Mississippi Corn Promotion Board
2020 Progress Report

Title: Interaction of Nitrogen and Zinc Rates for Corn and Cotton Grown in Rotation

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Project Summary

Zinc deficiency symptoms have continued to surface over the last several years and have been evident in both corn and cotton. The problem has been most evident on the sandier soils where organic matter levels are generally less than 1%. Efforts have been underway in the Mississippi Delta to increase organic matter levels by utilizing crop rotations. Soil test zinc has been observed in the deficient range and could be increased with zinc fertilizer applications. Both soil-applied and foliar products are available but the range in application cost can be quite expensive. Research at the Delta Research and Extension Center has shown significant yield increases when cotton follows corn compared to cotton following cotton. The advantage has averaged from 10-17% on a series of studies to over 20% in the Centennial Rotation. A corn/cotton rotation system is currently in place that has been used to evaluate the interaction of zinc rates and nitrogen rates for both the corn crop and the cotton crop. This will be a continuation of on-going research. The studies are located at the Delta Research and Extension Center with four nitrogen (N) rates (Corn: 160, 200, 240, and 280 lb N/acre; Cotton: 30, 60, 90, and 120 lb N/acre) and four zinc (Zn) rates (0, 5, 10, and 15 lb Zn/acre). Zinc sulfate was utilized (dissolved the dry material in water) and applied with a rolling coulter rig, similar to urea-ammonium nitrate solution. Averaged over all Zn application rates, the highest corn yield (207 bu/ac) and N uptake (205 lb/ac) were obtained with an N application rate of 280 lb N/ac. Statistically, the increase in N rate from 200 to 280 lb N/ac did not increase corn grain yield in the year 2020. Corn yield was increased by 17 bu/ac (9%) when N application rate was increased from 160 lb N/ac to 240 lb N/ac. Cotton lint yield was significant for N and Zn interaction treatments. The highest lint yield of 1514 lb/ac was obtained by 120 lb N/ac with 5 lb Zn/ac treatment. A regression analysis was performed between N rates and lint yields for different Zn rate treatments (Figure 1). Results indicated that for 15 lb Zn/ac application agronomic optimum yields were obtained with 90 lb N/ac. Similarly, for 5 and 10 lb Zn/ac application agronomic optimum yields were obtained with 120 lb N/ac and showed an increasing trend (Figure 1). Results from the study could be used by producers in their decision-making process.

Project Results/Outcomes

Due to extreme wet conditions and high precipitation, no tillage operations were completed for seedbed preparation in fall 2019. In spring 2020, seedbed preparation was completed in April which was followed by the planting of corn hybrid Pioneer 2089 VYHR @ 32,000 seeds/acre. Cotton hybrid PhytoGen 330 W3FE was planted in May @ 41,000 seeds/acre. Preplant nitrogen was applied at 120 lbs N/ac to corn and 30 or 60 lbs N/acre to cotton. The remaining N was applied as a split application to all the treatments. During preplant sidedressed application of N, Zinc sulfate was also applied to the treatments. Corn biomass samples were collected from all treatments to determine silage yield. Corn biomass samples were oven-dried, weighed, grounded, and analyzed for nitrogen and zinc concentration to determine N and Zn uptake by corn. Corn was harvested on Sept. 15, 2020, using a Kincaid 8xp plot combine, and grain samples were collected to determine grain harvest moisture, bushel test weight, seed index (100-seed weight), and grain quality (protein, starch, and oil). Cotton boll samples were collected before picking cotton and were processed for lint yield and fiber quality. Cotton was picked using a two-row cotton picker on Oct. 2, 2020. After harvesting, soil samples from each plot (0-6" depth) were collected for determining available nutrients in soils. All collected data were statistically analyzed using the Glimix procedure in SAS statistical software. The highest nitrogen uptake in corn biomass was 227 lb N/ac for treatment that received 280 lb N/ac with 5 lb Zn/ac (Table 1). There were no differences in corn yield based on N and Zn interactions (Table 1). Averaged over all Zn application rates, the highest corn yield (207 bu/ac) and N uptake (205 lb/ac) by corn were obtained with an N application rate of 280 lb N/ac. Statistically, the increase in N rate from 200 to 280 lb N/ac did not increase corn grain yield in the year 2020. Corn yield was increased by 17 bu/ac (9%) when the N application rate was increased from 160 lb N/ac to 240 lb N/ac. Similarly, N uptake by corn was increased by 20 lb/ac (11%) when the N application rate was increased from 160 lb N/ac to 240 lb N/ac.

