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Effect of Nitrogen and Phosphorus Fertilizers on Growth and Yield of Some Leguminous Forages

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ABSTRACT

The present study was conducted to evaluate the effect of nitrogen and phosphorus fertilizers on growth and yield of four leguminous forages which includes Clitoria (*Clitoria ternata* L.), Lubia (*Lablab purpureus* L.), Phillipesara (*Phaseolus trilobus* L.) and Guar (*Cyamopsis tetragonoloba* L.). A randomized complete block design with three replicates was used to compare four levels of fertilizer combinations of urea (46%N) and triple super phosphate (46%P) as follow : Zero urea-Zero phosphorus (ONOP) as a control, zero urea + 200 kg P_2O_5/ha (ON2P), 86 kg N/ha + zero phosphorus (2NOP) and 86 kg N/ha + 200 kg P_2O_5/ha (2N2P).

The application of nitrogen and phosphorus fertilizers in a rate of 86 kg N/ha + 200 kg P_2O_5/ha (2N2P) significantly improved the growth and productivity of these forages more than other treatments. Moreover, both fertilizers improved forage quality by increasing crude protein and decreasing crude fiber values.

Key Words : Fertilizers, Forage Yield, Legumes, Dry weight, Growth, Productivity.

INTRODUCTION

The production of forage crop is very important to livestock production in the Sudan. This is due to huge animal resource in the Sudan (more than 58 million of animal units) (Faki, et al., 1991). Animals have a social value to nomads which leads to the build-up of livestock population. The stocking rate is far in excess of the stock carrying capacity of the rangelands. Moreover, the establishment of new mechanized crop production schemes in areas which are traditionally natural rangelands constitute a potential threat by diminishing the grazing land. This encourages seasonal migration of animals resulting in continuous attack to the establishment schemes there (Al awad, personal communication).

Nomads in Sudan own 90% of the animal wealth in the country (El Haj et al., 1987). These animals are totally dependent on the natural vegetation as their only source of feed for maintenance and production, which is clearly reflected in the poor output and performance of animals resulting from poor quality of forages.

Irrigated pastures constitute only small portion in the large irrigated schemes Gezira and Rahad (Faki, et al., 1991). The increase in size of towns, the rise in the standard of living, the state policy of self sufficiency in food which halted imported canned milk and other commodities, have resulted in an increasing demand of animal products, that led to severe shortages and high prices of milk and meat (Y. T. Guma'a, 1991).

To satisfy this high demand in animal products, availability of high quality forage is a necessity to be harvested first and fed, then grazed by animals later. Hence one of the objectives of this study was to evaluate the response of some forage legumes to various levels of nitrogen and phosphorus fertilizers, because of their limiting factor for forage production in the Sudan (Gaffar, 1983). Another objective of the study was to evaluate Guar (*Cyamopsis tetragonoloba*), a relatively new forage legume in Sudan, known for its high protein content but has not been evaluated as a potential forage crop under Sudan conditions. Guar, besides being an important forage legume, it is also known to be an important ingredient in some industries.

MATERIALS AND METHODS

During 1987/88 and 1988/89 seasons, two experiments were conducted in the demonstration farm of the Faculty of Agriculture, University of Khartoum (15° 40N, 32° 32E). The soil of the experimental site is classified as Fine Amectitic Isohyper-thermic entice Chromustert clay soil (Gaffar, 1983).

The climate of the area is semi-desert with an average rainfall of 150 mm, falling mostly during July, August and September (Adam, 1975 and Whiteman, 1971). Average data of 20 years (1969-1989) of air temperature showed that maximum temperature ranges between 10 to 40°C in July (the hottest month), after which the temperature falls gradually by 3 to 5°C from August to January.

The experiment site was disc ploughed, disc harrowed and leveled. Ridging up of the leveled land was done and irrigation canals were established. The four legumes were grown in plots of 4x5 m^2, 80 cm apart on the top of the ridges.

The total cropped area was about 0.45 acres and the previous cultivated crop was *Sorghum bicolor* var. Dura (locally known as Abu Sabein).

The investigated forages were Clitoria (*Clitoria ternata* L.). Lubia (*Lablab purpureus* L.). Phillipesara (*Phaseolus trilobus* L.) and Cluster bean or Guar (*Cyamopsis tetragonoloba* (L.). Four levels of fertilizer combinations of urea and phosphorus were imposed on these four legumes. The fertilizer levels were zero urea - zero phosphorus (ONOP) as a control, zero urea + 200kg P_2O_5/ha (ON2P), 86kg N/ha + zero phosphorus (2NOP) and 86kg N/ha + 200kg P_2O_5/ha (2N2P).

