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Research Note

Fertilization Practices for Corn and Cotton in Subtropical South Texas

Robert Wiedenfeld

Texas A&M University Agricultural Research and Extension Center, 2415 E. Hwy 83, Weslaco, TX 78596

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ABSTRACT

Little recent work has been done on fertilization requirements for corn (*Zea mays* L.) and cotton (*Gossypium hirsatum* L.) in the Lower Rio Grande Valley of Texas. Foliar fertilization, acid fertilizer solutions, and P application are being used with little data to support their effectiveness in this area. In this study, soil nutrient status initially was very good except for very low NO_3^--N levels. Increasing N application increased plant N concentration and N uptake by both corn and cotton, and also increased yields of cotton but not corn. Acidification of the N fertilizer solution and P application on corn; and foliar application of part of the N applied on cotton had no effect on growth, N uptake or yield of either crop. Unusually heavy rainfall which resulted in standing water on part of the field substantially reduced yields in that area and may have reduced crop responses to fertilizer application.

RESUMEN

Existe poco trabajo realizado recientemente sobre los requerimientos de fertilización para el maiz *(Zea mays* L.) y el algodón *(Gossypium hirsatum* L.) en la parte baja del Valle del Rio Grande en Texas. El uso de prácticas de fertilización foliar, soluciones fertilizantes ácidas y de la aplicación de potasio ha sido realizado con la existencia de pocos datos que soporten su efectividad en esta área. En este estudio, la condición inicial de nutrientes en el suelo fué muy buena excepto por la presencia de niveles muy bajos de NO_3^-−N. El incremento en la aplicación de nitrógeno aumentó la asimilación y la concentración de este elemento en las plantas de algodón y de maiz e incrementó los rendimientos en el caso del algodón pero no en el del maiz. La acidificación de la solución fertilizante de nitrógeno y la aplicación de potasio en el maiz asi como la aplicación foliar de parte del nitrógeno aplicado al algodón no tuvieron efecto sobre el crecimiento, la asimilación de nitrógeno o la cosecha de ninguno de los cultivos. La presencia inusual de lluvias pesadas que provocaron el estacamiento del agua en parte del terreno de cultivo redujo substancialmente los rendimientos en esta área y puede haber reducido las respuestas del cultivo a la aplicación de fertilizantes.

Fertilization is a major input for crop production in the Lower Rio Grande Valley (LRGV) of Texas. Studies conducted in this region have found the need for up to 67 kg N/ha (60 lbs/acre) on cotton (Burleson et al, 1955, Burleson et al., 1958), while application of 134 kg N/ha (120 lbs/ac) placed near the seed has been found to delay seedling emergence (Burleson et al., 1955). No N fertilization studies on corn from the LRGV have been reported. Factors such as crop rotation have been found to strongly affect responses to N application (Dacus et al., 1961, Hipp and Gerard, 1971). Phosphorus levels have generally been found to be high in the LRGV, with Box (1968) reporting 82% of soils tested being high or medium in P in South Texas, and Pennington et al. (1982) reporting 69 to 92% of soils tested as high or medium in P in the LRGV, depending on county. Studies have not shown any yield responses to P application (Burleson et al., 1958, Dacus et al., 1961, Hipp, 1977), while Burleson et al. (1961) found that high levels of P induced Zn deficiencies in corn. Recommendations developed some time ago (Pennington and Metzer, 1976, Staff, 1964) for N call for 34-56 kg/ha (30-50 lbs/acre) on cotton with the higher rates on heavier soils, and 45-67 kg/ha (40-60 lbs/acre) on corn. Recommendations for P for both cotton and corn are that the P applied to other crops in rotation (vegetables) is adequate, or apply 45-67 kg/ha (40-60 lbs/acre) every 2-3 years for maintenance. Rates somewhat higher than these are commonly accepted as necessary today based on grower experience and the influence of advisors from fertilizer retailers. Fertilizer recommendations based on results obtained elsewhere are questionable since differences in climate and soil type substantially affect nutrient cycling as well as crop physiology.

Practices recently being suggested by various interests as ways to better meet crop nutrient requirements in the LRGV include foliar fertilization and the use of acid fertilizers. When using foliar fertilization, the nutrients must penetrate the cuticle of the leaf or the stomata and then enter the cells. It has been difficult to supply adequate N without severely burning the leaves. Foliar fertilization has been found to be effective in the application of micronutrients, and for application of N as urea on some fruit crops (Tisdale and Nelson, 1966). This method provides for rapid utilization of nutrients, but the response has often only been temporary. In the LRGV, foliar application of N has been evaluated on vegetables and on soybeans, and found effective only where severe nutrient deficiencies occurred (Wiedenfeld, 1984, Wiedenfeld et al., 1988)

Acid fertilizers are relatively new. They have been found to be effective in reclaiming Na-affected soils by solubilizing Ca compounds (Ryan and Tabbara, 1989). This characteristic may also increase P and micronutrient availability in calcareous soils (Mortvert and Kelsoe, 1987) such as in the LRGV.

