Effect of Seedbed Types and Phosphorus Fertilizer (TSP) on Growth and Yield of Clitoria (*Clitoria ternata*)

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Summary

A field experiment was conducted for two consecutive seasons (1997/98 and 1998/99) in the Demonstration Farm of the Faculty of Agriculture, Shambat to investigate the effect of seedbed types and phosphorus fertilizer rates on growth and yield of *Clitoria ternata*. The treatments consisted of flat beds versus ridges in addition to three levels of phosphorus fertilizer (0, 50, 100 kg/ha of P_2O_5). Application of phosphorus fertilizer though improved growth parameters (leaf to stem ratio, leaf area index, plant cover), as well as forage fresh yield, but the differences did not reach the statistical significant level. Moreover, sowing in ridges relatively improved both, growth parameters and fresh yield of Clitoria.

Keywords: *Clitoria ternata*; Seedbed; Phosphorus.

Introduction

Sudan is rich in animal resources; estimated at 103 million heads of cattle, sheep, goats, and camels (Ministry of Finance and National Economy, 1997). This huge animal resource contributes very much to the national economy through foreign earnings. Despite this large number of animals, the range condition of the country is poor and very much deteriorated to cope with animal needs. This necessitates that irrigated forages need to be given a priority in the irrigated sector to bridge the gap between forage supply and animal feed demands. Irrigated forages contribute only about 4% of the total forage available to livestock in the Sudan (Drrag *et. al.*, 1995).

Among the promising forage crops that could receive more attention is *Clitoria ternata*, which is also known as Kordofan butter fly bean. This crop can be grown both by rain and under irrigation. It is a high yielder and drought tolerant. Its nutritive value is not much different from that of alfalfa .It contains 14 to 22% crude protein, 9 to 12% digestible protein and 56% total digestible nutrients (TDN) as reported by Drrag *et.al.*, (1995).

Although the importance of phosphorus fertilizer to legumes has been recognized worldwide (Jin *et. al.*, 1992; Mugwira and Hague, 1993), such information is still very scanty in the Sudan. Hence one of the objectives of this study is to determine the effects of different levels of phosphorus fertilizer on growth and productivity of clitoria. Another objective of the study is to evaluate the effect of seedbed types on growth and forage yield of clitoria under the heavy clay alkaline soil of Shambat.

Materials and Methods

A field experiment was conducted for two consecutive seasons (1997/98 and 1998/99) in the Demonstration Farm of the Faculty of Agriculture at Shambat (latitude 15° 40´ N and longitude 32° 32´ E). In the first season the experiment was planted in August 1997, whereas in the second the season experiment was planted in April 1998. The soil of the experimental site is heavy clay (64% clay) alkaline soil with a pH of 8.05 and the phosphorus content is about 0.06%.

The treatments consisted of two types of seedbeds (flat versus ridges) and three levels of phosphorus (0, 50, 100 kg/ha of P_2O_5). Triple super phosphate (46% P) was the source of phosphorus fertilizer and was banded at the time of sowing at 5 cm depth. Five to six seeds were sown per hole at 15 cm spacing between holes and 70 cm spacing between ridges (ridge treatments) or rows (flat treatments). The ridge height was about 25 cm and planting was done halfway between the top and bottom of the ridge. In case of flat treatment the border ridge was about 25 cm high. The experimental design was randomized complete block with three replications. The pilot size unit was 35 m2 with six ridges or rows per plot.

The growth parameters, which were measured during the course of the study, included leaf area, leaf to stem ratio, cover estimation, and forage fresh yield. Leaf area was determined each time at harvest. Ten leaves were randomly taken from each plot, punctured and oven dried at 80° C for 48 hrs. Leaf area was calculated using the following formula:

$$\text{Leaf area} = \frac{\text{wt. of leaves X area of discs}}{\text{wt. of leaf discs}}$$

as reported by Watson and Watson (1953).

For leaf to stem ratio, three plants were randomly cut from each treatment. Leaves were separated from stems and both oven dried. The mean leaf to stem ratio was calculated by dividing dry weight of leaves by that of stems. Percent cover was estimated by a rectangular quadrat of 80 X 100 cm. The quadrat was randomly thrown in each plot and plants within the area of the quadrat were estimated as a percent in relation to the area of the quadrat. The cover estimation values were converted using the Arc-Sin transformation method before analysis of the data. For fresh yield determination the whole plot was harvested and fresh weight was measured immediately in the field using a spring balance. Five cuts were obtained during the first season compared to three cuts during the second season. Plants were harvested for forage determination when they attained full canopy or at early flowering, whichever came first.

Data was analyzed using the SPSS (Statistical Package

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for Social Sciences) and means were separated using the LSD procedure (Gomez and Gomez, 1984).

