Texas Corn Producers Board 2020 Research Project Final Report

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Project - Soil Nutrient Sustainability in Northeast Texas Corn – Phosphorus 2020

Researcher

David R. Drake - Texas A&M AgriLife Extension Commerce, TX email: drdrake@ag.tamu.edu

Summary

Two dryland corn fertility trials were conducted in Northeast Texas during 2020. One was a large plot trial with Ben Scholz, Collin County, producer; looking at fall strip-till and spring at planting fertilizer treatments. The second was a small plot replicated trial at the Greenville, Hunt County, TAMU Research, Extension, and Teaching Farm comparing nine treatments including: product, rate, and timing. Both Trials were conducted on Houston Black Clay soils with moderate to low soil test phosphorus that decreases with depth based on soil profile testing to 30 inches. Results of the large plot fertilizer timing trial showed an increase of 25 bushels per acre (bpa) with combined fall strip-till and at-planting phosphorus amendments compared to a nitrogen only treatment. Evaluation of the spring at-planting treatment by itself yielded 94.6 bpa, 5.7 bushels less than 100.3 bpa for the two amendments and 19.3 bushels more than the nitrogen only of 75.3 bpa.

The Greenville TAMU trial compared several commercial fertilizer products and rates with in-furrow at planting, post emergence broadcast, and at silking foliar treatment applications with a broadcast nitrogen only treatment as a control. Two of the nine treatments were significantly different for yield compared to the nitrogen only. The highest yielding treatment, 115 bpa, was an in-furrow at planting treatment followed by a foliar at silking application, both with macro and micro nutrient formulations. The second best treatment was a macro and micronutrient formulation applied in furrow at planting that yielded 111.4 bpa. These two treatments were statistically different than the nitrogen only yield of 85.2 bpa, but were not statistically different from each other or any of the other phosphorus fertilizer treatments and applications methods tested, although numerically greater. Agronomic responses to fertilizer amendments varied by treatment and application method but positive statistically significant responses were also observed in test weight, kernel weight, ear weight, and V4-V5 seedling mass. Plots were tissue sampled for nutrient content at V4-V5 as seedlings and at silking by sampling ear leaves. No significant differences for tissue nutrient content were observed among treatments and most nutrients concentrations were within the sufficiency range with the exception of some low phosphorus, and high potassium and calcium results. Given a standard calculation of nutrient removal by the corn crop only the top two treatments came close to replacing nutrients used in grain production. These results demonstrate a yield response from various phosphorus fertilizer treatments and provide corn producers with information to help evaluate their corn fertility practices.

Individual Trial Details

Fertility Timing and Placement in Collin County Ben Scholz – Cooperator

Treatments

1. Untreated Control (Nitrogen Side Dress) 25 gallons/ac of 28-0-0 + S (74 units of N)
2. At planting in-furrow applied Phosphorus (20.4 units P2O5) with 6 units N, 1.7 units K2O, and chelated Zinc as 6 gallons per acre liquid fertilizer.
3. Fall strip till subsurface banded Phosphorus (31.9 units P2O5) with 9.25 units N, 12.8 units K2O, humic acid, and chelated Zinc as a 10 gallons per acre liquid AND the spring in-furrow treatment above.

Design

Fall strip-till October 2019 Bigham Mfr
Planted April 16, 2020
Harvested August 27, 2020
Hybrid NK1694-3111
Plot Size 800ft X 12 Rows

Results

Applying phosphorus and other nutrients at planting increased yield 19.3 bushels per acre in this trial as compared to a nitrogen and sulfur topdress application alone. Applying additional nutrients in the fall with a strip till rig increased the yield an additional 5.7 bushels per acre. Fertilizer applications also increased test weight, and kernel size, as measured by 1000 kernel weight. The fertilizer did not statistically change plant population, stover amount, or the grain to stover ratio of the crop although there were numerical trends upward. See Table 1.

Table 1. Results of 2020 Collin County Corn Fertility Trial. Fall and spring applied phosphorus compared to spring applied phosphorus and nitrogen topdress only treatments. Ben Scholz cooperator.

Treatment	Yield bu/ac	Test Weight	1000 kernel Weight	Plant Population	Stover lbs/ac	Grain to Stover Ratio
Untreated (74 units N plus 13.25 units of S)	75.3	54.1	210.8	21,750	4689	0.452
Spring In-furrow at planting total (6-20.4-1.7) plus chelated Zinc	94.6	54.7	229.4	22,500	6396	0.464
Fall strip till (9.6-31.9-12.8) plus humic acid and chelated Zinc AND Spring In-furrow at planting total (6-20.4-14.5) plus chelated Zinc	100.3	55.8	239.1	22,083	7581	0.463
Significance P-value	0.005	0.0003	0.0004	N.S.	0.11	N.S.