Project Results

Corn silage Zn uptake was similar among all Zn treatment except the control when averaged over the N application rates (Table 1). Corn grain oil and protein content decreased with increased application of Zn fertilizer. Soil samples collected after harvesting corn in 2020 revealed significant differences in soil Zn and N concentrations. Soil Zn concentrations were highest for 15 lb Zn/ac treatment and decreased with lower Zn application rates. See cotton yield was affected by the main effects of N rate treatments with the highest seed cotton yield of 3177 lb/ac for 120 lb N/ac followed by 3073 lb/ac for 90 lb N/ac (Table 2). Cotton lint yield was significant for N and Zn rate treatments. Cotton lint yield was significant for N and Zn interaction treatments. The highest lint yield of 1514 lb/ac was obtained by 120 lb N/ac with 5 lb Zn/ac treatment. A regression analysis was performed between N rates and lint yields for different Zn rate treatments (Figure 1). Results indicated that for 15 lb Zn/ac application agronomic optimum yields were obtained with 90 lb N/ac. Similarly, for 5 and 10 lb Zn/ac application agronomic optimum yields were obtained with 120 lb N/ac and showed an increasing trend (Figure 1). Cotton lint samples were analyzed for fiber quality and fiber elongation increased with higher rates of Zn treatments when average over the N rate treatments (Table 2).

Figure 1. Regression analysis between N rates and lint yields for different Zn rate treatments

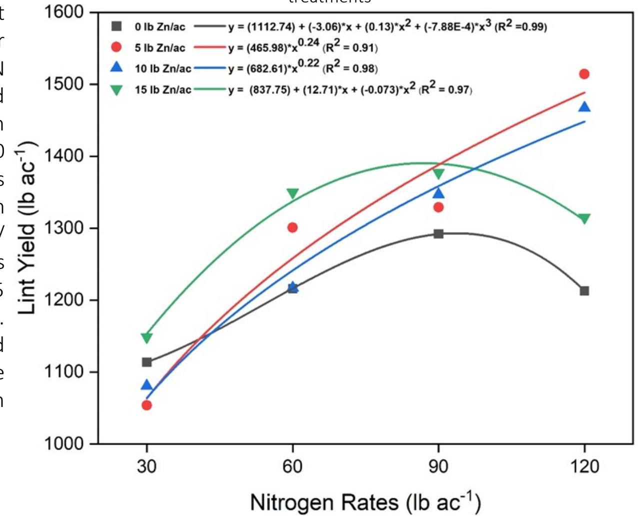

Table 1. Means represent nitrogen (N) and zinc (Zn) rate treatments' main effects and their interactions for corn silage N and Zn uptake, corn grain yields, grain oil, and protein content. Means followed by the same letter within a column or a row do not differ significantly at P<0.05.

N Rate (lb N/ac)	Silage N Uptake (lb/ac)					Silage Zn Uptake (lb/ac)					Corn Yield at 15.5% (bu/ac)					Grain Oil (%)					Grain Protein (%)				
	Zinc Rate (lb Zn/ac)				Main Effects	Zinc Rate (lb Zn/ac)				Main Effects	Zinc Rate (lb Zn/ac)				Main Effects	Zinc Rate (lb Zn/ac)				Main Effects	Zinc Rate (lb Zn/ac)				Main Effects
	0	5	10	15		0	5	10	15		0	5	10	15		0	5	10	15		0	5	10	15	
160	163c	186bc	192bc	185bc	181b	5.7	6.7	7.1	6.6	6.5	181	184	177	197	185b	3.62	3.68	3.62	3.62	3.64	7.14	6.98	6.76	6.84	6.93c
200	184bc	210ab	192bc	188bc	194ab	5.2	7.7	7.3	7.0	6.8	200	198	196	191	196ab	3.66	3.54	3.62	3.52	3.59	7.98	7.54	7.42	7.34	7.57b
240	225a	186bc	184bc	209ab	201a	6.3	6.1	6.9	7.5	6.7	201	202	190	218	202a	3.64	3.64	3.54	3.52	3.59	8.42	8.2	7.88	7.86	8.09a
280	193bc	227a	209ab	193bc	205a	6.4	7.3	7.4	8.0	7.3	200	204	211	214	207a	3.76	3.62	3.66	3.54	3.65	8.66	8.26	8.26	7.74	8.23a
Main Effects	191	202	194	194		5.9b	6.9a	7.2a	7.3a		195	197	194	205		3.67a	3.62ab	3.61b	3.55c		8.05a	7.75b	7.58bc	7.45c	

