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Effect of Irrigation, Nitrogen, and Plant Population on Corn and Sorghum Grown for Silage

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Summary

Sorghum produced greater dry matter yield than corn under irrigated and dryland conditions in 1987. Nitrogen fertilizer significantly increased dry matter when 160 lbs N/A were applied in both irrigated and dryland corn and sorghum. Irrigation significantly increased corn yield but not sorghum yield.

Introduction

Interest in the use of silage for dairy animals in the large and growing dairy industry of the West Cross Timbers has resulted in the need for information on species and hybrid selection, water response, nitrogen requirement, and plant population. Results of corn and sorghum hybrid performance comparisons have been published (Jones and Read 1986; 1985a; and 1985b). The objective of this test

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was to determine the effect of the above factors on dry matter production, crude protein, and component contribution to total yield. Only dry matter production will be reported here.

Procedure

The test site was a Windthorst fine sandy loam soil near Stephenville. Main plots were either irrigated or dryland and each was further subdivided into nitrogen rate, species, and plant population and replicated four times.

Fertilizer was applied to land previously moldboard-plowed and disked. All plots received 160 and 80 lbs P_2O_5 and K_2O, respectively. Nitrogen rates were 0, 160, and 320 lbs/A; ammonium nitrate, triple superphosphate, and muriate of potash were incorporated by disking.

Pioneer 3165 hybrid corn and DeKalb-Pfizer FS-25e hybrid forage sorghum were surplus seeded into 36-inch rows on April 9 and April 28, 1987, respectively. Sorghum was replanted on June 19 due to difficulty in achieving adequate plant population. Plants were thinned to approximately 0.6, 1.0, 2.2, and 3.8 plants per row-foot (PPRF) in corn and 2.2, 3.5, and 4.7 PPRF in sorghum. The high population in sorghum of 8 PPRF was not achieved due to difficulty in getting good germination despite overplanting and replanting.

Rainfall and irrigation varied by crop and harvest date. Corn received 13.75 inches of rainfall while sorghum had 4.50 inches. Corn and sorghum received 4.8 and 16.0 inches of irrigation, respectively.

Plants were harvested when the grain reached the soft dough stage. Corn was in medium dent, and in both corn and sorghum, soft dough corresponds to about 35 percent dry matter. Plant weight per 10 row-feet was determined and subsamples were taken to obtain dry matter percentages, component weights, and crude protein percentages. Dry matter percentages were determined by drying at 158°F.

Dry matter tonnage was subjected to general linear models procedures including analysis of variance(4). Nitrogen and plant population effects were tested by F tests using pairwise comparisons. Populations were tested and found to be discrete by frequency tabulations based upon plant counts made at harvest.

Results and Discussion

Dry matter yields of corn were significantly improved by the relatively small amount of irrigation despite high rainfall early in the season (Table 1). Sorghum did not show a response to irrigation despite much less rainfall during its growing period and much greater irrigation than corn. Sorghum produced significantly greater dry matter than corn under both irrigated and dryland conditions.

Nitrogen response occurred for both corn and sorghum under irrigation and dryland (Table 2). Dry matter significantly increased when 160 lbs N/A was applied. Yield of irrigated corn increased from 1.56 to 4.78 tons DM/A while yield of dryland corn increased from 1.24 to 4.55 tons/A. Dry matter yield of irrigated sorghum increased from 2.77 to 7.54 tons/A while dryland yield increased from 4.71 to 7.16 tons. The reason for greater yield at zero nitrogen in dryland sorghum as compared with irrigated sorghum is obscure.

Planned and actual plant population means and their standard deviations are listed in Table 3. Corn populations were very close to chosen levels with low variability. Sorghum populations were much greater than planned but also with low variability.

Dry matter of irrigated corn at 2.2 PPRF was as great as at 3.8 PPRF and greater than at 0.6 PPRF (Table 4). The interaction between nitrogen and 2.2 and 3.8 PPRF in irrigated corn (Fig. 1) indicates that 3.8 PPRF produced greater dry matter at the 160-N rate. In dryland sorghum 3.5 PPRF resulted in 6.60 tons DM/A over all nitrogen rates, and the dry matter at 4.7 PPRF was not significantly greater (Table 4). Population differences did not result in

TABLE 1. EFFECT OF WATER AND SPECIES ON TONS DRY MATTER PER ACRE

Species	Irrigated	Dryland	p(water)*
corn	3.71	3.36	0.004
sorghum	6.31	6.46	0.673
p(species)*	0.000	0.000	

*Probability level from analysis of variance.