Replicated Small Plot Fertilizer product by application method trial at Greenville TAMU University Research, Extension, and Teaching Farm

Treatments

Untreated Control (Nitrogen Only 300 lbs/ac 46-0-0 with Nutri-sphere)

1. Grower Standard 10-34-0 @ 5.0 gal/ac + NACHURS CornGrow @ 1 qt/ac in furrow at planting
2. 10-34-0 @ 10 gal/ac + NACHURS CornGrow @ 1 qt/ac in furrow at planting
3. NACHURS Triple Option @ 5 gal/ac + NACHURS CropMax @ 1 qt/ac in furrow at planting
4. NACHURS Impulse @ 4.75 gal/ac + NACHURS CropMax @ 1 qt/ac in furrow at planting
5. NACHURS Impulse @ 4.75 gal/ac + NACHURS CropMax @ 1 qt/ac post emergence
6. NACHURS Impulse @ 4.75 gal/ac + NACHURS CropMax @ 1 qt/ac + Kfuse @ 2 gal/ac in furrow at planting
7. NACHURS Impulse @ 5 gal/ac + NACHURS CropMax @ 2 qts/ac + Kfuse @ 2 gal/ac in furrow at planting
8. NACHURS Impulse @ 1.75 gal/ac + NACHURS Finish Line @ 1 qt/ac Foliar at V-12
9. NACHURS Impulse @ 5 gal/ac + NACHURS CropMax @ 1 qt/ac in furrow at planting followed by NACHURS Impulse @ 1.75 gal/ac + NACHURS Finish Line @ 1 qt/ac Foliar at V-12

Nutrient content of products

NACHURS Triple Option 4-13-17
NACHURS Impulse 10-18-4
NACHURS Kfuse 6-0-12 12% Sulfur
NACHURS CornGrow Chelated 0.4Cu 0.6Mn 3.5Zn
NACHURS CropMax 2-0-2 0.1B Chelated 0.15Cu 0.3Fe 1.5Mn 0.0005Mo 4 Zn
NACHURS Finishline 8-4-6 0.1B with Chelated 0.2 Cu,1 Zn,1 Mn,

Design

Randomized Complete Block with 4 replications
Plots were 4 rows X 32 ft
Hybrid DKC 65-99 seeded on April 16, 2020 @ 29,500 seeds per acre.

In-furrow at planting treatment using a seed firmer with a "Y-split" liquid applicator suppling 10 gallons per acre total volume.
Post-emergence foliar application 10 gallons total volume nozzle centered over the row. April 27, 2020,
Broadcast N application 300 lbs 46-0-0 treated with Nutri-sphere May 1, 2020,
Seedling harvest May 8, 2020,
Late foliar Application June 17, 2020 (#8) and July 2, 2020 (#9).
Ear leaf tissue sampling June 20, 2020,
Grain and stover Harvest August 24, 2020

Results

Yield and other agronomic differences were observed between phosphorus and other nutrient products, amounts, and application timing and methods. All products showed an increase in yield over nitrogen alone treatments. Agronomic measurements and yield components are presented in Tables 2 and 3.

Table 2. Seedling weight and tissue nutrient content, ear leaf nutrient content, followed by test weight and grain yield for a Corn fertility trial 2020

