Nitrogen Requirements and Nutrient Content of No-Tillage Tropical Corn and Forage Sorghum

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ABSTRACT

Tropical corn *(Zea mays* L) and forage sorghum *(Sorghum bicolor* L. Moench) can provide Florida farmers with alternatives in multiple cropping. The objectives of this study were to determine 1) inorganic N requirements for 'Pioneer brand X304C' corn and 'DeKalb FS25E' forage sorghum under no-tillage management, 2) leaf N-yield relationships and 3) content of nutrients. Crops were whole plots, and N rates (0, 6.7, 13.4 and 20.1 g N/m^2) were split plots with five replications. In-row subsoil no-tillage planting into rye *(Secale cereale* L) straw gave 79,000 corn seed/ha and 247,000 sorghum seed/ha Dry matter yield estimates were from middles of plots. MicroKjeldahl and dry ashing procedures were used for N and minerals, respectively. Dry matter per m^2 times concentration gave nutrient content per m^2. Dry matter increased from N fertilizer more in sorghum than in corn. Both crops removed similar amounts of N by the whole plant. They responded in N content to the highest N rate of 20.1 g N/m^2 with an average removal of 6.95 g N/m^2. This represents about 35% recovery of N in relation to the N applied. Suspected leaching from heavy rainfall resulted in deficiency levels of N and K in leaves of both crops.

INTRODUCTION

The number of dairy cattle in Florida is on the increase. As more dairies move into Florida, particularly into north Florida, there will be a demand for a high-quality feed. Tropical corn *(Zea mays* L.) and forage sorghum *(Sorghum bicolor* L. Moench) can provide Florida farmers with an opportunity to produce this type of feed.

Blevins et al. (1980) reported N fertilizer to be the greatest single energy input into corn production. As more N fertilizer is used, the contamination of ground water in Florida's sandy soils becomes an environmental concern. Loss of fertilizer from leaching can also be an economic concern,

Lang et al. (1989) reported a significantly higher ear leaf N concentration in corn when N was applied. They determined no differences in leaf N concentrations at three N rates (34, 67 and 134 kg N/ha). Grain and whole plant yields of 'Pioneer X304C' tropical corn responded to N rates when K-Mag™ was added.

A drop in yields of sorghum has been reported (Hipp and Gerard, 1971) when the leaf N concentration drops below 20 g/kg. Leaf N concentration accounted for about 63% of the variation in grain yields.

The objective of this experiment was to study the response of no-tillage tropical corn and forage sorghum to different N rates as measured by whole plant yield, leaf N concentration and plant nutrient content.

MATERIALS AND METHODS

The experiment was conducted at the Green Acres Agronomy Farm near Gainesville, Florida, in 1990. The soil is an Arredondo loamy sand to sand (Grossarenic Paleudult) (Soil Survey Staff, 1984). The site has a history of 14 years constant no-tillage rye *(Secale cereale* L.) succeeded by soybeans *(Glycine max* L. Merr.). 'Wrens abruzzi' rye was planted in the winter of 1989 and harvested 10 May 1990. Pioneer X304C tropical corn and 'DeKalb FS25E forage sorghum were planted on 20 May 1990. A Brown-Harden™ in-row subsoil no-tillage planter was used for each crop. Corn was planted at 79,000 seed/ha and forage sorghum at 247,000 seed/ha in 0.75-m-wide rows. The experimental design was a randomized complete block with the two crops as whole plots and inorganic N rates (ammonium nitrate) of 0, 6.7, 13.4 and 20.1 g N/m^2 as split plots.

Atrazine:(2-chloro-4-ethylamino-6-isopropyl-amino-1,3,5-triazine) + crop oil was sprayed over the top when forage sorghum was about 5 cm tall. Dual (Metolachlor:2-chloroo-N-(2-ethyl-6-rnethylphenyl)-N-(2-methoxy-l-methylethyl) acetamide) + Atrazine was applied to corn at planting. Gramoxone: (Paraquat:l.l'-Dimethyl-4,4'-bipyridinium ion + X77 surfactant was sprayed preplant on all crops. Furadan (#15g) (Carbofuran:2,3-Dihydro-2,2-dim-

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ethyl-7-benzopuranyl methylcarbamate) was applied at the rate of 2.2 kg ai/ha to all crops at planting. Lannate (Methomyl: S-Methyl-N-((methylcarba-moy1)oxy)thioacetimidate) was sprayed over the top of the crops one time to control insects.

