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Effect of Sowing Methods and Phosphorus Levels on Yield and Quality of Two Alfalfa Cultivars*

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Abstract : A study was conducted during the period from November 1993 to April 1995 at the Demonstration Farm of the Faculty of Agriculture, University of Khartoum, to investigate the effect of three levels of phosphorus fertilizer and two sowing methods on yield and quality of two alfalfa (*Medicago sativa* L.) cultivars. Levels of phosphorus fertilizer used were 0, 50 and 100 kg/ha P_2O_5 in the form of triple supersphosphate (48% P_2O_5). The two alfalfa cultivars (Hegazi and Pioneer 5929) were planted on flat and on ridges. Phosphate fertilization at the rate of 100 kg/ha P_2O_5 increased dry matter production, leaf to stem ratio and improved forage quality. Sowing on flat increased dry matter production. The local cultivar Hegazi was superior to the introduced variety in dry matter yield but the opposite was true for leaf to stem ratio and nutritive value.

INTRODUCTION

Natural rangelands are the main source of feed for livestock in the Sudan. These areas are diminishing due to expanding rainfed agriculture and drought. The large animal wealth in the country calls for a continuous supply of forage to improve dairy production around urban areas and to meet the requirements of animal production for local and foreign markets.

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This necessitates that great attention be given to irrigated forages to bridge the gap between supply and demand in livestock feeds.

Alfalfa (*Medicago sativa* L.) worldwide distribution is attributed to its high yield, good quality forage, symbiotic nitrogen fixation, suitability for mechanical harvesting and good recovery after cutting or grazing. In the Sudan, the area under alfalfa is estimated at 125 000 feddans (1 fed = 0.42 ha).

Commercial fertilizers are not used for alfalfa in the Sudan due to either ignorance of farmers or their attempt to reduce production cost. Alfalfa was reported to respond to phosphatic fertilizers through improved nodulation and increased forage yield (Abu Suwar and Mohammed 1997). Scant and contradicting information on alfalfa response to phosphatic fertilizers in the Sudan has been reported. Nayel and Khidir (1995) reported a significant increase in alfalfa fodder yield due to phosphorus application in the second season while the effect was not significant in the first season. Abu Suwar and Mohamed (1997), on the other hand, reported a positive response of phosphorus on alfalfa fodder and seed yield. This necessitates more research in this area. Hence, the objectives of this study were to examine the response of two alfalfa cultivars (Hegazi and Pioneer) to different levels of phosphates and two sowing methods, and to evaluate their effects on forage yield and quality.

MATERIALS AND METHODS

The study was carried out during the period from November 1993 to April 1995 at the Demonstration Farm of the Faculty of Agriculture, University of Khartoum, Shambat (latitude 15° 40′ N, longitude 32° 32′ E and 380m above sea level). The soil is a cracking clay moderately alkaline (pH 7.8 - 8.5). The climate of the area is semi-arid with a hot summer and short rainy season (67.9 mm/ annum).

The experimental area was ploughed, disc harrowed and levelled. The plots were made either flat or with ridges (80 cm apart). The treatments included two alfalfa cultivars, three levels of phosphorus in the form of triple superphosphate (48% P_2O_5) and two methods of sowing.

The two cultivars were Pioneer 5929 and Hegazi designated C_1 and C_2, respectively. The three levels of phosphorus were 0, 50 and 100 kg/ha of P_2O_5 which are referred to, henceforth, as P_0, P_1 and P_2, respectively, and the two methods of sowing were ridge (M_1) versus flat (M_2). Phosphorus fertilizer was applied immediately before planting. The treatments were arranged in a randomized complete block design and replicated four times.

Sowing was done on the 12th of November 1993 at the rate of 50 kg/ha by broadcasting seeds either on flat or on ridges. Irrigation was applied at an interval of 8 to 12 days depending on the season.

Measurements of leaf to stem ratio, dry matter yield and proximate analysis were performed. From each plot, ten plants were randomly selected and clipped for leaf to stem ratio determination, while for dry matter production a permanent pre-marked area of 30 x 70 cm was clipped each time from the centre of each plot (treatment). Samples for dry weight determination were oven-dried at 70°C for 48 hours until a complete dehydration was reached. The same samples of dry matter were ground and analyzed for crude protein and crude fibre determination. Crude protein was estimated using the micro-Kjeldahl method and crude fibre was estimated by the modified Acid Detergent Fibre Test.

