Mississippi Corn Promotion Board
2021 Progress Report

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

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Project Summary (Issue/Response)

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. The objectives of this study were to evaluate the interaction of nitrogen rates and zinc rates for optimizing corn and cotton yields in rotation on irrigated sandy soils and to determine the economic impact of the nitrogen and zinc applications while optimizing all other inputs. A corn/cotton rotation system is currently in place that has been used to address the above objectives. The study is located at the Delta Research and Extension Center with four nitrogen (N) rates (Corn: 160, 200, 240, and 280 lb N ac^{-1}; Cotton: 30, 60, 90, and 120 lb N ac^{-1}) and four zinc (Zn) rates (0, 5, 10, and 15 lb Zn ac^{-1}). Zinc sulfate was utilized (dissolved the dry material in water) and applied with a rolling coulter rig, similar to urea-ammonium nitrate solution. There were no interaction effects of Zn and N application rates for corn silage N uptake, corn silage Zn uptake, corn grain yield, corn grain protein content and harvest moisture in 2021. Corn yield for 240 and 280 lb N ac^{-1} was similar between both treatments and was at least 19 bu ac^{-1} greater when compared to 160 lb N ac^{-1} treatment. Cotton lint yield showed an interaction effect between N and Zn application rates and highest cotton lint yield of 1611 lb ac^{-1} was achieved with 90 lb N ac^{-1} plus 5 lb Zn ac^{-1} treatment. This yield was not different when additional Zn was added with 90 lb N ac^{-1} treatment. Therefore agronomic optimum cotton yield can be achieved with 90 lb N ac^{-1} plus 5 lb Zn ac^{-1} fertilizer application rate. Results from the study could be used by producers in their decision-making process.

Project Results/Outcomes

All data were statistically analyzed using the glimmix procedure in SAS statistical software. Nitrogen and zinc rates were treated as fixed factors and replications of the treatment were random factor. The model parameters were tested at alpha = 0.05. Mean comparisons were made using the T-grouping method with LSMEANS statement.

There were no interaction effects of Zn and N rate application for corn silage N uptake, corn silage Zn uptake, corn grain yield, corn grain protein content and harvest moisture in 2021. However, corn silage N uptake, corn grain protein content and corn yield were affected by the main effects of N rate application (Table 1) The highest yield 175 bu ac^{-1} was received with 280 lb N ac^{-1}. Corn yield for 240 and 280 lb N ac^{-1} was similar between both treatments and was at least 19 bu ac^{-1} greater when compared to 160 lb N ac^{-1} treatment. Corn silage Zn uptake was more than 14.1 lb Zn ac^{-1} for treatments 10 and 15 lb Zn ac^{-1} when averaged over N application treatments. Harvest moisture for corn increased as the N application rate was increased when averaged over the Zn application treatments.

Seed cotton yield was affected by the two-way interaction of N and Zn rate treatments (Table 2). The lowest seed cotton yield of 2528 lb ac^{-1} was observed in 30 lb N ac^{-1} and 0 lb Zn ac^{-1} treatment whereas a higher seed cotton yield of 3278 lb ac^{-1} was observed in 120 lb N ac^{-1} and 15 lb Zn ac^{-1} treatment. When N was applied at 30, 90, and 120 lb ac^{-1} with 10 or 15 lb Zn ac^{-1} the seed cotton yield showed no significant differences (Table 1). Cotton lint yield also showed an interaction effect and highest cotton lint yield of 1611 lb ac^{-1} was achieved with 90 lb N ac^{-1} plus 5 lb Zn ac^{-1} treatment. This yield was not different when additional Zn was added with 90 lb N ac^{-1} treatment. Therefore agronomic optimum cotton yield can be achieved with 90 lb N ac^{-1} plus 5 lb Zn ac^{-1} fertilizer rate. Cotton fiber fineness showed difference only with the main effects where cotton fiber fineness decreased with increasing rate of N application. In contrast, cotton fiber fineness increased with increasing rate of Zn application. Cotton fiber color showed significant differences with only N application rates (Table 2).