Nitrogen was used in form of urea (46%N) and phosphorus in a form of granulated triple superphosphate (46%P). Therefore, a total of 16 treatments were established. A randomized complete block design with three replicates was used. Each season's data was analyzed separately using the analysis of variance procedures and least significant differences test (LSD) for testing differences among forage means for the different measured characteristics.

An individual plot contained 5 rows and distance between plants were 10 cm. The actual seed rates of the four tested crops were 16, 9, 21, and 8 kg/ha for Guar, Clitoria, Lubia and Phillipesara, respectively.

Sowing was carried out by opening a shallow furrow, 5 cm deep, on a top of the ridges in August, 1987 for the first season and in April 1988 for the second season experiment. Phosphorus fertilizer was applied at time of sowing, whereas half amount of urea was applied at time of sowing and the other half was applied a month later. Irrigation was applied at 7-day intervals during the first season (summer season) (10 irrigations per growing season) and at 9-day intervals for the second season (rainy season) (8 irrigations per growing season). Weeding was done when necessary and Dieldrin (Cyclodine) was applied at a rate of 0.30 kg/ha to control termites that were present mainly on Lubia. Cutting was done at 5 cm above the soil surface and samples were taken from the two inner rows of each individual plot with excluding off one meter at the border when 40-50 percent blooming, collected together, then dried on an electric oven at 105°C for 24 hours.

The parameters measured during both seasons including number of green leaves, plant density (population) and dry weight, in addition to proximate analysis which performed on the dry matter samples of the first season only according to A.O.A.C. 1980.

RESULTS AND DISCUSSION

Effects of treatments on growth parameters and forage yield.

Nitrogen and phosphorus fertilizer showed a significant effect on number of green leaves, plant density and forge dry weight of the four forage legumes during both seasons (Table 1). The interaction between crops and treatments for plant density in the first season was not significant, but it was highly significant for dry weight in the second season ($P<0.05$) level (Table 1). This was more likely related to leaf shedding which is largely affected by time of harvest or to inhibition of microbial activity.

Table 1. Mean squares for plant density / m^2, dry weight (kg/ha) for two seasons (1987/88 and 1988/89).

Sources of Variation (S.O.V.)	D.F.	Plant Density (m^2) 1^{st} Season	Plant Density (m^2) 2^{nd} Season	Dry wt.(kg/ha) 1^{st} season	Dry wt.(kg/ha) 2^{nd} season
Replication	2	0.093	2.356	0.010	0.219
Crops (A)	3	73.610**	8.165**	43.062**	55.569 *
Treatments (B)	3	74.488**	49.607**	3.609**	8.495**
(A x B)	9	2.460NS	0.620NS	0.179NS	0.927**
Error	30	1.294	1.008	0.159	0.196
Total	47				
C.V. %		1.67	1.39	6.49	6.21

NS = Not significant at 0.05 Level of probability
* = Significant at 0.05 Level of probability
** = Significant at 0.01 Level of probability
C.V.= Coefficient of Variation

Treatments of 86kg N/ha + 200kg P_2O_5/ha (2N2P) and zero nitrogen + 200kg P_2O_5/ha (ON2P) and 86kg N/Ha + zero phosphorus (2NOP) depicted a high yield results for plant density and dry weight during both seasons (Tables 2, 3,4,5) respectively.

Table 2. Mean Value of Plant Density (m^2) for the first season (1987/88).

Crops	ONOP	ON2P	2NOP	2N2P
Clitoria	66.66 c	68.90	66.17 d	70.43 a
Lubia	62.02 c	66.33	61.00 d	68.21 a
Phillipesara	68.70 c	70.33 b	67.00 d	72.33 a
Guar	67.77 c	72.33 a	67.33 c	71.33 b

Means followed by the same letter (s) within each row are not significantly different at probability 0.05 level according to (L S D) test.

Table 3. Mean value of plant density (m^2) for the second season (1988/89)

Crop	ONOP	ON2P	2NOP	2N2P
Clitoria	71.25 c	74.00 b	71.67 c	76.00 a
Lubia	69.60 b	72.67 a	69.67 b	73.00 a
Phillipesara	70.76 c	73.80 b	71.00 c	74.33 a
Guar	71.10 c	73.67 b	70.00 d	75.00 a

Means followed by the same letter (s) within each row are not significantly different at probability 0.05 level according to (LSD) test.

Table 4. Mean value of forage dry wt. (kg/ha) for the first season (1987/88).

Crops	ONOP	ON2P	2NOP	2N2P
Clitoria	4.13 d	4.65 b	4.32 c	5.07 a
Lubia	5.09 b	5.57 a	4.43 c	5.67 a
Phillipesara	5.40 c	6.28 b	5.54 c	6.93 a
Guar	8.25 d	8.93 b	8.51 c	9.68 a

Means followed by the same letter (s) within each row are not significantly different at probability 0.05 level according to (LSD) test.