	Treatment	V4-V5 dry matter weight (g)	V4-V5 % N Tissue	V4-V5 P ppm Tissue	V4-V5 K ppm Tissue	Ear Leaf % N Tissue	Ear Leaf P ppm Tissue	Ear Leaf K ppm Tissue	Twt Lbs/ Bushel	Grain Yield Adj 15.5% moisture
9	NACHURS Impulse 10-18-4 @ 4.75 gal/ac + NACHURS CropMax @ 1 qt/ac in furrow fb NACHURS Impulse 10-18-4 @ 1.75 gal/ac + NACHURS Finish Line @ 1 qt/ac foliar at silking	6.30 ab	3.5	4566	43985	1.8	1572	23994	59.0 a	115.0 a
2	10-34-0 @ 10 gal/ac + NACHURS CornGrow @ 1 qt/ac in furrow	5.36 b	3.5	4748	39372	2.0	1461	22427	58.7 a	111.4 ab
3	NACHURS Triple Option 4-13-17 @ 5.0 gal/ac + NACHURS CropMax @ 1 qt/ac in furrow	6.00 ab	3.5	4885	42826	2.0	1640	24315	58.5 a	105.2 abc
4	NACHURS Impulse 10-18-4 @ 4.75 gal/ac + NACHURS CropMax @ 1 qt/ac in furrow	6.09 ab	3.2	4716	41321	1.8	1582	23918	57.9 ab	103.5 abc
6	NACHURS Impulse 10-18-4 @ 4.75 gal/ac + NACHURS CropMax @ 1 qt/ac + NACHURS K-fuse @ 2.0 gal/ac in furrow	5.31 b	3.5	5078	44211	1.7	1497	24213	58.0 ab	101.1 abc
5	NACHURS Impulse 10-18-4 @ 4.75 gal/ac + NACHURS CropMax @ 1 qt/ac broadcast post emergence at 10 gal total volume	5.15 b	3.6	5366	43064	1.8	1469	25311	58.2 ab	100.3 abc
7	NACHURS Impulse 10-18-4 @ 4.75 gal/ac + NACHURS CropMax @ 2 qt/ac + NACHURS K-fuse @ 2.0 gal/ac in furrow	7.58 a	3.8	4247	41146	1.7	1611	23128	57.6 ab	99.8 abc
1	Grower Standard 10-34-0 @ 5.0 gal/ac + NACHURS CornGrow @ 1 qt/ac in furrow	7.47 a	3.2	4832	42017	1.8	1385	24371	57.7 ab	95.8 abc
8	Nothing in furrow NACHURS Impulse 10-18-4 @ 1.75 gal/ac + NACHURS Finish Line @ 1 qt/ac foliar at silking	_	-	-	-	1.7	2089	24198	57.7 ab	89.9 bc
	Untreated (138 units N only)	4.49 b	3.7	4818	41666	1.65	1389	25497	56.7 b	85.2 c
	Mean	5.97	3.5	4807	42127	1.8	1556	24232	57.9	99.4
	Statistical Probability (F)	0.0059	No statistically significant differences observed						0.0025	0.0007

Table 3 Plant population, seedling weight, ear weight, kernel number, kernel weight, stover mass, grain to stover ratio, test weight, and grain yield of a Corn fertility trial at TAMU Farm in Greenville, TX 2020.

	Treatment	Plant Population	V4-V5 Seedling weight	Average Ear Weight (g)	Kernel Number Per Ear	Kernel Weight 1000k (g)	Stover Pounds Per Acre	Grain To Stover Ratio	Twt Lbs/ Bushel	Grain Yield Adj 15.5% moisture
9	NACHURS Impulse 10-18-4 @ 4.75 gal/ac + NACHURS CropMax @ 1 qt/ac in furrow fb NACHURS Impulse 10-18-4 @ 1.75 gal/ac + NACHURS Finish Line @ 1 qt/ac foliar at silking	29,039	6.30 ab	114.2 a	428	240 a	6320	0.493	59.0 a	115.0 a
2	10-34-0 @ 10 gal/ac + NACHURS CornGrow @ 1 qt/ac in furrow	28,448	5.36 ab	111.2 a	409	241 a	6539	0.497	58.7 a	111.4 ab
3	NACHURS Triple Option 4-13-17 @ 5.0 gal/ac + NACHURS CropMax @ 1 Qt/ac in furrow	28,754	5.99 ab	110.1 a	427	228 ab	5623	0.532	58.5 a	105.2 abc
4	NACHURS Impulse 10-18-4 @ 4.75 gal/ac + NACHURS CropMax @ 1 qt/ac in furrow	28,827	6.09 ab	105.5 a	422	223 ab	5764	0.498	57.9 ab	103.5 abc
6	NACHURS Impulse 10-18-4 @ 4.75 gal/ac + NACHURS CropMax @ 1 qt/ac + NACHURS K-fuse @ 2.0 gal/ac in furrow	28,338	5.03 ab	104.0 ab	432	218 ab	5361	0.479	58.0 ab	101.1 abc
5	NACHURS Impulse 10-18-4 @ 4.75 gal/ac + NACHURS CropMax @ 1 qt/ac broadcast post emergence at 10 gal total volume	28,805	5.15 ab	96.8 ab	393	221 ab	5729	0.470	58.2 ab	100.3 abc
7	NACHURS Impulse 10-18-4 @ 4.75 gal/ac + NACHURS CropMax @ 2 qt/ac + NACHURS K-fuse @ 2.0 gal/ac in furrow	28,502	7.58 a	99.7 ab	401	222 ab	5960	0.474	57.6 ab	99.8 abc
1	Grower Standard 10-34-0 @ 5.0 gal/ac + NACHURS CornGrow @ 1 qt/ac in furrow	29,023	7.47 a	98.5 ab	400	220 ab	6081	0.471	57.7 ab	95.8 abc
8	Nothing in furrow NACHURS Impulse 10-18-4 @ 1.75 gal/ac + NACHURS Finish Line @ 1 qt/ac foliar at silking	28,618	-	102.0 ab	428	210 ab	6269	0.495	57.7 ab	89.9 bc
	Untreated (138 units N only)	28,007	4.49 b	83.5 b	387	203 b	5411	0.485	56.7 b	85.2 c
	Mean	28,599	5.97	4807	42127	221	5853	0.490	57.9	99.4
	Statistical Probability (F)	0.0663	0.0059	0.0178	0.3800	0.0223	0.6191	0.6285	0.0025	0.0007