Table 2. Means represent nitrogen (N) and zinc (Zn) rate treatments' main effects and their interactions for seed cotton yield, lint yield, cotton fiber quality (fineness and elongation). Means followed by the same letter within a column or a row do not differ significantly at P<0.05.

N Rate (lb N/ac)	Seed Cotton Yield (lb/ac)					Lint Yield (lb/ac)					Fiber Fineness (millitex)					Fiber Elongation (%)				
	Zinc Rate (lb Zn/ac)				Main Effects	Zinc Rate (lb Zn/ac)				Main Effects	Zinc Rate (lb Zn/ac)				Main Effects	Zinc Rate (lb Zn/ac)				Main Effects
	0	5	10	15		0	5	10	15		0	5	10	15		0	5	10	15	
30	2562	2412	2455	2586	2504c	1114ef	1054f	1081f	1149ef	1100c	4.81bcde	5.01a	4.94ab	4.86abcd	4.90a	6.00	5.95	6.00	5.93	5.97
60	2828	3022	2800	3108	2939b	1216de	1301cd	1217de	1350bcd	1271b	4.63e	4.82bcd	4.91abc	4.91abc	4.82ab	5.78	5.95	6.15	6.10	5.99
90	2915	3020	3138	3219	3073ab	1292cd	1329bcd	1347bcd	1377abc	1336ab	4.71de	4.79bcde	4.75cde	4.81bcde	4.76b	5.83	5.88	6.08	6.00	5.94
120	2989	3304	3295	3121	3177a	1213de	1514a	1467ab	1315cd	1377a	4.91abc	4.75cde	4.75cde	4.76cde	4.79b	5.78	5.83	5.88	6.00	5.87
Main Effects	2823	2940	2922	3009		1209	1299	1278	1298		4.76	4.84	4.84	4.83		5.84c	5.90bc	6.03a	6.01ab	

Project Impacts/Benefits

Zinc deficiencies are being observed in some areas and some fields around the state in multiple crops including corn and rice and occasionally in cotton. Soil tests around indicate a low soil available Zn in a growing number of soils. As grain crops are grown in place of cotton and with the higher nutrient removal, nutrient deficiencies are going to continue. This is particularly true with sulfur (S) as the supply of S to the soil is dwindling. The current research, especially for corn, has demonstrated a need and response to zinc. Further studies are needed for soil-applied S but also research with other S sources. The S and Zn issues are not going away as long as nutrient removal continues to occur. Without supplemental micronutrient applications, nutrient deficiencies will be severe for soil with low organic matter soils Several Zn sources are available in the marketplace and that indicates the need must be present. The interaction of N rates along with Zn rates helps examine the interaction of the two nutrients. Producers need the results from unbiased research to aid in their decision-making process. The soil samples collected after the harvest of corn or after picking cotton revealed that continuous application of Zn helped in the buildup of the zinc in the soil. The results from this study can be used by growers to decide agronomic and economic optimum Zn and N rates that can be used for higher net returns.

Project Deliverables

Results from these studies are being presented at the Southern Branch – American Society of Agronomy (Southern Association of Agricultural Scientists). This information in the form of deliverables is being made to producers and consultants as needed and will be better as more information (through repeated studies) becomes available. Have studies across multiple environmental seasons adds dependability to the outcomes of the research. With time and replications, the information gathered can be used to make sound decisions on Zn applications in both corn and cotton. The key to success is knowing what soil test Zn levels are present and also factors, such as pH, that influences Zn availability.

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