Effect of nitrogen and phosphorus on growth and yield of maize

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Abstract

Field trials were carried out at the Gezira Research Station for three seasons (1998 to 2000) with the objective of studying the performance of the maize hybrid "PAN-6480", a newly released hybrid, to different levels of N and P. Four rates of N (0, 86, 129 and 172 kg N/ha) and three rates of P (0, 43 and 86 kg P_2O_5/ha) were used. Observations with regard to days to flowering, plant population and grain yield were recorded. Grain yields increased with the addition of N up to 86 kg N/ha, beyond which increases were not significant. The crop showed a poor response to P application and no increase in yield was obtained with the addition of P up to 86 kg P_2O_5/ha. Hence, it is recommended that only 86 kg N/ha be applied to the crop at sowing to obtain high yields.

Introduction

Maize is the third important cereal food crop in the world being exceeded by wheat and rice. It is produced mainly in the temperate countries as well as some tropical zones. In the Sudan, maize is an alien crop and has been grown on a small scale at different locations under rain, flood and irrigated conditions. It is very popular among farmers in Southern Blue Nile, some parts in the north and at a wider scale in Southern Sudan, where it is the second food crop. It is a typical monoecious plant highly cross- pollinated (95%), yet self pollination may reach up to 5% (Poehlman and Sleper, 1995). Maize, like many cereal crops, requires certain quantities of some elements, e.g. N, P, and K for maintaining good yield levels. High yields of maize have been obtained in the tropics mainly through the use of improved genotypes, fertilizers and good cultural practices (Saha et al, 1994). The low yields obtained in the traditional sector in Sudan or elsewhere were mainly attributed to low soil fertility particularly N and P, moisture content and poor management (FAO, 1971; Smaling, 1993, CSO, 1993 and Mokwunye et al., 1996). In most of the maize producing areas in the world, inorganic fertilizers are relied upon to improve crop yields and maintain soil fertility. However, the wide use of these fertilizers is hampered by their high costs, and the highly variable crop responses under small scale farming (Garts, 1970, Blackie, 1995 and Badiune and Delgalo, 1995).

Soils of the Sudan are known to be heterogeneous and poor in nitrogen. Hence, on-farm fertilizer trials can yield useful results that can be used as guide for good fertilizer recommendations. This study was, therefore, conducted to investigate the effects of Nitrogen and Phosphorus fertilizers on yield and some growth parameters of maize hybrid (PAN-6480).

Materials and methods

Field trials were conducted at Gezira Research Station for three seasons (1998 to 2000) with the objective of testing the performance of the maize hybrid PAN-6480, a newly released hybrid, to different levels of nitrogen and phosphorus fertilizers. Four levels of

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nitrogen, (0N, 2N, 3N and 4N) and three levels of phosphorus, (0P, 1P and 2P), making 12 different treatments, were used. Urea and Triple Super Phosphate were used as sources of N and P, respectively. The experiment was carried out in a randomized complete block design with four replications. Each plot consisted of 12 rows, each 9 m long and 80 cm apart. Planting was made during the first week of July at 2 seeds/hole and at spacing of 25 cm apart, thinned to one seedling 2 weeks later. Both nitrogen and phosphorus fertilizers were applied at planting time. Urea was broadcasted while Triple Super Phosphate was applied on band along the side of the ridge and covered with soil. The recommended agronomic practices were followed throughout the course of the study Flowering date and plant height were taker in season 1998 and plant population and grain yield over the three seasons. Economic evaluation of the effect of nitrogen on the grain yield, partial budget was estimated for the average yield of the three seasons. For maize and urea, current prices (year 2005) were used. These were SD 51/kg as field price for maize, and SD 5000/sack (50kg) for urea. Net benefit from applying different levels of nitrogen were compared. Net benefits of a treatment are the difference between the benefits due to and the cost of the treatment in question. Benefits are the product crop yields associated with a particular treatment and the price of the crop. Costs, on the other hand, comprise the costs of fertilizer treatments and their application.

Results and discussion

The effect of different levels of nitrogen and phosphorous fertilizers on grain yield and other growth parameters of maize hybrid are presented in tables 1- 3 for the seasons 1998, 1999 and 2000. Analysis of variance showed no significant differences among the treatment combinations for flowering date and plant population (Tables 1 and 2). However, significant differences among the treatments means were found for plant height and grain yield (Tables 1 and 3).