Fertilizer was applied at 450 kg/ha of 0-10-20 plus 340 kg/ha of K·Mag™ at planting. N rates were split, with 1/2 applied at planting and 1/2 when plants were 0.4 m tall.

Both crops were irrigated as needed using a over-head sprinkler system. water was applied every four days (2.54 cm) depending on rainfall.

Corn ear leaf samples were taken at early tas-seling and silking. Forage sorghum leaves were taken from the third leaf from the flag at early bloom. Forage yields were taken at about 35% dry matter. Leaf and whole plants were analyzed for N using the micro-Kjeldahl technique (Gallaher et al., 1975; Gallaher et al., 1976). Minerals were dry ashed, and solutions were analyzed for P by colorimetry, for K by flame emission spectrophotometry and for Ca, Mg, Cu, Fe, Mn and Zn by atomic absorption spec-trophotometry.

RESULTS AND DISCUSSION

Both crops were expected to show a dry matter yield increase as N rates were increased. Dry mat-ter yield and nutrient content for both crops are shown in Table 1. Dry matter yield increased from N fertilizer more for sorghum than for corn.

Table 1. Dry matter yield and nutrient content for corn and forage sorghum.

	Drv Matter			Nitroaen			Phosphorus		
Treatment	Corn	Sorghum	Mean	Corn	Sorahum	Mean	Corn	Sorahum	Mean
g N/m²	Kg/m²			g/m²			g/m²		
0	0.35b[1]	0.71c**	0.53	2.67	3.11	2.89c	1.14	1.59	1.36b
6.7	0.64a	1.44b**	1.04	4.61	6.06	5.34b	1.50	2.31	1.91a
13.4	0.85a	1.50b**	1.18	6.10	6.26	6.18ab	1.49	2.20	1.84a
20.1	0.87a	1.92a**	1.40	5.94	7.97	6.95a	1.43	2.36	1.90a
MEAN	0.68	1.39		4.83	5.85NS		1.39	2.12**	

	Potassium			Calcium			Maanesium		
Treatment	Corn	Sorghum	Mean	Corn	Sorghum	Mean	Corn	Sorghum	Mean
g N/m²	g/m²			g/m²			g/m²		
0	2.42	6.50	4.46b	0.93b	1.60c**	1.27	0.76b	1.30c**	1.03
6.7	4.17	10.58	7.38a	1.53a	3.18b**	2.36	1.22a	2.33b**	1.78
13.4	4.88	9.82	7.35a	1.67a	3.39b**	2.53	1.31a	2.53b**	1.92
20.1	4.49	11.80	8.15a	1.96a	4.52a**	3.24	1.328	3.26a**	2.29
MEAN	3.99	9.68**		1.52	3.17		1.15	2.35	

	Copper			Manganese			Iron		
Treatment	Corn	Sorghum	Mean	Corn	Sorghum	Mean	Corn	Sorghum	Mean
Q N/m²	mg/m²			mg/m²			mg/m²		
0	0.76	1.46	1.11a	9.48 b	23.60c**	16.54	48.6	40.0	44.3b
6.7	1.18	1.53	1.36a	16.11ab	50.72b**	33.42	180.1	69.8	125.0a
13.4	1.42	0.78	1.10a	18.70ab	55.60b**	37.15	109.7	56.7	83.2ab
20.1	0.88	2.44	1.65a	22.34a	73.73a**	48.04	180.3	82.2	131.2a
MEAN	1.06	1.55NS		16.66	50.92		130.0	62.2**	

Zinc

Treatment	Corn	Sorghum	Mean
Q N/m²	mg/m²		
0	20.79	17.05	19.32b
6.7	35.02	29.62	32.32a
13.4	32.67	39.79	36.23a
20.1	36.67	39.16	37.92a
MEAN	31.29	31.61 NS	

'Values in columns among N rates not followed by the same letter are significantly different at the 0.05 level of probability according to L.S.D. test. Values in rows between crops are significantly diiferent at the 0.01 level of P with a ** or 0.05 level of *P* with a * or are non-significant with NS.

A significant increase in corn dry matter was observed at the first increment of N. Sorghum showed similar results except that a significant increase was observed at the 20.1-g N/m^2 level over the 6.7- and 13.4-g N/m^2 rates. This increase may indicate sorghum's ability to extract N from the soil at a greater depth than corn. Both crops removed similar amounts of N by the whole plant, responding to the highest N rate of 20.1 g N/m^2. In general, forage sorghum removed more P, K, Ca, Mg and Mn than did corn. Both crops removed similar quantities of Cu and Zn, but corn removed more Fe than did forage sorghum.