TABLE 2. NITROGEN EFFECTS ON TONS DRY MATTER PER ACRE IN IRRIGATED AND DRYLAND CORN AND SORGHUM

Irrigated							
Corn (Pounds N Per Acre)				Sorghum (Pounds N Per Acre)			
0	160	320	p*	0	160	320	p*
1.56	4.78	—	0.000	2.77	7.54	—	0.000
1.56	—	4.80	0.000	2.77	—	8.63	0.000
—	4.78	4.80	0.94	—	7.54	8.63	0.17
Dryland							
1.24	4.55	—	0.000	4.71	7.16	—	0.000
1.24	—	4.29	0.000	4.71	—	7.45	0.000
—	4.55	4.29	0.285	—	7.16	7.45	0.38

*Probability of a greater F value for the nitrogen rate comparison in each row. Values of 0.05 or less commonly denote significant differences.

TABLE 3. PLANNED AND ACTUAL PLANT POPULATIONS

Corn			*Sorghum*		
Plants Per Row-Foot					
Planned	Actual	SD*	Planned	Actual	SD*
0.5	0.60	0.02	1	2.22	0.13
1.0	1.02	0.04	2	3.50	0.18
2.0	2.20	0.17	4	4.68	0.27
4.0	3.79	0.17	8	—	—

*Standard deviation.

