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The Effect of Nitrogen and Phosphorus Fertilization on Growth, Yield and Quality of Forage Maize (*Zea mays* L.)

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Abstract: In this study the effect of nitrogen and phosphorus application on growth, forage yield and quality of fodder maize was studied. The variety used was Giza 2. Nitrogen was applied at the rates of (0, 40 and 80 kg N ha^{-1}), while phosphorus levels were (0, 50 and 100 kg P_2O_5 ha^{-1}). Parameters studied were plant height, number of leaves per plant, stem diameter and Leaf Area Index (LAI). Moreover days to 50% tasseling, dry matter yield, crude protein and crude fiber contents were studied. Results showed that addition of nitrogen fertilizer significantly increased plant height, stem diameter and LAI. Phosphorus fertilization has no significant effect on the growth attributes. Application of nitrogen allowed the crop to reach 50% tasseling earlier. Phosphorus on the other hand has no effect on days to 50% tasseling. Nitrogen fertilization significantly increased the forage dry matter yield. In contrast phosphorus has no effect on the dry matter yield. Nitrogen was significantly increased the protein content of forage maize, on the other hand phosphorus has no effect on the crude protein content. Neither nitrogen nor phosphorus has a significant effect on the crude fiber content.

Key words: Nitrogen, phosphorus, dry matter yield, crude protein, crude fiber, forage maize

INTRODUCTION

The production of forage crops is very important for live stock production in the developing countries. In Sudan the major grass forage crops include, Abusabien (*Sorghum bicolor*), Sudangrass (*Sorghum sudanense*), sorghum-sudangrass hybrids and recently maize (Khair, 1992). Compared to others, maize performed very well in winter, so production of forage maize in winter solves the problem of livestock feed shortage during the cool season (Ageeb, 1977).

Fertilizer application is one of the principle factors that materially set up the forage yield. An adequate supply of nutrients at each stage is essential for optimum growth and development of forage maize (Cox *et al*., 1993). The essential nutrients such as nitrogen and phosphorus are important for plant growth and yield (Marschner, 1997). Gromove *et al*. (1994) reported that the efficiency of utilization of nutrients from fertilizers applied to soils depends on weather condition, biological characteristic of the crops and fertilizer rates.

Nitrogen is almost deficient in soils of Africa and most of the tropics. Positive response of maize to nitrogen fertilizer has been reported by (Patel *et al*., 1967; Aflakpui *et al*., 1997). Reddy *et al*. (1985) stated that the yield of fodder maize was increased by increasing the levels of nitrogen fertilizer. Nitrogen plays an important role in quality of forage crops. Minson (1990) reported that nitrogen application increased the crude protein percentage of tropical grasses. Many investigators found that there was an increase in the protein content of forage maize by increasing nitrogen levels (Ganguar and Karla, 1988; Cox *et al*., 1993). On the other hand, Arnon (1975) found that higher levels of nitrogen showed little effect on the fiber content of forage maize.

In plants, phosphorus is a common component of organic compounds. Phosphorus deficiency, however, significantly reduced plant growth (Marschner, 1997). Ayub *et al*. (2002) noticed that nitrogen and phosphorus application increased the green fodder yield of maize. Phosphorus application enhanced the crop to reach 50% tasseling and silking earlier (Chapman and Carter, 1976). Rai *et al*. (1984) reported an increase in the leaves protein content of maize in response to phosphorus application.

The studies conducted indicated that application of nitrogen resulted in high forage yield and high quality of forage maize. However limited research has been carried out to evaluate the effect of phosphorus fertilizer on the forage maize yield and quality. The main objective of this study was to investigate the influence of different levels of nitrogen and phosphorus on growth, yield and nutritive value of forage maize.

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MATERIALS AND METHODS

In 1999/2000, field experiment was conducted at the demonstration farm of the Faculty of Agriculture, University of Khartoum, Shambat, Sudan. The soil was cracking clay with about 50% clay with a pH of 8.0. The average temperature for the study period was 25°C while the average relative humidity was 29%.

The soil was ploughed, harrowed, leveled then ridged to 70 cm. An open pollinated maize cultivar (Giza 2) was sown at the rate of 107 kg ha^{-1}. The plot size was 3×4 m^2. Seeds were sown on 19th of November 1999. Irrigation was applied at 10-12 days intervals.