N Rate	Silage N Uptake (lb/ac)					Silage Zn Uptake (lb/ac)					Corn Yield at 15.5% (bu/ac)					Harvest Moisture (%)					Grain Protein (%)				
(lb N/ac)	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	186	186	155	180	177c	7.1	9.9	12.8	11.8	10.4b	155	157	150	149	153c	17.8	17.9	18.2	17.5	17.8c	9.1	8.7	8.7	8.6	8.8d
200	194	180	198	194	192c	6.5	9.4	13.2	12.7	10.5b	169	164	168	168	167b	17.2	18.4	18.3	18	18.0bc	9.4	9.6	9.3	9.4	9.4c
240	231	224	209	217	220b	10.2	12	12.4	16.3	12.8a	172	171	174	170	172ab	17.5	18.6	18.8	18.5	18.3ab	10	9.7	10	10	9.9b
280	210	252	272	256	248a	8	13.4	17.8	16.2	13.8a	173	176	168	183	175a	18.4	18.6	18.3	18.5	18.5a	10.4	10.2	10.4	10.1	10.3a
Main Effects	205	211	209	212		7.9c	11.2b	14.1a	14.3a		167	167	165	168		17.7b	18.4a	18.4a	18.1a		9.7	9.6	9.6	9.5	

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, harvest moisture and grain protein content. Means followed by the same letter within a column or a row do not differ significantly at P<0.05.

N Rate	Seed Cotton Yield (lb/ac)					Lint Yield (lb/ac)					Fiber Fineness (millitex)					Fiber Color (Rd)				
(lb N/ac)	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	2528g	2538g	2654fg	2909d-g	2924b	955j	1227fghi	1393bcd	1377cde	1238b	4.57	4.59	4.5	4.53	4.55a	83.7	82.63	83.65	83.7	83.42b
60	2878d-g	3038c-f	3064cde	3561ab	2872b	1122hi	1348cdef	1347cdef	1232efgh	1262b	4.33	4.54	4.63	4.67	4.54ab	83.93	83.85	83.88	84	83.91a
90	3039c-f	3228bcd	3359abc	3491ab	3278a	1083ij	1611a	1535ab	1530ab	1440a	4.15	4.42	4.5	4.59	4.41bc	84.28	84.28	83.73	83.68	83.99a
120	2729efg	2761efg	3052cde	3665a	3050b	1241efgh	1274defg	1447bc	1132ghi	1273b	4.26	4.38	4.31	4.41	4.34c	84.78	84.38	84.28	84	84.36a
Main Effects	2658c	3135ab	3279a	3052b		1100c	1365ab	1431a	1318b		4.33b	4.48a	4.48a	4.55a		84.17	83.78	83.88	83.84	

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 color). Means followed by the same letter within a column or a row do not differ significantly at P<0.05.

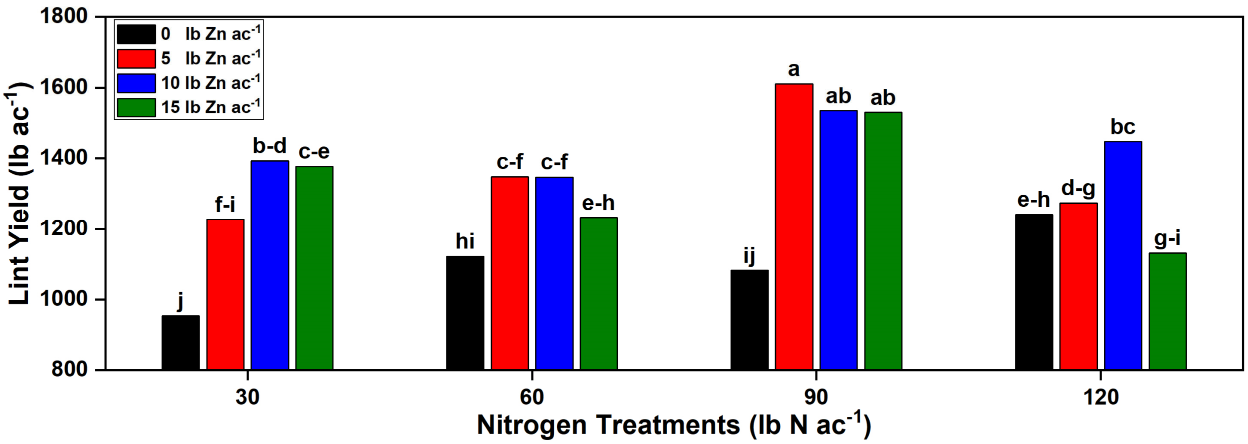

Figure 1. Average cotton lint yields for an interaction effect between N and Zn rate treatments. Means followed by the same letters on the bars do not differ significantly at P<0.05.

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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