Mississippi Corn Promotion Board

2020 Progress Report

Title: Stepwise Evaluation of High Tech Production Systems Contrasted to Existing Standard Production Systems

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Project Summary

As corn acreage and production has increased over the last few years in the South, the need for continued evaluation and incorporation of technology adapted to the region is needed. The grain yields produced exceed the calibration range of many soil tests and biotechnological advances are continuing at great costs to the producer. They face many decisions about inputs to incorporate and what inputs result in economic gains. Yield gains do not always lead to financial gains when the whole-farm enterprise is considered. Research has shown yield gains but have not included the economic implications. Researchers have utilized a stepwise technique that creates a "high tech" system and then systematically removes an input such as additional N, P, K, or fungicide then evaluates yield gain or loss. Inputs for the project included: Whole plots (SR vs TR and seeding rates of 32K or 40K); and Subplots (N rates, P and K rates, S, Zn, and fungicides). The input addition treatments were N-210, N-280, N-280+P&K, N-280+P&K+S, N-280+P&K+S+Zn, and N-280+P&K+S+Zn+F whereas input deletion treatments were N-280+P&K+S+Zn+F, N-280+S+Zn+F, N-280+Zn+F,N-280+F, N-280, and N-210. The 24-treatment studies were located at the Delta Research and Extension Center following soybean. Planting pattern (single-row [SR] vs twin-row [TR]) was evaluated at 32,000 and 40,000 seed/acre (whole plots). Heavy rainfall during the early growing season delayed planting until 12 April. Corn grain yield was significant for the main effects of planting patterns, seeding rates, and input additions. Twin row planting had average yield of 226 bu/ac which was 7.4 bu/ac higher compared to single row planting when average over seeding rates and input addition treatments. Corn grain yield was higher for 40K seeding rate compared to 32K seeding rate (224 vs 219 bu/ac). Treatment N-280+P&K and N-280+P&K+S+Zn+F had the highest grain yield of 227 bu/ac compared to N-280 (215 bu/ac) and N-210 (216 bu/ac) treatments when averaged over planting patterns and seeding rates. For input deletion treatments corn grain yield was significantly higher for N-280+P&K+S+Zn+F, N-280+S+Zn+F, N-280+Zn+F, N-280+F compared to nitrogen only treatments. On average grain moisture was lower for nitrogen only treatments compared to other input treatments indicating that more inputs result in delayed field drying of corn.

Project Results/Outcomes

The studies were planted on 12 April with a John Deere SR planter or Monosem TR planted into a prepared seedbed. Heavy rainfall during the early growing season made March plantings difficult with over 40 inches of rainfall occurring in the first half of 2020. However, even with late planting treatments were able to establish well, and timely application of inputs was favored by some dry windows that allowed for fieldwork. The input addition and deletion treatments were performed in May 2020 and fungicide application was applied at tasseling in June. The initial fertilizer N application was made post-emergence at V2 growth stage at 120 lb N/acre applied as urea-ammonium nitrate (UAN, 32% N). The solution was applied with a rolling coulter applicator to both sides of the row for both SR and TR systems. The remaining N was applied with the same applicator around V5-6 growth stage. The dry fertilizer additions were broadcast-applied in May by simulated aerial application followed by incorporation with a cultivar. Zinc was dissolved in water and applied with the rolling coulter applicator at a rate of 10 lb Zn/acre as zinc sulfate. The fertilizer phosphorus (P) and potassium (K) were applied at a rate of 90 lb P2O5/acre and 120 lb K2O/acre with pre-weigh bags. Sulfur (S) was applied at 20 lb S/acre. Corn was harvested on Sept. 16, 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). All collected data were statistically analyzed using the Glimmix procedure in SAS statistical software. Table 1 represents the probability values of type III tests of fixed effects for both input addition and deletion treatments. Corn grain yield was significant for the main effects of planting patterns, seeding rates and input additions. Twin row planting had an average yield of 226 bu/ac which was 7.4 bu/ac higher compared to single row planting when average over seeding rates and input addition treatments. Corn grain yield was higher for 40K seeding rate compared to 32K seeding rate (224 vs 219 bu/ac). Treatment N-280+P&K and N-280+P&K+S+Zn+F had highest grain yield of 227 bu/ac compared to N-280 (215 bu/ac) and N-210 (216 bu/ac) treatments when averaged over planting patterns and seeding rates (Table 2). Similarly, for input deletion treatments corn