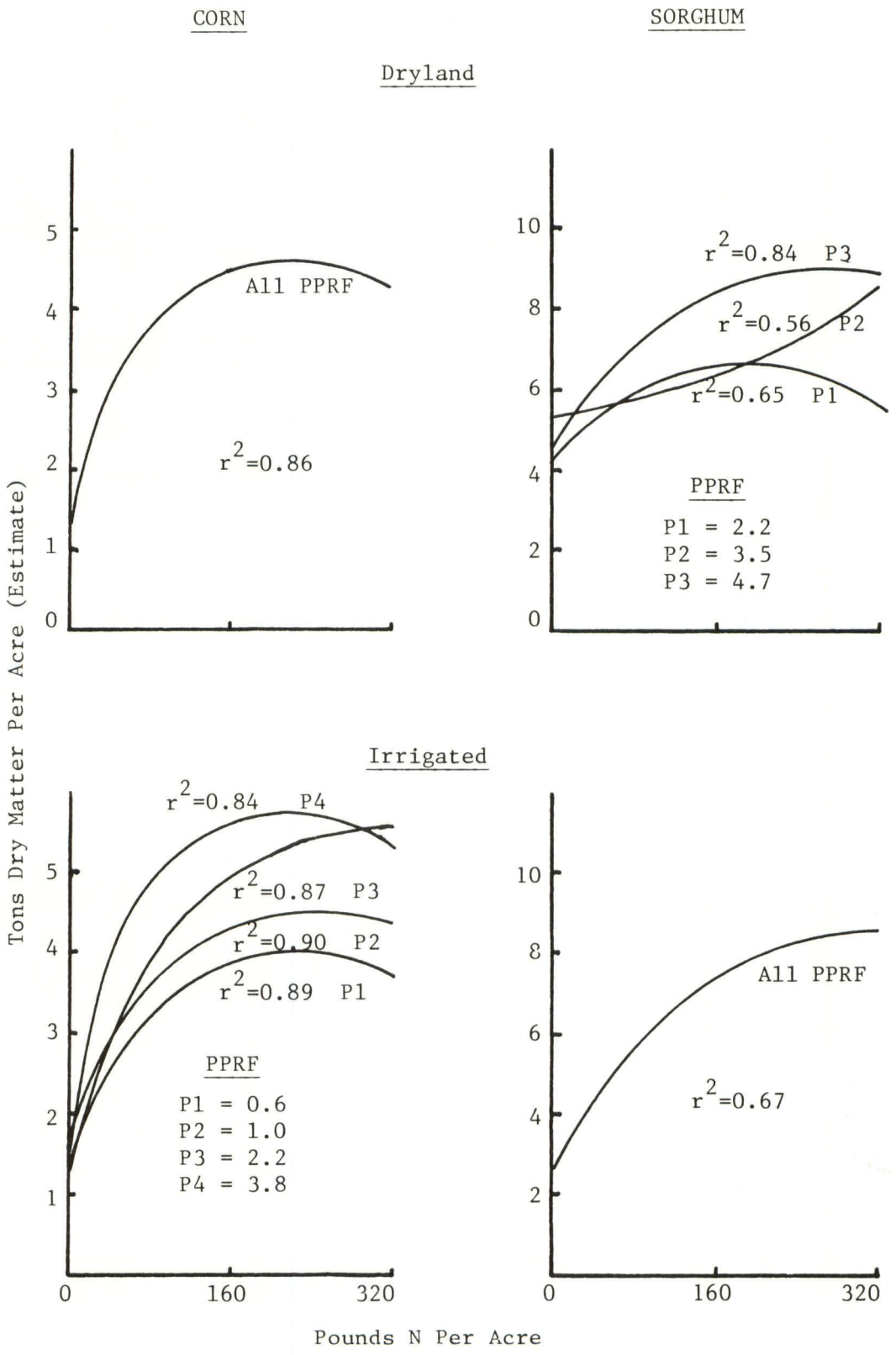

*Figure 1. Regression of pounds fertilizer nitrogen per acre or tons dry matter per acre of irrigated and dryland corn and sorghum at differing plants per row-foot (**PPRF**).*

significant yield differences in irrigated sorghum or dryland corn.

Regression equations for both irrigated and dryland corn fit the original yields relatively well with coefficients of determination (r^2) of 0.84 to 0.90 for differing plant populations (Fig. 1). Dry matter yield at 4.7 PPRF in dryland sorghum was also well defined by a regression equation (r^2=0.84). Unlike other populations the curve for 3.5 PPRF for dryland sorghum shows an increasing rate of response to applied nitrogen. This indicates a much greater nitrogen response to the 320-N rate than at other populations, but also less response to the 160-N rate. The regression equations and the standard error (SE) of the estimates are given in Table 5.

Literature Cited

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TABLE 4. PLANT POPULATION EFFECTS ON TONS DRY MATTER PER ACRE OF IRRIGATED AND DRYLAND CORN AND SORGHUM

Irrigated								
Corn Plants Per Row-Foot					*Sorghum Plants Per Row-Foot*			
0.6	1.0	2.2	3.8	p*	2.2	3.5	4.7	p*
3.12	3.49	—	—	0.170				
3.12	—	4.01	—	0.003				
3.12	—	—	4.24	0.000	No Significant Differences			
—	3.49	4.01	—	0.067				
—	3.49	—	4.24	0.011				
—	—	4.01	4.24	0.383				
				Dryland				
					5.46	6.60	—	0.011
No Significant Differences					5.46	—	7.49	0.000
					—	6.60	7.49	0.117

*Probability of a greater F value for the population comparison in each row. Values of 0.05 or less commonly denote significant differences.

TABLE 5. REGRESSION INTERCEPTS, NITROGEN COEFFICIENTS, STANDARD ERRORS, AND COEFFICIENTS OF DETERMINATION (r^2) FOR ESTIMATED TONS DRY MATTER PER ACRE IN IRRIGATED AND DRYLAND CORN AND SORGHUM AT DIFFERENT POPULATIONS

Plants Per Row-Foot	Intercept	Coefficient for		SE	R^2
		N	N^2		
		Corn (dryland)			
All	1.236	0.032	−0.0000698	0.160	0.86
		Corn (irrigated)			
0.6	1.58**[1]	0.023**	−0.0000509**	0.226	0.89
1.0	1.68**	0.025**	−0.0000522**	0.252	0.90
2.2	1.38**	0.033**	−0.0000609**	0.416	0.87
3.8	1.63**	0.039**	−0.0000858**	0.463	0.84
		Sorghum (dryland)			
2.2	4.27**	0.0255**	−0.0000676	0.407	0.65
3.5	5.20**	0.0049	−0.0000145	0.646	0.56
4.7	4.66**	0.0348**	−0.0000667**	0.573	0.84
		Sorghum (irrigated)			
All	2.765**	0.041**	−0.000072**	0.537	0.672

[1]Two asterisks indicate that the intercept or coefficient is significant at p=0.01 or less.