The rates of nitrogen fertilizer were: 0N (0 kg N ha^{-1}), 1N (40 kg N ha^{-1}) and 2N (80 kg N ha^{-1}). The phosphorus fertilizer rates were: 0P (0 kg P_2O_5 ha^{-1}), 1P (50 kg P_2O_5 ha^{-1}) and 2P (100 kg P_2O_5 ha^{-1}). Treatments were arranged in a split plot design with four replications, in which the nitrogen treatments comprised the main plots and the phosphorus treatments were the subplots.

Five plants from the two inner ridges of each plot were randomly selected and then tagged for determining plant height, number of leaves per plant, stem diameter and Leaf Area Index (LAI). Also days from sowing to the day when 50% tasseling is reached were recorded.

Plants were harvested at the milky stage. One meter length from each of the two middle ridges were harvested and then dried to estimate the dry matter yield. Crude protein was determined using Kjeldhal method while the crude fiber was determined according to AOAC (1990).

All the data obtained were subjected to analysis of variance. The means were separated using the Least Significant Difference (LSD) as out lined by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Effect of nitrogen and phosphorus on the growth attributes: Nitrogen application significantly increased the plant height. The nitrogen levels of 40 and 80 kg N ha^{-1} produced statistically similar plant height, but significantly higher than the control (Table 1). This increase might be due to the positive effect of nitrogen element on plant growth that leads to progressive increase in internodes length and consequently plant height. Similar results were reported by Sharma (1973) and Mohammed *et al*. (1987). Increasing nitrogen levels did not significantly affect number of leaves per plant (Table 1). This was probably attributable to the genetic factor which controls number of leaves per plant. Addition of nitrogen resulted in a significant increase in stem diameter (Table 1). The significant effect of nitrogen application on stem diameter has also been reported by Ayub *et al*. (2002). Significant increase in the LAI was recorded by increasing nitrogen rates. The largest LAI of 25.20 was obtained under the highest nitrogen level (80 kg N ha^{-1}) compared to (40 kg N ha^{-1}) and control which scored 16.78 and 7.93 respectively (Table 1). Since nitrogen promotes growth, it enhanced leaf expansion and development. This influence may result in an increase in leaf length and width and leaf blade size. This result is in conformity with (Flesch and Dale, 1988).

The results showed that phosphorus application has no significant effect on the studied growth parameters (Table 1). Similar results were found by Withers *et al*. (2001), who reported that phosphorus fertilizer did not benefit the growth of forage maize. This response may be due to factors in the soil affecting phosphorus availability. The availability of phosphorus might be affected by phosphorus fixation by the heavy clay soil on which the experiment was conducted. The high alkaline pH of the soil could also be responsible for the solubility and availability of phosphorus. Yang and Jacobsen (1990) observed that when phosphorus fertilizer was added to soil with pH of 8.5, phosphorus quickly reacts to form less soluble compounds with calcium and possibly magnesium.

Days to 50% tasseling: The results showed that nitrogen application significantly enhanced the crop to reach 50% tasseling earlier compared to control (Table 2). Similar result was reported by Balko and Russel (1980).

Table 1: Effect of nitrogen and phosphorus fertilization on the growth parameters at the age of eight weeks

Treatments	Plant height (cm)	No. of leaves/plant	Stem diameter (mm)	Leaf area index
Nitrogen				
0N	88.53b	15.97a	10.61b	7.93c
1N	143.47a	15.98a	12.67a	16.78b
2N	160.68a	15.86a	13.38a	25.20a
LSD (0.05)	26.43	NS	1.73	5.43
Phosphorus				
0P	136.77a	16.01a	12.37a	16.44a
1P	126.27a	16.00a	12.17a	18.24a
2P	129.63a	15.80a	12.17a	15.21a
LSD (0.05)	NS	NS	NS	NS

* Means within columns followed by the same letters are not significantly different at 5% level using LSD test, * LSD (0.05) = Least significant difference at 5% level, * NS = Not Significant

Table 2: Effect of nitrogen and phosphorus on number of days to 50% tasseling

Nitrogen	Days to 50% tasseling	Phosphorus	Days to 50% tasseling
0N	63.92a	0P	60.92a
1N	60.25b	1P	61.17a
2N	59.50b	2P	60.50a
LSD (0.05)	1.53	LSD (0.05)	NS