Project Results

grain yield was significantly higher for N-280+P&K+S+Zn+F, N-280+S+Zn+F, N-280+Zn+F, N-280+F compared to nitrogen only treatments (Table 2). Grain moisture at harvest showed an interaction effect of planting patterns and inputs additions or deletions (Table 1). On average grain moisture was lower for nitrogen only treatments compared to other input treatments indicating that more inputs result in delayed field drying of corn (Table 2). Bushel test weight was significantly lower for N-280 treatment when compared to all other input addition and deletion treatments (Table 2). Grain quality was also affected by input addition and deletion treatment's main effects (Table 1). Grain oil was 3.72% for N-280+P&K+S treatment and was significantly higher than N-280+P&K+S+Zn, N-208 and N-210 input addition treatments. Grain protein in input addition treatment was significantly higher for all treatments when compared to the N-210 treatment. Treatment N-280+P&K+S and N-280+P&K+S+Zn+F had seed index of 30.41 and 30.95 which was significantly higher than N-280 and N-210 treatments (Table 2). For input deletion treatments, N-280+P&K+S+Zn+F had a grain protein of 8.98% and was significantly higher than all other treatments. Seed index for N-280 and N-210 input deletion treatments was lowest 27.87 and 27.82 g/100 seeds among all other treatments (Table 2). The interaction between planting patterns and input addition or deletion treatments was significant for grain starch content. In general grain, starch was highest for nitrogen-only treatments when compared to all other treatments.

Table 1. Probability value table for parameters collected from input additions and deletions corn study in year 2020. Statistical analysis was performed at $p<0.1$. Model significance is indicated in bold values.

	Source of variation	df	Grain Yield @ 15.5% bu/ac	Grain Moisture %	Test Weight lb/bu	Grain Oil	Grain Protein %	Grain Starch	Seed Index g/100 seeds
Input additions	Planting Pattern (PP)	1	**0.0095**	0.5873	0.8317	**0.0517**	**0.0030**	**0.0110**	0.1346
	Seeding Rate (SR)	1	**0.0975**	0.3753	**0.0784**	0.5544	**0.0263**	0.3235	**0.0612**
	Input Additions (IA)	5	**0.0428**	**<.0001**	**0.0935**	**0.0612**	**<.0001**	**0.0008**	**0.0002**
	PP x SR	1	0.3611	0.5873	0.3404	0.8436	1.0000	0.2305	0.5844
	PP x IA	5	0.5871	**0.0043**	0.3760	0.2606	0.3233	**0.0954**	0.9743
	SR x IA	5	0.2884	0.9967	0.9772	0.7444	0.7843	0.1289	0.9224
	PP x SR x IA	5	0.9173	0.9803	0.9947	0.8026	0.9642	0.6106	0.1364
Input deletions	Planting Pattern (PP)	1	0.1848	0.2083	0.4856	**0.0798**	**0.0120**	0.1050	0.0372
	Seeding Rate (SR)	1	0.9426	0.2583	**0.0273**	0.4487	0.2447	**0.0579**	**0.0171**
	Input Additions (IA)	5	**0.0002**	**0.0021**	**0.0777**	0.1230	**<.0001**	**<.0001**	**0.0003**
	PP x SR	1	0.2423	0.6734	0.2508	1.0000	0.7259	0.3563	0.4586
	PP x IA	5	0.7103	**0.0333**	0.7395	0.9818	0.4892	**0.0215**	0.7173
	SR x IA	5	0.2064	0.5236	0.9699	0.6564	0.2152	0.5542	0.3841
	PP x SR x IA	5	0.1538	0.8741	0.8253	0.6854	0.9187	0.9415	0.8883

Table 2. Means represent input additions and deletions treatments' main effects for corn grain harvest moisture, test weight, corn grain yields, grain oil, protein, starch content and seed index. Means followed by the same letter within a column or a row do not differ significantly at $p<0.1$.