Table 5. Mean value of forage dry wt. (kg/ha) for the second season (1988/89)

Crops	ONOP	ON2P	2NOP	2N2P
Clitoria	5.24 b	5.94 a	5.17 b	5.93 a
Lubia	4.95 d	5.68 b	5.31 c	6.30 a
Phillipesara	5.84 c	8.23 b	5.95 c	9.07 a
Guar	9.30 d	10.40 b	9.67 c	11.15 a

Means followed by the same letter (s) within each row are not significantly different at probability 0.05 level according to (LSD) test.

Leguminous crops will provide some of their own nitrogen requirement through atmospheric nitrogen fixation. They may require a small doze of nitrogen as a starter for this process, (Atwal and Sidhu, 1964). The amount of nitrogen added during this experiment was equivalent to 86kg N/ha, therefore, it might acted as a starter and had a positive effect on green leaves, plant density and forage dry weight. A similar finding was reported by Mohamed and Daw elmadina (1979) in case of chickpea. Atwal and Sidhu (1964) reported that the application of nitrogen to guar and berseem in small dozes improve production, growth and nitrogen fixation in both crops.

The addition of nitrogen fertilizer might have knocked down the process of nitrogen fixation in these crops by inhibition of microbial activity.

Evelyn and Ahmed (1965) reported that, urea application just before sowing did not give a significant differences in yield of Lubia. Nambiar et al. (1986) reported that some legumes including groundnut are poor utilizers of nitrogen fertilizer. Huxley (1980) stated that legumes, as many others have pointed out, are well adapted to survive in nitrogen poor soils, but equally same species such as cowpea appears to be badly adapted to agriculturally nitrogen-rich soil.

On the other hand, Rashied et al. (1993) reported that phosphorus fertilizer increased the yield of Lablab CV., cowpea, pigeon pea and butterfly pea significantly. They also stated that, Lablab CV. Barazillian and Lablab CV. Highworth gave 6.73, and 5.64 tons of dry yield/ha, respectively, which is similar to the two-year average yield in this experiment, that equal to 5.38 t/ha for Lubia. Yield in case of guar was highest among crops under study, whereas it was lowest in case of clitoria, and yield of April sowing was greater than that of August sowing.

Effect of treatments on forage nutritive value

Results of proximate analysis of the different forage legumes (Table 6) indicated that nitrogen and phosphorus fertilizers significantly increased crude protein, oil and ash content, while their effects on crude fiber and dry matter was not significant for all crops ($P<0.05$).

The high percentage of 17% and 31% of crude protein and crude fiber, respectively were recorded for clitoria (Table 7). This result agrees with that reported by El Haj et al. (1987) who found that clitoria on 60 days post sowing was found to have crude protein of 15.2% and crude fiber of 24.4%. Al awad (1983) (Personal communication) found that crude protein for clitoria was 16.5%. The minimum percentage of crude protein was recorded for phillipesara (11.4%), whereas the minimum percentage of crude fiber (28.1%) was recorded in case of guar.

Summary and Conclusion

The application of nitrogen and phosphorus fertilizers to leguminous forages significantly improved their growth and productivity during both seasons. The negative effect of interaction between crops and treatment in some of the sampling occasions could largely be attributed to leaf shedding which is affected by time of harvest or to inhibition of microbial activity. Moreover, nitrogen and phosphorus fertilizers improved forage quality as indicated by the high crude protein and low crude fiber values. Guar productivity exceeded those of other forages during both seasons, it produced 8.84 t/ha and 10.13 t/ha (average treatments) of dry matter yield during the first and second season, respectively, with low crude fiber content. This encouraging result showed the promising future of this multiple use crops to be raised under Sudan conditions.

Table 6. Mean squares for crude fiber, dry matter, crude protein, oil and ash content,

Sources of variation S. O. V.	D.F.	Crude fiber	Dry matter	Crude protein	Oil	Ash
Replication	3	19.065	87.742	0.195	0.002	0.251
Treatments	3	6.437NS	1.530NS	26.253**	0.140**	5.476 *
Error	9	9.287	35.404	1.275	0.013	1.015
Total	15					
C.V. %						

NS = Not significant at 0.05 level of probability
* = Significant at 0.05 level of probability
** = Highly significant at 0.01 level of probability

Table 7. Proximate analysis of the forage legumes (%)

Crops	Crude fiber	Dry Matter	Crude Protein	OIL	ASH
Clitoria	31.0 a	95.7 a	17.0 a	1.20a	6.60a
Lubia	28.7 ab	94.8 a	15.9 b	1.05b	4.50b
Phillipesara	29.7 ab	95.0 a	11.4 d	0.80c	6.85a
Guar	28.1 b	94.2 a	13.1 c	0.84c	7.00a

Means followed by the same letter (s) within each columns are not significantly different at probability 0.05 level according to (LSD) test.