* Means within columns followed by the same letters are not significantly different at 5% level using LSD test, * LSD (0.05) = Least significant difference at 5% level, * NS = Not Significant

Table 3: Effect of nitrogen and phosphorus fertilization on the dry matter yield (tons ha^{-1})

Treatments	Dry matter yield (tons ha^{-1})
Nitrogen	
0N	3.74b
1N	8.45a
2N	12.18a
LSD (0.05)	4.40
Phosphorus	
0P	8.43a
1P	8.39a
2P	7.56a
LSD (0.05)	NS

* Means within columns followed by the same letters are not significantly different at 5% level using LSD test, * LSD (0.05) = Least significant difference at 5% level, * NS=Not significant

Table 4: Effect of nitrogen and phosphorus on crude protein and crude fiber contents

Treatments	Crude protein (%)	Crude fiber (%)
Nitrogen		
0N	3.67c	21.13a
1N	5.81b	22.10a
2N	9.06a	21.74a
LSD (0.05)	1.25	NS
Phosphorus		
0P	5.81a	21.00a
1P	5.69a	21.52a
2P	7.07a	22.50a
LSD (0.05)	NS	NS

* Means within columns followed by the same letters are not significantly different at 5% level using LSD test, * LSD (0.05) = Least significant difference at 5% level, * NS = Not Significant

Phosphorus did not affect days to 50% tasseling (Table 2). This might be attributed to the unavailability of phosphorus due to fixation process in the alkaline soils of the experimental site.

Dry matter yield: Application of nitrogen was significantly increased the dry matter yield of forage maize over the control by 55.7% for 1N and 69.3% for 2N (Table 3). This result was expected since the results of the growth attributes showed that nitrogen application significantly increased the plant height, stem diameter and leaf area index. This result is in conformity with the finding of (Singh *et al.*, 1992; Ayub *et al.*, 2002). Phosphorus fertilization has no effect on the forage dry matter (Table 3). This result was also expected due to the non significant effect of phosphorus on the growth attributes of forage maize.

Forage quality: In this study forage quality determined in terms of crude protein and crude fiber contents. The effect of nitrogen fertilization on crude protein content was significant. The maximum 9.06% and minimum 3.67% crude protein contents were recorded at nitrogen levels of 80 kg N ha^{-1} and control, respectively (Table 4). This result emphasized the fact that nitrogen played a great role in protein synthesis. Similar result was obtained by Khandaker and Islam (1988) and Singh *et al.* (1992). Phosphorus application resulted in a non significant increase in the protein content of forage maize (Table 4). This result has also been reported by Patel *et al.* (1993).

Both nitrogen and phosphorus did not significantly affect the crude fiber content of forage maize. The results were confirmed by Primost (1964), who reported that crude fiber content was not affected by nitrogen fertilization. Rathoare and Kumar (1977) reported similar results. They stated that phosphorus had no significant effect on the crude fiber content of grasses. But these results are in contrast with those of (Ayub *et al.*, 2002). They reported that the crude fiber content was significantly influenced by the application of nitrogen and phosphorus. These contradictory results might have been due to differences in the soil pH and the climatic conditions.

CONCLUSIONS

The results indicate that nitrogen improved vegetative growth, forage yield and crude protein content. On the other hand the effect of phosphorus was not significant on the growth attributes, dry matter yield, crude protein content and crude fiber content of forage maize.

Alkaline and relatively high clay content of the soil may be behind the low availability of phosphorus and consequently the insignificant effect of phosphorus on the growth attributes, dry matter yield, crude protein content and crude fiber content of forage maize.

REFERENCES

Aflakpui, G.K.S., G. Bolfrey-Arku, P.B. Allou, A.H. Dakurah and K.O. Adu-Tutu, 1997. Effect of rate and time of nitrogen fertilizer application on *Striga hermonthica* infestation in field- grown maize. Ghana J. Agric. Sci., Vol. 30.

Ageeb, O.A.A., 1977. Cereal forage crops. Annual Report of the Hudeiba Res. Station 1976/77, Sudan.

AOAC., 1990. Association of Official Agricultural Chemists. Official Methods of Analysis. 15th Edn. Washington DC.

Arnon, I., 1975. Fertilizer Use in Dry Regions. Back Ground and Principles. Leonard Hill, London, Vol. 1.

Ayub, M., M.A. Nadeem, M.S. Sharar and N. Mahmood, 2002. Response of maize (*Zea mays* L.) fodder to different levels of nitrogen and phosphorus. Asian J. Plant Sci., 1: 352-354.