Results and Discussion

Leaf Area

Addition of phosphorus fertilizer (TSP) significantly increased the leaf area in both seasons except for the first two cuts of the first season (Table 1). The effect of phosphorus was manifested toward the end of the season. This might be related to the low mobility of phosphorus in the soil. This finding is confirmed by Ahmed (1978) who reported that phosphorus fertilizer increased leaf area in clitoria.

Sowing in ridges consistently produced higher leaf area compared to sowing on the flat during both seasons. This increase in leaf area was significant in both seasons except for the second cut of the second season (Table 1). It should be recalled that ridge sowing in heavy clay soils is an advantage to seedling survival and plant growth as the growing plants are relatively away from the bottom of the ridge where water ponds and salts accumulate in such soils and may have adverse effects on growing plants. This finding is in line with the results of Abusuwar (1994) on sorghum and Abusuwar *et.al.*, (1999) on alfalfa.

Table 1. Effect of seedbed type and Phosphorus Fertilizer on Leaf Area (cm2) of clitoria during 1997 and 1998 seasons.

Seasons / Treatments	1997					1998		
Phosphorous	**Ist cut**	**2nd cut**	**3rd cut**	**4th cut**	**5th cut**	**Ist cut**	**2nd cut**	**3rd cut**
P0	38.55	39.60	51.70	70.13	44.05	68.36	66.57	50.52
P1	36.55	41.10	46.90	76.72	51.20	74.85	83.94	54.62
P2	37.20	36.40	55.10	73.14	56.31	73.40	78.13	45.61
LSD (0.05)	NS	NS	04.02	02.81	09.13	05.01	08.25	04.01
Seedbed type								
Flat	35.93	37.00	49.40	71.76	49.49	68.47	75.90	45.26
Ridge	39.00	41.00	53.00	74.89	51.54	75.93	76.50	55.23
LSD (0.05)	02.81	03.01	02.97	02.93	01.85	02.88	NS	07.38
CV(%)	09.31	17.44	20.01	17.02	24.26	11.37	11.37	30.39

P0 =No phosphorus (control).
P1 =50 kg P_2O_5/ha.
P2 =100 kg P_2O_5/ha.
NS = Not Significant.

Leaf to Stem Ratio

Application of phosphorus fertilizer showed no significant effect on leaf/stem ratio. This was true for all cuts in the two seasons.

Differences between sowing in ridges and sowing on the flat with respect to leaf/stem ratio were not significant in both seasons (Table 2).

Cover Estimation

No significant differences in percent plant cover as a result of phosphorus application were reported in both seasons (Table 3). However, the lower phosphorus fertilizer rate (50 kg P_2O_5/ha (P1)) resulted in higher plant cover in both seasons except the second and the fifth cuts of the first season.

Sowing on ridges consistently produced higher plant cover during both seasons except for the first cut of the first season and the last cut of the second season (Table 3). These differences reached the significant level for the second and fifth cuts of the first season and the first cut of the second season. Ridge sowing was relatively superior over flat sowing, though not significantly different with respect to leaf/stem ratio and the same trend was observed with leaf area. Since percent cover is largely affected by leaf area and leaf/stem ratio, it is expected that percent plant cover would be higher with ridge sowing.

Table 2. Effect of Seedbed Type and Phosphorus Fertilizer on Leaf/Stem Ratio of Clitoria During 1997 and 1998 Seasons.

Seasons / Treatments	1997					1998		
Phosphorous	**Ist cut**	**2nd cut**	**3rd cut**	**4th cut**	**5th cut**	**Ist cut**	**2nd cut**	**3rd cut**
P0	2.39	1.15	0.76	3.54	3.56	0.89	1.16	2.51
P1	2.37	1.12	0.93	3.47	2.81	0.98	1.12	2.97
P2	2.07	1.02	0.93	3.70	2.73	1.00	1.20	2.47
LSD (0.05)	NS	NS	NS	NS	NS	NS	NS	NS
Seedbed type								
Flat	02.37	01.11	0.70	3.51	3.17	0.99	1.17	2.52
Ridge	02.18	01.07	1.05	3.59	2.90	0.92	1.15	2.79
LSD (0.05)	NS	NS	NS	NS	NS	NS	NS	NS
CV(%)	17.02	17.10	25.31	22.07	23.76	23.41	12.19	24.72

P0 =No phosphorus (control).
P1 =50 kg P_2O_5/ha.
P2 =100 kg P_2O_5/ha.
NS = Not Significant.

Table 3. Effect of Seedbed Types and Phosphorus Fertilizer on Percent Cover Estimation of Clitoria During 1997 and 1998 Seasons.