The crops under investigation have the potential for supplying nomads and animal producers with acceptable levels of forage yield during the dry summer months.

Furthermore, proper crops management practices may contribute to the establishment of a better animal production system in the Sudan.

REFERENCES :

Adam, A.I. 1975. Semi-detailed soil survey and land capability classification of north-east Khartoum. Soil Survey Dept., Ministry of Agric.

Atwal, A.S. and G.S. Sidhu. 1964. Legumes in the economy of soil. 2. Fixation and excretion of nitrogen by Indian legumes under controlled conditions in sand culture. Indian J. Agric.Sci. 34:139-145.

Al awad, S.H. 1983. (personal communication). Forage crops in the Sudan. Dept. of Agronomy, Faculty of Agric. Unpublished data.

El Haj, M. G., M.A. Maglad and M.H. Hakir. 1987. Evaluation of the feeding value of clitoria as a legume forage for sheep fattening. Sudan Agric. J. 12:75-89

Evelyn, S.H. and S. Ahmed. 1965. Crop sequence trials. Ann. Rep. Gezira Res. Sta. Sudan.

Faki, H.H.M., Khattab, H.I., Ishag, H.M., Ahmed, F.A. and El Sayed, M.A. (1991). Prospects of investment in Animal Sector, in the Central State of Sudan, in Guma'a, Y.T. (ed.). Chances and opportunities of Investment in the Center State of Sudan, Gezira University Press, Wad Medani, Sudan. P. 81-98.

Gaafar, M.O. 1983. Evaluation of some methods of soil chracterization in the Sudan. M.Sc. Thesis, University of Khartoum, Sudan.

Huxley, P.A. 1980. Nitrogen nutrition of cowpea IV-Uptake and distribution of a single doze of early applied nitrogen. Tropical Agric. 57-193-202.

Mohamed, G.E. and I. Daw elmadina, 1979. The response of chickpea to nitrogen, phosphate and potassium. Ann. Rep. Hudaiba Res. Sta. P. 5., Sudan.

Nambiar, P.T., T.J. Rego and B.S. Rao. 1986. Compression of the requirements and utilization of nitrogen by genotypes of sorghum and nodulating and non-nodulating groundnut. Field Crops Res. 15: 165-179.

Rashied, S. Modawi, Yassin Mohamed Ibrahim and Salwa Al-Wahab (1993). Preliminary evaluation of the productivity of some summer forage legumes in U.A.E. Emir, J. Agric. Sci. 5:53-58.

Whiteman, A.J. (1971). The geology of the Sudan Republic. Clarendon Press Oxford, 1971, 1-15.

Y.T. Guma'a (1991). (ed.) Chances and opportunities of investment in Central State of Sudan, Gezira University Press, Wad Medani Sudan. P. 72-73.

مجلة الإمارات للعلوم الزراعية (١٩٩٦) ٨ : ٧٣-٨٣

أثر إضافة سمادي النيتروجين والفسفور على نمو وإنتاجية بعض محاصيل العلف البقولية

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ملخص :

أجريت هذه الدراسة لتقييم أثر إضافة سمادي النيتروجين والفسفور على نمو وانتاجية أربعة أنواع من محاصيل العلف البقولية المهمة والتي تشمل كل من الكلايتيوريا، اللوبيا (البلاب) ، الفلبسارا والقوار. تم استخدام تصميم القطاعات العشوائية الكاملة مع ثلاث مكررات وذلك لمقارنة أربعة مستويات مركبة من اليوريا ٤٦٪ نيتروجين والسيوبر فوسفيت ٤٦٪ فسفور كما يلي :

صفر نيتروجين + صفر سيوبر فوسفيت (كشاهد) ، صفر نيتروجين + ٢٠٠ كجم سيوبر فوسفيت/هكتار + ٢٠٠ كجم سيوبر فوسفيت للهكتار أدت الى تحسين نمو وانتاجية محاصيل الاعلاف معنويا أكثر من المعاملات الأخرى إضافة لذلك أدت إضافة هذه الأسمدة الى تحسين نوعية الاعلاف من حيث محتواها من البروتين الخام وتقليل محتواها من الالياف الخام.

كلمات مفتاحية : أسمدة ، علف ، غلة ، بقول ، وزن جاف ، نمو ، انتاجية .