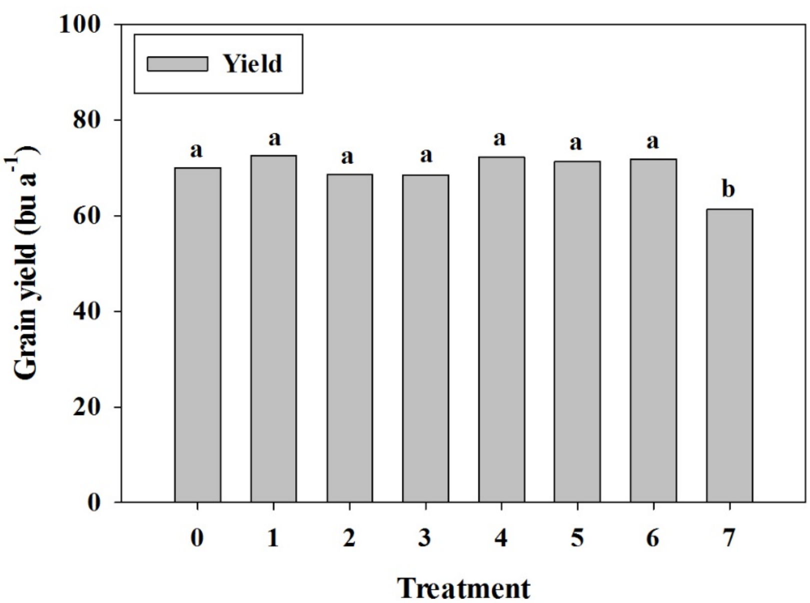
DL, Pelletized lime; PL, poultry litter; LL, liquid lime
*, **, ***, and **** show significance at the α = .05, .01, .001 and .0001 levels, respectively.

Table 3. Effect of plant part and liming treatment on selected nutrient concentrations at R1/R2 and R3/R4 growth stage.

Treatment effects	N	P	K	Mg	N	P	K	Fe	Mn
	------------------%-----------------				-------------%-----------			----ppm-----	
		R1/R2				R3/R4			
Plant part									
Leaves	5.38	0.35	1.60	0.41	5.26	0.30	1.67	167	105
Stem	1.76	0.25	3.12	0.32	1.67	0.19	1.95	48	22
Flower+pod	-	-	-	-	3.49	0.37	2.69	102	46
Treatments									
Control	3.54	0.30	2.44	0.36	3.56	0.28	2.09	99	58
20%PL+80%DL	3.56	0.31	2.49	0.36	3.49	0.29	2.02	105	58
50%PL+50%DL	3.65	0.31	2.39	0.38	3.38	0.28	2.17	97	59
80%PL+20%DL	3.66	0.32	2.47	0.38	3.40	0.29	2.15	110	57
100%PL	3.63	0.31	2.33	0.38	3.49	0.29	2.25	92	63
100% DL	3.47	0.29	2.26	0.37	3.56	0.29	2.16	121	51
LL[a]	3.56	0.30	2.39	0.36	3.52	0.29	2.07	101	57
LL[b]	3.47	0.29	2.13	0.40	3.39	0.27	1.92	118	61
Sig. ($P \leq 0.05$)									
Plant part (PP)	****	****	****	****	****	****	****	****	****
Treatment (Trt)	ns	ns	ns	*	ns	ns	*	**	***
Trt*PP	ns	ns	ns	ns	ns	ns	ns	ns	ns

DL, Pelletized lime; PL, poultry litter; LL, liquid lime

*, **, ***, and **** show significance at the α = .05, .01, .001 and .0001 levels, respectively.



Treatmen ts

0 -

Figure 1. Soybean grain yield. Bar with the same letters are not significantly different at P≤0.05