Heavy rains and suspected leaching of N resulted in deficient N (14 to 16 g/kg) in diagnostic leaves of both crops, as shown in Table 2. However, sorghum leaves had a significantly higher N concentration at all N levels. Corn had a significant increase in N leaf concentration at the 13.4- and 20.1-g N/m^2 levels. Both corn and sorghum leaves were below the sufficiency range for N according to Jones (1974) and Lockman (1972). They reported the sufficiency ranges to be at 27.5 - 32 g N/kg for corn and 29.0 - 34.0 g/N kg for sorghum. As N rates were increased, the P, Cu, Fe and Zn concentration decreased in the leaves of corn and sorghum. Ca, Mg and Mn leaf concentration increased as N rates increased. The K was below the sufficiency range, 17.5 - 22.5 g/kg for corn (Jones, 1974) and 14 - 17 g/kg for sorghum (Lockman, 1972), in all cases indicating loss of K from leaching.

SUMMARY

The low response of no-tillage corn and forage sorghum *to* N fertilizer was thought *to* be due to heavy rainfall and leaching soon after sidedress N was applied. Both N and K deficiency levels were detected from diagnostic leaf analysis. This provided support that these elements had likely leached out of the root zone. In sandy soils, N and K fertilizer should be applied to no-tillage corn and forage sorghum in several small applications to prevent leaching losses due *to* heavy rainfall.

Table *2*, Leaf concentratlons of corn and forage rorghum at four nitrogen rates.

	Nitrogen			Phosphorus			Potassium		
Treatment	Corn	Sorahum	Mean	Corn	Sorahum	Mean	Corn	Sorghum	Mean
g N/m^2	g/kg			g/kg			g/kg		
0	12.78b[1]	11.30b**	12.04	4.26a	2.96a*	3.61	17.30	16.88	17.09a
6.7	12.68b	14.64a**	13.66	3.45b	2.63ab*	3.04	16.50	14.76	15.63b
13.4	16.20a	15.30a**	15.75	3.12b	2.73ab*	2.93	16.54	14.58	15.56b
20.1	16.60a	15.80a**	16.20	3.31b	2.50b*	2.91	15.48	13.08	14.28c
MEAN	14.57	14.26		3.54	2.71		16.46	14.83**	

	Calcium			Maanesium			Manganese		
Treatment	Corn	Sorahum	Mean	Corn	Sorghum	Mean	Corn	Sorghum	Mean
g N/m^2	g/kg			g/kg			mg/kg		
0	3.04c	2.14c*	2.59	1.72c	1.85ab*	1.78	33.00	26.20	30.60a
6.7	3.79b	2.55bc*	3.17	2.19b	1.68b*	1.93	30.60	28.20	29.40a
13.4	4.91a	2.83ab*	3.87	2.35ab	1.89ab*	2.12	29.80	31.20	30.50a
20.1	5.22a	3.24a*	4.23	2.55a	2.11a*	2.33	38.20	34.00	36.10a
MEAN	4.24	2.69		2.20	1.88		32.90	30.40NS	

	Copper			Iron			Zinc		
Treatment	Corn	Sorahum	Mean	Corn	Sorahum	Mean	Corn	Sorahum	Mean
g N/m^2	mg/kg			mg/kg			mg/kg		
0	6.00	5.40	5.70a	72.00	52.00	62.00a	40.60a	21.20a*	30.90
6.7	5.20	3.20	4.20b	58.00	52.00	55.00a	31.00b	21.00a*	26.00
13.4	4.20	4.40	4.30b	72.00	44.00	58.00a	29.00b	21.40a*	25.20
20.1	3.80	2.40	3.10c	60.00	42.00	51.00a	31.00b	20.80a*	25.90
MEAN	4.80	3.85*		65.50	47.50**		32.90	21.10	

[1] Values in columns among N rates not followed by the same letter are significantly different at the 0.05 level of probability according to L.S.D. test. Values in rows between crops are significantly different at the 0.01 level of *P* with a ** or 0.05 level of *P* with a * or are non-significant with NS.

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ACKNOWLEDGMENTS

The authors acknowledge the technical field laboratory assistance of Mr. Howard C. Palmer and chemistry laboratory assistance of Mr. James R. Chichester.