This study was conducted to evaluate the effectiveness of foliar fertilization, fertilizer solution pH, and P application on crop growth, nutrient availability and yield under irrigation in a subtropical environment.

MATERIALS AND METHODS

A field study was conducted in 1992 at the Texas A & M University Agricultural Research and Extension Center at Weslaco on a Hidalgo sandy clay loam soil. The area was prepared into raised beds 102 cm (40 in.) wide for cotton, and 76 cm (30 in.) wide for corn. Preplant soil samples were taken to a depth of 15 cm (6 in.) from random spots within 8 zones evenly distributed over the study area. The soil samples were composited within each zone and were analyzed by the Extension Soil Testing Laboratory (Texas Agricultural Extension Service, College Station, TX 77843) for NO_3^-— N, P, K, micronutrients, salinity, pH and organic matter content.

Treatments applied to cotton consisted of three total N rates - 0, 56 and 112 kg/ha (0, 50 and 100 lbs/acre); and 4 foliar N rates - 0, 19, 37 and 56 kg/ha (0, 17, 33 and 50 lbs/acre). Preplant applications were made consisting of the total N rate less the amount of N that was to be foliar applied later, and was applied banded in the soil as liquid N-32 (½ urea-N, ½ NH_4NO_3-N). Foliar N applications were made in weekly applications at a constant rate of 19 kg N/acre (17 lbs/acre) beginning on 26 May and continuing for the number of weeks necessary to achieve the foliar N application rate specified by the treatment plan. Foliar fertilizer consisted of urea along with a sticker-spreader and was diluted such that the total spray volume was 281 L/ha (30 gals/acre) and was applied using a CO_2 pressurized sprayer. While the foliar N rate was somewhat high, no ''burning'' of the foliage was observed.

Treatments applied to corn consisted of three N rates - 0, 67 and 134 kg/ha (0, 60 and 120 lbs/acre); two N fertilizer solution pH's - 1 and 7; and two P_2O_5 rates - 0 and 45 kg/ha (0 and 40 lbs/acre). Phosphorus application was combined only where N fertilizer pH was 7, giving a total of 8 treatments. Nitrogen fertilizer consisted of liquid N-32, and no pH adjustment was made for the pH 7 treatment while the solution pH for the pH 1 treatment was adjusted using sulfuric acid, with approximately 32 ml of H_2SO_4 per liter of N-32 (4.1 fl. oz./gal.) required. Phosphorus consisted of granular triple superphosphate (0-45-0). Both fertilizers were applied in bands - P directly below and N below and to both sides of the seed row.

Treatments were arranged in randomized block designs and were replicated 4 times for each crop. Plots were 6 rows wide for both crops [6.1 m (20 ft.) wide for cotton, 4.6 m (15 ft.) wide for corn], and the length was 7.6 m (25 ft.) for cotton, and 12.2 m (40 ft.) for corn. Crops were planted on 19 and 20 March - cotton cultivar DP&L 50, and corn cultivar Pioneer 3165Y. Herbicide bensuilide (O, *O-bis (1-methylethyl) S-[2[(phenylsulfonyl) amino] ethyl 1 phosphor-odithioate)* (Prefar, ICI Agricultural Products, Wilmington, DE, 1989) was applied to cotton following planting and no herbicide was applied to corn. Insecticide use consisted of carbofuran (Furadan, FMC Corporation, Philadelphia, PA 19103) applied to corn at planting; and applications of azinphos-methyl (Guthion, Mobay Corporation, Kansas City, MO 64120) to cotton on 7 May; 5, 9, 25 and 29 June; and 12 July. The crops were hand-thinned to a 7.6 cm (3 in.) spacing for cotton, and 15 cm (6 in.) spacing for corn [plant populations - 129,100/ha (52,300/acre) for cotton and 85,9000/ha (34,800/acre) for corn]. Weeds were controlled using mechanical cultivation and hand-hoeing.