Two treatments had statistically significant differences from the nitrogen only treatment for yield. The highest yielding, 115 bu/ac; was an infurrow treatment of 5 gallons of 10-18-4 plus micronutrients followed by a foliar treatment of 2 gallons of 10-18-4 plus micronutrients. This was 29.8 bu/ac higher than the control N only treatment. The next highest, 111.4 bu/ac; was a 10 gallon rate of 10-34-0 plus micronutrients in furrow. This was 18.3 bushels greater than no additional fertilizer. These were numerically greater than each other and the other fertilizer treatments but none of the fertilizer treatments could be separated by a statistical α=0.05 confidence level. All infurrow at planting treatments increased yield by at least 10.6 bu/ac. The foliar treatments also increased yield but timing and type of treatment made small numerical differences. The early post emergence application of the same infurrow treatment increased yield by 15 bushels per acre over the untreated but was 3.2 bushels less than the infurrow timing. The at silking foliar treatment with a reduced nutrient content increased yield by 11.5 bu/ac when combined with an infurrow treatment but showed a small 4.7 bu/ac yield increase when that was the only treatment. Adding additional potassium and sulfur at planting or doubling the micronutrient to 2 quarts per acre showed small differences in yield. Repeating the study in additional years should help separate differences between the treatments. All of these treatments and products should be carefully evaluated by producers in terms of soil test recommendations, cost, and ease of application.

Yield and Yield Components

Fertility treatments increased the yield components of test weight, average ear weight, and average kernel weight. The kernel number and amount of plant biomass also increased but not at a statistically significant level.

Seedling Size and Seedling Nutrient Content

In-furrow at planting nutrient application increased V4-V5 seedling size compared to the untreated plots. There were no significant differences in seedling nutrient content for the macro and micronutrients measured. The seedling nutrient content was within the general sufficiency range of published recommendations. Seedling size and nutrient content did not correlated well with final grain yield. In two treatments, 10 gallons per acre (gpa) of 10-34-0 and 5 gpa Impulse 10-18-4 plus 2 gpa K-fuse 6-0-12-12, there was reduced seedling size, possibly attributed to nutrient salinity; but this did not have a negative effect on final grain yield. This high volume nutrient treatment would be of greater seedling damage risk in lighter textured soils

Plant Population

There were no statistically significant differences in plant population at a strict $\alpha = 0.05$ but the difference between the untreated control and the infurrow treatment with the highest yield was 1032 plants per acre with a probability of $P = 0.06$. All fertilized treatments had higher plant populations than the untreated control suggesting fertilizer application can positively affect population.

Ear Leaf Nutrient Concentrations.

There were no statistically significant ear leaf nutrient content differences between treatments. Average nutrient levels of N & P were borderline and low respectively. K and Ca were high and the rest of the micronutrients were in the sufficiency range. There was one numerical increase in ear leaf P attributed to a foliar treatment 3 days prior to sampling leaves in one of the treatments.

General Soil Fertility and Cropping Sustainability

Plot soil tests showed low phosphorus and zinc with nutrients decreasing with sampling depth. Samples were submitted to the Texas A&M Soil Testing Lab in College Station and processed using Mehlich 3. Table 4 shows the average soil test results and the critical level for recommending amendments if results are below that level.

Table 4. Soil test phosphorus and zinc of 2020 corn fertility plots

Sample depth (inches)	Phosphorus	Zinc
0”-6”	19 ppm	0.65
6”-18”	9 ppm	0.26
18”-30”	1 ppm	0.44
Critical Level	50 ppm	0.81 ppm

The above soil tests would generate amendment P2O5 recommendations of up to 75 lbs per acre and Zinc of up to 4 lbs per acre. These amounts were not applied in the trial. Another way to look at nutrient amount is to consider the amount removed by the crop. Using the Greenville trial average for yield of 99.4 bushels per acre this crop would remove N-P-K in the following amounts:

Nitrogen: 99.4 X 0.9 = 89 pounds/ac

Phosphorus 99.4 X 0.37 = 36.8 pounds/ac

Potassium 99.4 X 0.27 = 26.8 pounds/ac

Only the two highest yielding treatments come close to replacing the nutrients removed by the grain and neither one meets the phosphorus recommendations for a broadcast fertilizer recommendation. It should be noted that direct phosphorus placement in the root zone reduces recommendations compared to broadcasting prior to tillage. If these are the only nutrient inputs producers are using than soil nutrient levels would most likely be declining. Crop nutrient removal would be even greater with higher yield or if the complete plant was removed for example if the stubble was baled for hay.