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Effect of nitrogen rate on yield of Acha, *Digitaria exilis* Kippis Stapf in the sudan savanna zone of Nigeria

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ABSTRACT: A randomized Complete Block design experiment with three replicates was carried out in 2001 and 2002 on Acha at the experimental site of the National Cereals Research Institute, Rice Research Station, Birnin Kebbi located at Lat. 12°32'N; Long. 04°12'E Alt 200MSL in the Sudan Savanna zone of Nigeria. Seven nitrogen rates (0, 10, 20, 30, 40, 50 and 60kgN/ha) were evaluated on Ex-Sum accession of Acha to determine the appropriate nitrogen requirement for optimum yield and profitability of Acha. Additional nitrogen application above 30kgN/ha did not give any significant increase in number of productive tillers/plant and plant height at maturity. Economic analysis also indicated that it would be a wise and profitable decision to limit nitrogen application to 30kgN/ha in Acha production.

Key words: Nitrogen rate; Acha; Grain yield; Net benefit.

Introduction

Each year, West African farmers devote approximately 300,000 hectares to cultivate Acha, which supplies food to 3 – 4 million people (National Research Council, 1996). Between 1983 and 1996, its output of production in Nigeria increased yearly from 18,000 to 64,000 tons (Central Bank of Nigeria, 1996).

However, the per hectare production of Acha is usually low. It ranges between 150 – 600 kg/ha (Purseglove, 1975 and Anon., 1995). One important factor among others that is responsible for low yield in crop is the soil fertility status (National Research Council, 1996). Others include seed rate, plant population, inherent genetic factors, time of sowing, time of harvest, crop variety, pest and diseases, weeds and climatic factors such as rainfall and temperature.

Although, it is stated that Acha can be grown on poor and marginal soils, it can also do well in moderately rich soil (Purseglove, 1975; Wrigley, 1981; Gibbon and Pain, 1985; Clayton and Renvoire, 1986; Anon., 1995; Hag and Ogbe, 1995). The response of Acha to nitrogen, a key plant nutrient has not been conclusive. (Purseglove, 1975), hence there is no nitrogen recommendation for its optimum production even at the Millennium. Generally, Acha is considered agronomically primitive because there were only few attempts to optimize on a scientific basis, the process of growing it (National Research Council, 1996)

Different nitrogen rates were therefore evaluated in Acha field with the objective of determining the appropriate nitrogen requirement for optimum yield and profitability.

Materials and Methods

A Randomized Complete Block design experiment with three replicates was carried out in 2001 and 2002 on Acha at the experimental site of the National Cereals Research Institute, Rice Research Station, Birnin Kebbi located at Lat. $12^{o}32$'N; Long. $04^{o}12$'E, Alt. 200MSL. The initial soil nutrient status of the site was: pH (H_2O) = 5.0; % Organic carbon = 0.13; % Organic matter = 0.22; % Total nitrogen = 0.05; Phosphorus = 8.7 ppm; Potassium = 0.14 m.e; % sand = 95.08; % Silt = 3.56 and % Clay = 1.36.

Land preparation was by ploughing and harrowing on 3 and 7 June, 2001 and 5 and 7 June, 2002 respectively. Sowing by broadcast at 25 kg/ha seed rate was carried out on 8 June in both respective year. Phosphorus and Potassium were applied basal to each plot at the rate of 30kgP_2O_5/ha and 30 kgK_2O/ha respectively. Application of nitrogen was in two splits in plot where nitrogen was applied, half at sowing and the other half at 6 weeks after sowing (WAS). The treatments were seven nitrogen rates viz: 0, 10, 20, 30, 40, 50 and 60 kgN/ha. The Acha plant type used was Ex-Sum accession. The field was well maintained in both years.

Data were taken on days to 50% flowering, plant height at maturity, number of productive tillers per plant and grain yield at 14% moisture content. Calculation of the net benefit was made by subtracting production cost from gross benefit. Field price was used in the calculation.
The Marginal Rates of Return (MRR) was calculated by using the formula:

$$MRR = \frac{[\text{Net benefit of treatment (a)} - \text{Net benefit of treatment (b)}] \times 100}{\text{Total variable cost of (a)} - \text{Total variable cost of (b)}}$$

Analysis of variance was carried out on the data collected with MSTATC Software and the means obtained were compared using New Duncan Multiple Range Test.

Results and Discussion

Days to 50% flowering

The no. of days to 50% flowering was not significantly different in 2001(Table 1). In 2002, the 0 kgN/ha plot had significantly higher no. of days to 50% flowering than plots with 10 – 40 kgN/ha but not significantly different from plots treated with 50 – 60 kgN/ha (Table 1). The no. of days to 50% flowering in both years did not indicate any wide differences. While it ranged between 70 – 72 days in 2001, it ranged between 67 and 69 days in 2002.

Number of productive tillers/plant

The no. of productive tillers/plant was significantly different in both years (Table 1). The no. of productive tillers/plant became higher as the nitrogen rate increased from 0 – 30 kgN/ha in both years. There was however no significant difference in the no. of productive tillers/plant between plot of 30 kgN/ha to 60 kgN/ha in both 2001 and 2002. This result indicated that nitrogen has increasing effect on productive tillers as from 0 – 30 kgN/ha. Additional nitrogen above 30 kgN/ha did not give any significant increase in no. of productive tillers/plant and hence not contributing further advantage.