Seasons / Treatments	1997					1998		
Phosphorous	**Ist cut**	**2nd cut**	**3rd cut**	**4th cut**	**5th cut**	**Ist cut**	**2nd cut**	**3rd cut**
P0	60.23	52.26	84.07	87.01	73.44	87.01	90.00	81.03
P1	66.45	51.24	87.04	90.00	70.82	87.01	90.00	87.01
P2	63.17	47.76	83.96	87.01	66.63	84.02	87.01	77.79
LSD (0.05)	NS	NS	NS	NS	NS	NS	NS	NS
Seedbed type								
Flat	65.54	46.19	84.07	88.01	67.68	82.02	88.01	83.58
Ridge	60.53	55.99	85.97	88.01	72.91	90.00	90.00	79.97
LSD (0.05)	NS	07.17	NS	NS	04.72	07.13	NS	NS
CV(%)	20.00	13.35	11.40	07.13	16.03	09.07	04.75	11.85

P0 =No phosphorus (control).
P1 =50 kg P_2O_5/ha.
P2 =100 kg P_2O_5/ha.
NS = Not Significant.

Fresh Yield

Phosphorus application slightly increased, the forage fresh yield in several cuts in both seasons, although the differences were not significant (Table 4). Application of 100 kg of P_2O_5/ha (P2) exceeded that of P1 (50 kg P_2O_5/ha) during the first, third, and the fifth cuts of the first season. Several researchers indicated that phosphorus fertilizer increased fresh yield of clitoria (Mohamed, 1990, Groza *et. al.*, 1972; Ibrahim *et.al.*,1996) . Clitoria being a leguminous crop is expected to respond positively to phosphorus fertilization.

Although phosphorus fertilization improved growth parameters and increased fresh yield, it did not reach the statistical significant level. This might be explained on the basis that in heavy clay soils phosphorus is fixed by the soil and becomes unavailable for plant uptake. This might sug-

Table 4. Effect of Seedbed Types and Phosphorus Fertilizer on Forage Fresh Yield (tons/ha) of Clitoria During 1997 and 1998 Seasons.

Seasons / Treatments	1997					1998		
Phosphorous	**Ist cut**	**2nd cut**	**3rd cut**	**4th cut**	**5th cut**	**Ist cut**	**2nd cut**	**3rd cut**
P0	15.03	07.19	16.90	11.63	09.07	18.31	21.08	13.65
P1	15.64	06.51	13.75	12.90	08.35	20.09	23.38	15.66
P2	16.31	06.71	18.05	11.96	08.43	17.60	19.63	11.43
LSD (0.05)	NS	NS	NS	NS	NS	NS	NS	NS
Seedbed type								
Flat	15.42	06.64	16.08	11.77	08.30	18.03	20.93	13.47
Ridge	16.03	06.96	17.72	12.54	08.93	19.81	21.79	13.69
LSD (0.05)	NS	NS	NS	NS	NS	NS	NS	NS
CV(%)	08.09	21.40	28.87	12.64	26.71	18.92	12.32	02.09

P0 =No phosphorus (control).
P1 =50 kg P_2O_5/ha.
P2 =100 kg P_2O_5/ha.
NS = Not Significant.

gest using soil microorganisms like mycorrhizae in such soils to assist plant roots in the uptake of phosphorus.

Sowing in ridges produced higher forage fresh yield compared to sowing on the flat during both seasons (Table 4). However, differences were not big enough to reach the significant level. The insignificant increase in fresh yield as a result of ridge sowing could be explained on the basis that all growth parameters measured in this experiment (leaf area, leaf to stem ratio, and plant density (Abusuwar and Abdella, 2001), were favored by ridge sowing and this was reflected in higher fresh yield. Ahmed (1978) reported that sowing in ridges increased growth and yield of clitoria in heavy clay soils.

It can be concluded from the results of this study that although phosphorus fertilization of clitoria improved growth and fresh yield, but the differences were not statistically significant. This might suggest that when applying phosphorus fertilizer to heavy clay soils, consideration should be given to the mechanisms which would free the fixed phosphorus, like using the mycorrhizal fungus.Moreover, sowing in ridges, particularly in heavy clay soils, showed some superiority over sowing on the flat.

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أثر نوعية المهد وسماد السوبر فوسفات الثلاثي على نمو وإنتاجية علف الكلايتوريا

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الخلاصة:

تضمن البحث تجربة حقلية بالمزرعة التجريبية بكلية الزراعة – جامعة الخرطوم خلال موسمي 97/1998 و98/1999 لمعرفة تأثير ثلاث مستويات من سماد السوبر فوسفات الثلاثي (صفر، 50 و100 كجم/هكتار) ونوعية المهد (الزراعة في أرض مُسطحة وسرابات) علي نمو وإنتاجية علف الكلايتوريا. استُعمل تصميم القطاعات العشوائية الكاملة بثلاث مكررات.

أظهرت إضافة سماد السوبر فوسفات الثلاثي تحسناً في معايير النمو وزادت من إنتاجية العلف الطازج إلا أنَّ الفروقات كانت غير معنوية، كما أدت الزراعة في سرابات إلى زيادة في معايير النمو مُقارنةً بالزراعة في أحواض وكانت الزيادة معنوية فقط في حالة مساحة الورقة. انعكست زيادة معايير النمو على زيادة إنتاجية العلف.

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