In season 1998, the yields were generally very high ranging from 4370 to 6680 kg/ ha. However, in the other two seasons, the yields were moderate ranging between 2420-4130 kg/ha for 1999 and 1890-3330 kg/ha for 2000. The moderate yields were attributed mainly to poor crop establishment and some shortages of irrigation water during the flowering and filling stages. The results showed that, maize responded favorably to nitrogen application and there was an increase in yield with the increase of nitrogen up to 2N after which the yields remained almost the same with the increase of nitrogen up to 4N (Table 3). The data also indicated that the addition of phosphorus alone has no affect on grain yield.

Partial budget was computed for maize and the results were shown in Tables 4, 5 and 6. For the sake of comparison, dominance analysis was carried out and dominated treatments were eliminated from further consideration. Promising treatments are shown through their dominance over others in the sense that they realize higher net benefits with same or lower levels of variable costs (Table 6). Marginal analysis was also carried out to show the relative profitability of the promising (non-dominated) treatments (Table 6). Treatment 2N gave the highest net benefits and the marginal analysis indicated that application of this treatment was profitable as shown by the high marginal rate of returns (283%). This means that for every SD 1 invested in the application of this treatment, the farmer can expect to get back that SD plus an additional of about SD 3.

Conclusions

The following conclusions can be drawn from this study:

1. Maize responded favorably to N application up to 2N.
2. Maize showed no increase in yield due to phosphorus up to 2P.
3. Interaction between Nitrogen and Phosphorus was not significant.
4. Economic evaluation indicated that application of 2N was the most profitable treatment with high return on investment.

Recommendation

Based on the above results, we suggest the application of 2N as urea at planting time for hybrid maize, PAN-6480.

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Table 1. The effect of N and P fertilizers on number of days to flowering and plant height of maize hybrid (PAN- 6480),GRS, season 1998

Treatment	Number of days to flowering				Plant height (cm)			
	0P	1P	2P	N mean	0P	1P	2P	N mean
0N	60	60	59	60	246	242	237	242
2N	58	57	57	57	265	255	249	257
3N	57	58	58	58	257	260	263	260
4N	56	58	56	57	266	255	296	272
P means	58	58	58	58	259	253	262	258
S.E.±		NS				15.3		

Table 2. The effect of N and P fertilizers on plant population (000) of maize hybrid (PAN-6480), GRS (average of three Seasons, 1998 to 2000)

Treatment	P level			
	0P	1P	2P	N mean
N level				
0N	35.8	37.8	37.1	36.9
2N	36.9	34.7	35.9	35.8
3N	35.8	35.3	35.8	35.6
4N	35.6	35.0	35.9	35.5
P mean	36.1	35.7	36.2	35.9
S.E.±		NS		

Table 3. The effect of N and P fertilizers on grain yield (kg/ha) of maize hybrid (PAN-6480), GRS (three seasons, 1998 to 2000).

Treatment	1998				1999				2000			
	0P	1P	2P	N mean	0P	1P	2P	N mean	0P	1P	2P	N mean
0N	4296	4506	4321	4375	2258	2530	2469	2419	1906	1886	1880	1891
2N	6054	6253	6237	6182	4350	3168	3792	3770	3236	3378	2819	3145
3N	6292	6574	6481	6368	3940	3533	3553	3676	3482	3485	2786	3251
4N	6446	6911	6692	6684	4299	3623	4488	4137	3431	3514	3056	3334
P means	5772	6061	5933	5903	3712	3214	3576	3501	2543	3066	2656	2928
S.E.±		456								288		

Table 4. Partial budget for the effect of nitrogen fertilizer on grain yield of maize hybrid, PAN-6480 (average of three seasons, 1998 to 2000)

Treatment	Yield (kg/ha)	Gross benefits (SD/ha)	Costs that vary (SD/ha)	Net benefits (SD/ha)
0N	2895	147645	0	147645
2N	4365	222615	19385	203025
3N	4432	226032	29180	196647
4N	4718	240618	39180	201438

Table 5. Dominance analysis for NP experiment on maize hybrid, PAN-6480, GRS (average of three seasons, 1998 to 2000)

Treatments	Costs that vary (SD/ha)	Net Benefits (SD/ha)
0N	0	147645
2N	19590	203025
3N	29385	196647 D
4N	39180	201438 D

D = Dominated

Table 6. Marginal analysis of undominated treatment in NP experiment on maize hybrid, PAN-6480 (average of three seasons, 1998 to 20000)

Treatment	Cost that vary (SD/fed)	Marginal costs (SD/fed)	Net benefits (SD/fed)	Marginal net Benefits (SD/fed)	Marginal Rate of Return (%)
0N	0		147645		
2N	19590	19590	203025	55380	283