Plant height at maturity

Higher nitrogen rate gave higher plant height at maturity in both years (Table 1). Plant height at maturity was significantly higher at nitrogen rate of 30 – 60 kgN/ha than at 0 – 20 kgNha in both years.

Table 1: Effect of nitrogen rate on some growth parameters of Acha in 2001 and 2002.

Nitrogen level	Days to 50% flowering		Productive tillers per plant		Plant height at maturity (cm)	
	2001	2002	2001	2002	2001	2002
0	70[a]	69[a]	20[c]	14[b]	62.0[c]	66.0[b]
10	71[a]	67[b]	22[bc]	20[b]	63.3[c]	68.0[b]
20	71[a]	67[b]	25[b]	26[ab]	67.3[c]	69.0[b]
30	72[a]	67[b]	30[a]	31[a]	72.0[b]	74.0[a]
40	71[a]	67[b]	31[a]	33[a]	73.0[ab]	75.0[a]
50	72[a]	68[ab]	31[a]	30[a]	75.0[a]	75.0[a]
60	72[a]	68[ab]	32[a]	31[a]	75.0[a]	75.0[a]
SE ±	1.0	0.8	2.2	3.4	1.3	2.3
CV%	1.8	1.6	12.1	15.9	2.2	7.9

Figures in the same column followed by the same letter(s) are not significantly different at P = 0.05 of DMRT.

No significant difference occurred between 0 – 20 kgN/ha The result gave an indication of no marked advantage of applying nitrogen above 30 kgN/ha.

Grain yield

Although grain yield increased as nitrogen rate increased up to 30 kgN/ha, before the decline thereafter in both years, there was no significant difference in the grain yield in the different nitrogen rates (Table 2). This does not mean that nitrogen has no contributing effect on the grain yield of Acha. It only confirmed that Acha can be grown in poor and marginal soil as stated by Purseglove (1975) and Wrigley (1981). The soil in the experimental site as shown in the materials and methods was low in nutrients such as nitrogen, organic carbon, organic matter, and potassium. Only phosphorus was at the medium level of 8.7 ppm. The soil is also mainly sandy (95.08%) which is known to be poor in nutrient content.

The decline in grain yield above 30 kgN/ha may also suggest that there is an optimum level of response of Acha to nitrogen rate. However, recommendation cannot be based on grain yield value alone where treatments had varying production cost. The profitability of production has to be taken into consideration.

Net benefit

Significant difference occurred in the net benefit value among the nitrogen rates used in both years (Table 2). Highest significant net benefit of ₦ 31,660 = and ₦36,234 = were obtained in 2001 and 2002 respectively at 30 kgN/ha.

Plot with nitrogen rate of 40 kgN/ha was next in high value to plot with nitrogen rate of 30 kgN/ha while plot where nitrogen was not applied at all had the least net benefit in both years. Okuneye (1985) stated that if agriculture is considered as a business that gives income to the farmer, the cost and return of agricultural activities should be considered to guide the farmer on the economics of his production activities. The net benefit derived from each nitrogen rate applied is necessary to guide the farmer on decision making on the use of farm inputs. Nitrogen rate of 30 kgN/ha was therefore more profitable than other rates in Acha production.

Table 2: Effect of nitrogen rate on grain yield and net benefit of Acha in 2001 and 2002

Nitrogen rate (kg N/ha)	Grain yield (kg/ha)		Net benefit (N/ha)	
	2001	2002	2001	2002
0	550.0[a]	611.1[a]	25,800[b]	29,468[b]
10	566.7[a]	625.0[a]	26,000[b]	29,500[b]
20	601.7[a]	666.6[a]	27,300[b]	31,198[b]
30	687.6[a]	763.9[a]	31,660[a]	36,234[a]
40	670.0[a]	750.0[a]	29,800[ab]	34,600[ab]
50	643.3[a]	708.3[a]	27,400[b]	31,300[b]
60	643.3[a]	705.0[a]	26,600[b]	30,300[b]
SE ±	115.0	123.9	1890	2241
CV%	24	22	26	28

Figures in the same column followed by the same letter(s) are not significantly different at P = 0.05 of DMRT.

Table 3: Effect of nitrogen rate on Marginal Rates of Returns of Acha production in 2001 and 2002

Nitrogen Rate (kg N/ha)	Marginal Rate of Returns (%)	
	2001	2002
0		
10	25[c]	4[c]
20	163[b]	212[b]
30	545[a]	630[a]
40	-233[e]	-204[d]
50	-300[e]	-413[e]
60	-100[d]	-125[d]
SE ±	45	52
CV%	25	28

Figures in the same column followed by the same letter(s) are not significantly different at P = 0.05 of DMRT.

Marginal Rates of Returns (MRR)

The MRR measures what farmers stand to gain on average from shifting from one treatment to another (expressed in percentages). Shift from one nitrogen rate to another gave significant difference in both years (Table 3). There was positive value in shift from 0 – 10 kgN/ha; 10 – 20 kgN/ha and 20 – 30 kgN/ka in each year. However, shift from 30 – 40 kgN/ha; 40 – 50 kgN/ha and 50 – 60 kgN/ha gave negative values,

indicating loss in benefit in both years. The highest positive value of 545% and 630% of the MRR in 2001 and 2002 respectively obtained in shift from 20 to 30 kgN/ha showed that it would be a wise decision to limit nitrogen rate application to 30 kgN/ha in Acha production.

Conclusion

The economics of production of Acha at the different nitrogen rates indicated that it is more profitable to produce Acha at 30 kgN/ha.

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