	Inputs	Grain Yield @15.5% (bu/ac)	Grain Moisture (%)		Test Weight (lb/bu)	Grain Oil (%)	Grain Protein (%)	Grain Starch (%)		Seed Index (g/100 seeds
			Single Row	Twin Row				Single Row	Twin Row	
Input additions	N-210	216bc	15.2d	15.8bc	59.2ab	3.64bc	8.41b	72.68a	72.66a	28.66d
	N-280	215c	15.8bc	15.7c	58.9b	3.61c	8.9a	72.59ab	72.54abc	29.62c
	N-280+P&K	227a	15.7c	16.1ab	59.4a	3.68ab	8.98a	72.26bcd	72.36abc	30.05bc
	N-280+P&K+S	223ab	16.1ab	15.7c	59.6a	3.72a	8.88a	71.75e	72.43abc	30.41ab
	N-280+P&K+S+Zn	224ab	16.3a	16.1ab	59.4a	3.64bc	8.9a	72.24cd	72.45abc	30.21abc
	N-280+P&K+S+Zn+F	227a	16.4a	16.4a	59.6a	3.67ab	8.96a	71.99de	72.36abc	30.95a
Input deletions	N-280+P&K+S+Zn+F	210a	14.8bcd	15.1a	60.1a	3.74	8.98a	72.13f	72.26ef	29.31a
	N-280+S+Zn+F	214a	14.9abc	15.1a	59.8ab	3.73	8.68b	72.26ef	72.41cde	29.07a
	N-280+Zn+F	213a	14.7cde	15ab	59.9ab	3.68	8.56bc	72.59bcd	72.33ef	28.68a
	N-280+F	212a	15ab	14.7cde	59.8ab	3.72	8.63b	72.25ef	72.39de	29.07a
	N-280	202b	14.8bcd	14.6ed	59.4c	3.74	8.41c	72.44cde	72.9a	27.87b
	N-210	199b	14.5ed	14.7cde	59.7bc	3.69	8.04d	72.69ab	72.64bc	27.82b

Project Impacts/Benefits

Station research and on-farm research have both shown benefits from increased seeding rates and N rates in corn. Often the small increases in grain yields from increasing N rates has not been profitable even though the differences are significant. On-farm big plot research has shown grain yields increase up to 40,000 (40K) seeds/acre. Current research is being completed to take seeding rates in the Mid-South to even higher levels. After several years of research, going above 45K is not giving higher yields but is decreasing profits. In the same study, increasing N rates above recommended levels has also not resulted in higher grain yields but does reduce profitability. The current project is planned for continuation. The combination of input factors is vital to profitable corn production in the Mid-South. The study puts together in one study many of the fertility and production-related inputs that pose questions for producers each year. The overall impact is to increase profitability and this may be obtained with current yields. The producers often seek higher yields but greater profitability should be more important. While higher yields are important, the unit cost of production is more important. The proposed research also shows the impact of just adding extra fertilizer when it may not be needed. Applying fertilizer for the sake of application may not be profitable. Soil sampling and belief in the product delivered is equally important to profitability. Producers should know the philosophy of the person/company handling their fertilizer needs and remember that they are in business to sell a product. Applying unneeded fertilizer can be a detriment to the environment and pocket book.

Project Deliverables

Results from this project will be the topic of discussion for the upcoming southern branch ASA Conference. One must be cautious in presenting limited data. However, when delivered properly, it can be quite useful to producers because it allows them to compare the practices with on-going research. As the studies are repeated and additional support for the practices become available, more confidence will be gained in the results and a stronger push for adoption. Theory is good but not always practical or economic. The popular press pushes information, supported by seed companies for high yields in yield contests. Unfortunately, when the grower is asked about his/her whole-farm yields and the profitability of their "garden" plot, he/she is reluctant to respond.

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