Measurements were taken to determine total above ground biomass produced, plant nutrient concentration and uptake, and yield. Samples consisting of two whole plants including all above ground material both vegetative and fruiting were taken from each plot on 24 June. These were air dried, weighed, ground, and analyzed for total N concentration using a wet acid digestion and a Wescan® Ammonia Analyzer (Altech Associates, Deerfield, IL 60015). Plant population was determined on 6 July for the corn and 16 July for the cotton by counting all plants in a 3.1 m (10 ft.) section in each plot. Corn plots were harvested for yield on 20 July by hand-picking all ears from the middle two

Table 1. Soil test analyses of samples taken preplant from throughout the study area.

	NO_3^-−N	P	K	Ca	Mg	Zn	Fe
				ppm			
mean	5.1 (vl[z])	>180 (vh)	808 (vh)	19,950 (vh)	567 (vh)	0.26 (m)	6.4 (h)
std. dev.	1.4	—	50	3080	47	0.06	0.67
	Mn	Cu	S	Na	salinity	pH	% O.M.[y]
				ppm			
mean	6.0 (h)	1.26 (h)	39 (h)	93 (vl)	301 (n)	8.6	1.3
std. dev.	0.71	0.10	5.8	18	48	—	0.16

[z]n = none, vl = very low, m = medium, h = high, vh = very high

O.M.[y] = organic matter

rows of each plot. The corn was thrashed, weighed, and the moisture content and bushel weight were determined. Corn yields are reported on a 15% moisture basis. Cotton plots were harvested on 5 August and 12 August by hand-picking the cotton from all open bowls in the two middle rows of each plot, then weighing. Cotton yields reported include both lint and seed.

All data were analyzed statistically using the GLM procedure of the SAS software system for data analysis, and means were compared using orthogonal contrasts or multiple linear regression, as appropriate (SAS Insitute Inc., 1988).

RESULTS AND DISCUSSION

Soil samples taken preplant showed very low levels of $NO_3^- - N$, high levels of all other nutrients, and no salinity hazard (Table 1). Organic matter content averaged 1.3% which is above average for the LRGV of 0.5 to 1.0%.

Plant biomass samples taken on 24 June showed no significant response by either crop to any fertilizer treatment (Tables 2 and 3). Corn and cotton produced an average of 11,700 and 5,700 hk/ha (10,400 and 5,100 lbs/acre) total dry matter, respectively. Plant N concentration increased with increasing N applied to both crops, with corn showing a quadratic response (Table 2) while cotton showed a linear response (Table 3). This resulted in linear increases in N uptake for both crops with increasing N applied. While corn produced roughly twice as much biomass as cotton, total N uptake for corn was only 17% greater than for cotton since cotton had a higher plant N concentration than did corn. Fertilizer pH and P application on corn, and foliar N application on cotton had no significant effect on plant N concentration or N uptake for either crop (Tables 2 and 3).

Corn yields were not affected by rate of N application (Table 2), while cotton yields showed a linear increase with increasing N applied (Table 3). Again fertilizer pH and P application on corn, and foliar N applications on cotton had no significant effects on yields of either crop.

Above average rainfall was received during this study, and this

Table 2. Corn total dry weight, plant N concentration and uptake 95 days after planting; and yield for various fertilizer treatments.

treatment		total dry wt.		N conc.	N uptake		yield	
		kg/ha	lbs/acre	%	kg/ha	lbs/acre	kg/ha	bu/acre
N rate								
kg/ha	(lbs/acre)							
0	(0)	11,200^z	10,000	0.95	112	100	4,200	68.0
67	(60)	11,700	10,500	1.25	147	131	4,000	64.0
134	(120)	11,800	10,600	1.26	150	134	3,900	63.0
significance		NS		Q**	L*		NS	
pH								
7		12,000	10,700	1.23	149	133	3,800	60.6
1		11,900	10,700	1.25	148	133	3,400	54.6
significance		NS		NS	NS		NS	
P_2O_5 rate								
kg/ha	(lbs/acre)							
0	(0)	11,300	10,100	1.14	138	120	3,800	61.6
45	(40)	11,900	10,600	1.15	138	124	4,200	68.3
significance		NS		NS	NS		NS	
average		11,700	10,400	1.17	139	124	3,900	62.4

z Mean comparisons were made using orthogonal contrasts and differences were linear (L), quadratic (Q), at the 5% (*), 1% (**), or not significant (NS).

probably had an impact on the yield levels, and also possibly on the fertilizer responses obtained in this study. Total rainfall received during this study was 32.8 cm (12.9 in.) for corn and 38.6 cm (15.2 in.) for cotton, which is more than 50% above the 78 year average, with most of the rain being received in April and May. No irrigations were applied to corn, and only one irrigation was made on cotton on 26 June. Surface drainage on this block of land was from south to north, or from block 1 to block 4 for both crops. When heavy rainfall was received, water tended to stand longer on the north end of the field. This resulted in visually evident reduced plant growth, and also was evident in reduced yields of both crops from blocks 1 to 4 (Fig. 1).