RESULTS AND DISCUSSION

Dry matter production

Phosphorus fertilizer increased dry matter production in 11 out of 12 harvesting dates with a significant increase in harvesting dates 6 and 12 (Table 1). The highest level of 100 kg/ha of P_2O_5 (P_2) increased dry matter by 23% compared to the control, whereas the 50 kg/ha (P_2) of P_2O_5 increased dry matter by 11% over the control. It was noticed that phosphorus application increased plant density and plant height (data not reported in this paper), therefore, dry matter production was expected to be increased. Similar results on alfalfa were reported by Patel *et al.* (1990) and Abu Suwar and Mohammed (1997) and on peas by Voss *et al.* (1990). On the other hand, Nayel and Khidir (1995) found no significant effect of phosphorus on dry matter of alfalfa in 12 cuts of the first season

of the crop, while in the second season highly significant effect was obtained in three out of four cuts.

Dry matter production was higher when alfalfa was grown on flat compared to that on ridges in 9 out of 12 harvesting dates with a significant increase in 7 harvests (Table 1), although higher plant densities were observed on ridges compared to flat plots. It is expected to have higher plant densities on ridges than on flat, although the same amount of seeds was applied for both treatments, since seeds sown on ridges were confined to the top of the ridges, and the bottom of the ridges was clear of seeds. This way, theoretically, ridge sowing had more or less double the amount of seed rate compared to flat beds. Consequently, plants grown in flat beds have the advantage of less competition compared to plants grown on ridges and, therefore, higher forage yields were obtained in flat beds than in ridges. Moreover, sowing on ridges, especially under cracking clay soils, gives alfalfa plants an advantage with respect to waterlogging to which alfalfa is sensitive. Similar results were reported by Sheaffer *et al.* (1988) and Grossen *et al.* (1994).

The local variety Hegazi out-yielded the introduced variety Pioneer 5929 in dry matter production in 10 out of 12 harvesting dates with significant increase in two (Table 1). Higher plant density was shown by the local variety Hegazi, and this was reflected in higher dry matter production compared to the introduced variety Pioneer. In addition, variety Hegazi has been grown in the Sudan for about 80 years (Agabawi 1968); this is why it is more adapted to the local conditions compared to the introduced one (Abu Suwar and Mohammed 1997).

Leaf to stem ratio (LSR)

Phosphorus fertilizer increased leaf to stem ratio in all sampling dates, except the first sampling with significant increase in the 9th sampling date (Table 2). Fertilization is known to increase vegetative growth and delays senescence and, therefore, increases leaf to stem ratio (Abu Suwar and Mohamed 1997 1977). Kaylan *et al.* (1976) reported that phosphorus significantly increased the number of branches and consequently leaf to stem ratio of pigeon pea.

Pioneer gave higher leaf to stem ratio than the variety Hegazi in 11 out of 12 harvesting dates (Table 2). This may be attributed to the leafy nature of the introduced variety compared to the local variety. Volence and Cherney (1990) reported that the rate of shoot elongation is a varietal character which affects leaf to stem ratio.

Forage nutritive value

Phosphorus fertilizer significantly improved forage quality in terms of crude protein in summer, autumn and winter seasons (Table 3). As noted earlier, leaf to stem ratio was increased by phosphorus application and this was reflected in higher crude protein in fertilized plots since leafy plants are more nutritious than fibrous stemy plants.

Pioneer produced significantly higher crude protein and lower crude fibre than the local variety in all seasons (Table 3). As noted with leaf to stem ratio, Pioneer was more leafy than the local variety and this was reflected in higher protein and lower crude fibre. Similar results were reported by Abu Suwar and Mohammed (1997).

With respect to variation in nutritive value between different seasons, it was noticed that summer sampling produced higher protein and lower crude fibre, while higher values of crude fibre and lower values of crude protein were detected in winter and autumn samples, respectively.

It can be concluded from the results of this study that

1. phosphorus fertilizer at the rate of 100 kg/ha of P_2O_5 increases dry matter yield, leaf to stem ratio and nutritive value of alfalfa,

2. sowing alfalfa on flat increases dry matter yield, and

3. the local variety Hegazi is superior to the introduced variety Pioneer in forage yield, but the introduced variety is superior to the local variety in forage quality.