Balko, L.G. and W.A. Russell, 1980. Response of maize inbred lines to nitrogen fertilizer. Agron. J., 72: 723-728.

Chapman, S.R. and L.P. Carter, 1976. Crop Production Principles and Practices. W.H. Freeman and Company. USA.

Cox, W.J., S. Kalonge, D.J.R. Cherney and W.S. Reid, 1993. Growth, yield and quality of forage maize under different nitrogen management practices. Agron. J., 85: 341-347.

Flesch, T.K. and R.F. Dale, 1988. Nitrogen argument for corn leaf area models. Agron. J., 80: 784-788.

Ganguar, B. and G.S. Karla, 1988. Influence of maize legume association and nitrogen levels on maturity, grain quality and protein productivity. Field Crops Abstr., 41: 017, Abst., 7638.

Gomez, K.A. and A.A. Gomez, 1984. Statistical Procedure for Agriculture Research. 2nd Edn., John Wiley and Sons Inc., New York, USA.

Gromove, A.A., V.F. Abaimer, N.D. Kanhove and V.B. Schukin, 1994. The effect of increasing calculated doses of fertilizers in cereal fallow-row crop rotation on southern Chernozem in the Orenburg Region. Agron. Khimiya No. (6) pp: 59-66.

Khair, M.A.M., 1992. Effect of genotypes and harvesting dates on the forage yields and quality of forage sorghum. Annual Report, Gezira Res. Station. 1992/93. Wad Medani, Sudan, pp: 54-58.

Khandaker, Z.H. and M.M. Islam, 1988. Effects of nitrogen and stage of maturity on yield and quality of fodder maize. Bangladesh J. Animal Sci., 17: 47-53.

Marschner, H., 1997. Mineral Nutrition of Higher Plants. 2nd Edn., Academic Press. Hacourt Brace and Company, London.

Minson, D.J., 1990. The Chemical Composition and Nutritive Value of Tropical Grasses. In: Skerman, P.J. and F. Riveros, Tropical Grasses. (FAO Plant Production and Protection Series, No. 23), pp: 163-180.

Mohammed, M.I., M.A. Noor and A.N. Alis, 1987. The influence of the level of nitrogen fertilizer and spacing on maize in Somalia. Field Crops Abst., 33: 127, Abst. 1151.

Patel, A.I. K.N. Agarwal and A.R. Patel, 1967. Effect of spacing, seed rate and fertilizer on the yield of sorghum. Ind. J. Agric. Sci., 38: 805-810.

Patel, K.I., R.P.S. Ahlawat and S.J. Trivadi, 1993. Effects of nitrogen and phosphorus on nitrogen uptake and protein percentage of forage sorghum. Gujrat Agric. Univ. Res. J., 18: 87-88.

Primost, E., 1964. Dependence of yield and quality of maize for silage on nitrogen application and weather. Herbage Abst., 34: 1590.

Rai, R.K., S. Mahati and M.N. Sinha, 1984. Phosphorus efficiency in maize-wheat sequence. Ind. J. Agron., 29: 267-273.

Rathoare, D.N. and V. Kumar, 1977. Quality component of Dinanth grass and sorghum forage as affected by nitrogen and phosphorus fertilization. Ind. J. Agric. Sci., 47: 401-404.

Reddy, T.V., M.R. Reddy, K.T. Rangamanner and M.H. Khan, 1985. Effect of different levels of nitrogen fertilization on the quality of maize fodder. Ind. J. Animal Nutr., 2: 120-122.

Sharma, R.K., 1973. Response of maize to nitrogen fertilization. Madras Agric. J., 60: 399-400.

Singh, N.S., K. Singh, N. Singh and S. Singh, 1992. Nitrogen requirement of fodder sorghum grown in different cropping systems. Intl. J. Trop. Agric., 10: 165-167.

Withers, P.J.A., S. Peel, A.G. Chalmers, S.J. Lane and R. Kane, 2001. The response of manured forage maize to starter phosphorus fertilizer on chalk land soils in southern England. Grass and Forage Sci., 55: 105-113.

Yang, J.E. and J.S. Jacobsen, 1990. Soil inorganic fractions and their uptake relationships in calcareous soils. Soil Sci. Soc. Am. J., 54: 1666-1669.