Table 3. Cotton total dry weight, plant N concentration and uptake 96 days after planting; and yield for various fertilizer treatments.

treatment		total dry wt.		N conc.	N uptake		yield	
		kg/ha	lbs/acre	%	kg/ha	lbs/acre	kg/ha	lbs/acre
total N								
kg/ha	(lbs/acre)							
0	(0)	5,060	4,510	1.85	92	82	2,520	2,260
56	(50)	5,510	4,920	1.90	107	96	2,870	2,570
112	(100)	6,040	5,400	2.05	130	116	3,030	2,710
significance		NS		L**	L*		L*	
Foliar N								
kg/ha	(lbs/acre)							
0	(0)	6,030	5,380	1.92	116	104	3,050	2,720
19	(17)	6,010	5,370	2.04	131	117	3,020	2,700
37	(33)	5,550	4,960	1.96	113	101	3,000	2,700
56	(50)	5,510	4,920	1.99	114	102	2,740	2,450
significance		NS		NS	NS		NS	
average		5,690	5,080	1.96	116	103	2,910	2,590

[z]Mean comparisons were made using multiple linear regression and differences were linear (L) at the 5% (*) or 1% (**) level, or not significant (NS).

SUMMARY

Both corn and cotton showed responses to N application: for corn only in N concentration and uptake, and for cotton also in yield. The other fertilizer practices evaluated including acid fertilizer pH, P application and foliar N application had no effect on growth, N uptake or yield. The lack of response to low fertilizer pH and P application are as expected since the soil was very high in P initially. While NO_3^- – N levels were low in the soil initially, the soil could have had a high N mineralization potential from previous crop residues since organic matter content in the soil initially was somewhat above what is normally encountered in the LRGV under cultivation. None-the-less, growth and yield responses to N fertilizer may have been restricted by the flooded soil conditions that existed in part of the field for part of the crop's growth.

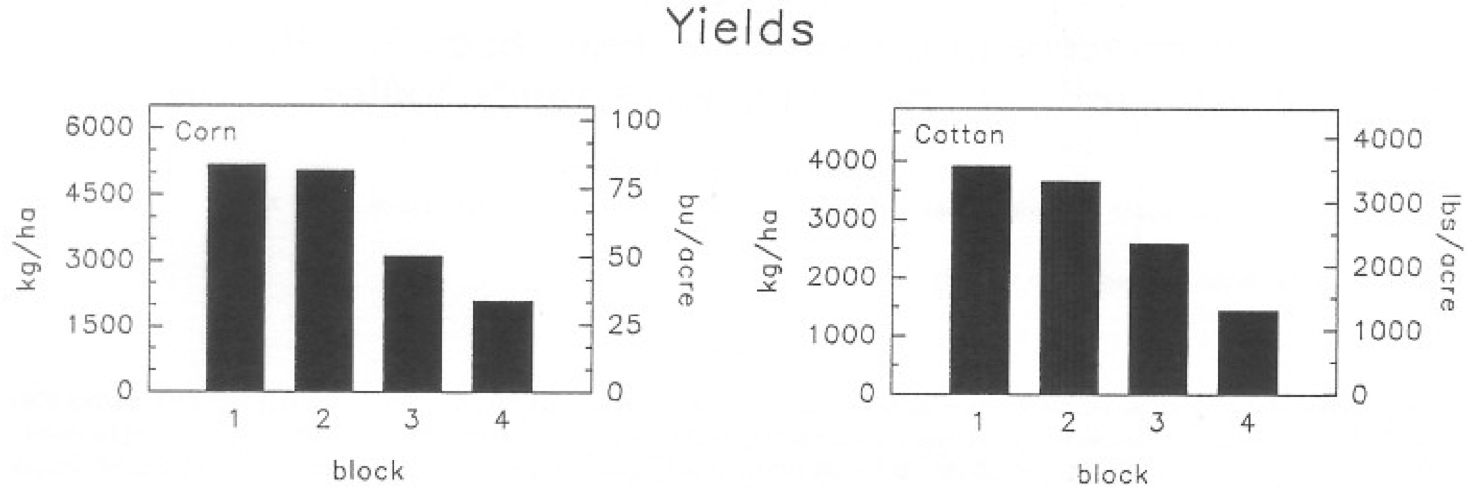

Fig. 1 Corn and cotton yields for the 4 blocks in which this study was replicated. Blocks were arranged from south (1) to north (4) with the most standing water occuring on the north end of the study site.

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