Table 1. Effect of phosphorus levels, sowing methods and alfalfa cultivars on forage dry matter (tons/ha) at different harvesting dates.

Treatment	Sampling dates											
	1	2	3	4	5	6	7	8	9	10	11	12
	12.1.94	13.2.94	12.3.94	15.4.94	10.5.94	12.6.94	12.7.94	12.8.94	12.9.94	27.12.94	29.1.95	7.3.95
Phosphorus levels												
P_0	1.8	1.8	2.1	2.4	3.2	2.5	2.3	2.2	1.8	1.6	2.3	1.69
P_1	1.6	2.1	2.5	2.8	3.4	2.8	2.5	2.3	1.9	1.9	2.5	2.04
P_2	1.7	2.3	2.6	2.9	4.2	3.6*	2.8	2.5	2.0	1.9	2.8	2.14*
SE±	0.1	0.52	0.15	0.17	0.41	0.32	0.28	0.2	0.2	0.17	0.23	0.12
LSD (0.05)	NS	NS	NS	NS	NS	0.66	NS	NS	NS	NS	NS	0.25
Sowing methods												
M_1	1.6	1.8	2.1	2.3	3.4	3.1	2.8	2.5	2.1	1.6	2.4	1.74
M_2	1.8	2.2*	2.6*	3.0*	3.7	2.9	2.3	2.8	1.7	1.9*	2.8*	2.12*
SE±	0.01	0.12	0.14	0.14	0.3	0.2	0.23	0.2	0.2	0.14	0.19	0.12
LSD (0.05)	0.02	0.26	0.3	0.29	NS	NS	NS	NS	NS	0.29	0.4	0.25
Cultivars												
C_1	1.8	2.0	2.3	2.6	3.6	2.9	2.4	2.2	1.7	1.6	2.3	1.91
C_2	1.7	2.1	2.5	2.8	3.5	3.0	2.7	2.4	2.1	2.0*	2.9*	1.94
SE±	0.08	0.42	0.13	0.02	0.3	0.2	0.23	0.2	0.2	0.14	0.19	0.12
LSD (0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	0.29	0.4	NS
CV	17%	22%	18.3%	18.2%	32%	30%	31%	33%	30%	28%	25%	22%

P_0 = Control; P_1 = 50 kg/ha of P_2O_5; P_2 = 100 kg/ha of P_2O_5;
M_1 = Sowing on ridges; M_2 = Sowing on flat;
C_1 = Pioneer 5929; C_2 = Hegazi.

Table 2. Effect of phosphorus levels, sowing methods and alfalfa cultivars on leaf to stem ratio at different harvesting dates.

Treatment	Sampling dates											
	1	2	3	4	5	6	7	8	9	10	11	12
	12.1.94	13.2.94	12.3.94	15.4.94	10.5.94	12.6.94	12.7.94	12.8.94	12.9.94	27.12.94	29.1.95	7.3.95
Phosphorus levels												
P_0	1.4	1.1	1.07	0.99	0.72	1.25	0.92	0.80	0.85	1.03	0.72	1.15
P_1	1.2	1.2	1.11	1.03	0.72	1.30	0.96	0.86	0.88	1.09	0.73	2.15
P_2	1.3	1.2	1.12	1.19	0.73	1.31	0.98	0.88	0.93*	1.14	0.78	2.18
SE±	0.08	0.05	0.04	0.06	0.03	0.05	0.03	0.03	0.02	0.07	0.03	0.06
LSD (0.05)	NS	NS	NS	NS	NS	NS	NS	NS	0.05	NS	NS	NS
Sowing methods												
M_1	1.45	1.16	1.07	0.99	0.67	1.31	0.94	0.82	0.88	1.06	0.68	1.15
M_2	1.34	1.19	1.10	1.02	0.76*	1.26	0.97	0.81	0.89	1.06	0.77*	1.17
SE±	0.06	0.03	0.03	0.05	0.03	0.04	0.03	0.02	0.02	0.05	0.02	0.04
LSD (0.05)	NS	NS	NS	NS	0.06	NS	NS	NS	NS	NS	0.05	NS
Cultivars												
C_1	1.5*	1.3*	1.14	0.99	0.81*	1.38*	0.83	0.93*	0.93*	1.08	0.82*	1.27*
C_2	1.3	1.1	1.04	1.02	0.63	1.19	0.80	0.85	0.85	1.03	0.63	1.05
SE±	0.06	0.04	0.03	0.05	0.03	0.04	0.03	0.02	0.02	0.05	0.02	0.04
LSD (0.05)	0.13	0.08	0.06	NS	0.06	0.09	NS	0.05	0.05	NS	0.05	0.09
CV	17.3%	12%	10%	17%	13%	12.5%	12%	8.7%	8.7%	191%	13.1%	14.5%

P_0 = Control; P_1 = 50 kg/ha of P_2O_5; P_2 = 100 kg/ha of P_2O_5;
M_1 = Sowing on ridges; M_2 = Sowing on flat;
C_1 = Pioneer 5929; C_2 = Hegazi.

Table 3. Effect of phosphorus levels, sowing methods and alfalfa cultivars on crude protein (C.P%) and crude fibre (C.F.%) during summer, autumn and winter.

Treatment	C.F. %			C.P.%		
	1 22.4.94 Summer	2 12.8.94 Autumn	3 10.12.94 Winter	4 22.4.94 Summer	5 12.8.94 Autumn	6 10.12.94 Winter
			Phosphorus levels			
P_0	20.85	18.81	19.28	9.63	10.92	12.33
P_1	25.03	20.56	22.72	10.81	13.06	13.86
P_2	25.41	23.35	24.43	14.87	16.71	17.06
SE±	0.17	0.28	0.28	0.34	0.21	0.18
LSD (0.05)	0.36	0.57	0.58	0.71	0.43	0.37
			Sowing methods			
M_1	23.40	20.05	21.54	13.40	14.08	14.12
M_2	25.95	21.77	22.74	10.14	13.05	14.22
SE±	0.14	0.22	0.23	0.28	0.18	0.14
LSD (0.05)	0.29	0.46	0.47	0.58	0.37	0.30
			Cultivars			
C_1	24.95	23.13	22.54	10.99	12.29	14.12
C_2	24.42	18.77	21.74	12.57	12.84	14.71
SE±	0.14	0.22	0.23	0.28	0.18	0.14
LSD (0.05)	0.29	0.46	0.47	0.58	0.37	0.30
CV	2.08%	3.7%	3.6%	8.4%	4.4%	3.6%

P_0 = Control; P_1 = 50 kg/ha of P_2O_5; P_2 = 100 kg/ha of P_2O_5;
M_1 = Sowing on ridges; M_2 = Sowing on flat;
C_1 = Pioneer 5929; C_2 = Hegazi.

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مجلة جامعة الخرطوم للعلوم الزراعية : المجلد السادس - العدد الأول ، 1998م

تأثير طريقة الزراعة وسماد الفوسفور على إنتاجية ونوعية صنفين من البرسيم

التوم الصادق على وعوض أبوسوار وفتح الرحمن على مصطفى

قسم المحاصيل الحقلية - كلية الزراعة
جامعة الخرطوم - السودان

موجز البحث : أجرى البحث فى المزرعة الايضاحية بكلية الزراعة جامعة الخرطوم خلال الفترة من نوفمبر 1993 إلى أبريل 1995م لدراسة تأثير طريقة الزراعة (فى أحواض مسطحة وعلى السراب) وسماد السوبر فوسفات (صفر و 50 و 100 كجم/هكتار) على إنتاجية ونوعية البرسيم الحجازى والبرسيم البايونير 5929 .

أثبتت الدراسة أن جرعة 100 كجم/هكتار من سماد السوبرفوسفات أدت إلى زيادة معنوية فى كمية المادة الجافة ونسبة الأوراق للساق وتحسين نوعية العلف المنتج ، وأن الزراعة فى الأحواض المسطحة زادت من الإنتاجية الجافة مقارنة بالزراعة فى سرابات (مروز) . أثبتت الدراسة أيضاً أن الصنف المحلى "حجازى" تفوق على الصنف المستورد "بايونير 5929" فى الإنتاجية من المادة الجافة والعكس صحيح فى نسبة الأوراق للساق ونوعية العلف المنتج حيث تفوق الصنف "بايونير 5929" على "الحجازى" .