Effect of Low Seed Rate on Seed and Forage Yield of Alfalfa in the River Nile State, Sudan

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ABSTRACT

An on-farm survey of plant population of one year old, yet highly productive alfalfa (*Medicago sativa L.*) swards in Khartoum North area، revealed that the plant population after one year from establishment, was equal to that resulting from a seed rate of I .5 kg/ha (i.e. 2.8% of the sown seeds). This suggested that the optimum seed rate for the production of each of the forage and seed of alfalfa in Sudan should be reconsidered. In this context, an experiment was conducted at Hudeiba Research Station for three years during the period of Dec. 1995 - January 1998 to study the time course forage and seed yield patterns of alfalfa sown with five low seed rates (i.e., 2.4, 4.8, 7.2, 9.6 and 12 kg/ha). The results indicated that the highest seed rate (12 kg/ha) produced the highest forage yield in a few cuts only. The variations among the time course forage yields of the various seed rates over the two years were either nonsignificant or enatic. The cumulative annual forage yield of the two higher seed rates، (9.6 and 12 kg/ha) was invariably higher than those of the other seed rates. For seed yield, the lowest seed rate (i.e., 2.4 kg/ha) resulted in the highest seed yield in the first two seed production cycles (SPC) in 1996 as well as in the annual total of the first year. Differences among the seed rates in other SPCs as well as the annual total of 1997 were either lacking or erratic. It is therefore, concluded that for dual purpose (forage and seed) alfalfa, the seed rate should not exceed 9.6 kg/ha, and for seed production the seed rate of 2.4 kg/ha is the optimum.

INTRODUCTION

Alfalfa farmers in the Sudan tend to use extremely high seed rates، mostly about 53 kg/ha, and few studies have been conducted to address this problem. For instance, Nayel and Khidir (1995) reported that forage yield was highest when 40 kg seeds were used compared to 30 or 50 kg/ha. On the other hand, Salih (1994) found that 12 kg/ha was the best compared to 24 or 36 kg/ha. In accord with Salih (1994) findings, Khair (1997)found no significant differences in forage yield of several seed rates within the range of 12-72 kg/ha. Accordingly, he suggested 12 kg/ha or lower as the optimum seed rate.

The common practice in Sudan is to grow alfalfa for forage for the first two to three years then during .March - May of the 3rd or 4th year, the crop is left to produce seeds (Nayel and Khidir, 1995). A possible rationale for that is the progressive loss of plants during the first two years of the crop age which makes the plant population of the 3rd year optimum for seed production. The time course population dynamics of alfalfa during the establishment year showed that the calculated seed rates for the persisting plants are 7-8 kg/ha at the age of two months and only 3-4 kg/ha at the age of 10 months (Khair, 1997). A survey in farmers' fields in Khartoum North area revealed that the persisting plants in several one year old fields were equivalent to that resulting from 1-2 kg/ha (Khair *et al*. 1998). The original seed rate was 53 kg/ha. Hence, the loss of a large number of plants through self-thinning is inevitable when unnecessarily high seed rates are used. The question of whether the optimum seed rate of alfalfa for seed and forage production could be reduced below 12 kg/ha needs to be elucidated. Such low seed rate may enable harvesting of the seeds during the alfalfa establishment year. The objective of this study was, therefore, to investigate the time course forage and seed yield patterns as well as the annual total yields at seed rates $\leq$ 12 kg/ha.

MATERIALS AND METHODS

A field experiment involving alfalfa, (*Medicago sativa L*.) was conducted in the Hudeiba Research Station Farm (Lat. 7^0 34' N, Long. 33^0 56' E) during the period 17 Dec. 1995 to early 1998. The land was

prepared by disc ploughing, disc harrowing, leveling and ridging to 60 cm. The treatments comprised five seed rates (*viz* 2.4, 4.8, 7.2, 9.6 and 12 kg/ha) which were randomly allocated in a randomized complete block design with four replications. The plot size was 6.0 x 4.2m with 7 ridges.

Seeds were drilled on the top of the ridge to a depth of 3-5 cm and irrigated immediately. Further irrigations were at intervals of 7-10 days. Urea was applied at the rate 93 kg/ha prior to the third irrigation. The plots were kept weed free by hand weeding.

In each plot, the two outermost ridges were left as margins. The middle ridge was also considered a margin to divide each plot into two halves، each consisting of two ridges for either forage or seed yield. The net area each was 7.2 m^2 . The forage was cut every four weeks and hence the number of cuts were 12 for 1996/97 and for 1997/98, seasons. In each at, the fresh matter was immediately weighed in the field.. A sub-sample of one kilogram was then oven-dried for dry matter determination. Seeds were harvested throughout each year in cycles referred to as seed production cycles (SPC). The SPC denotes the gestation period for each seed yield. Hence, there were 4 and 5 SPC in each of 1996/97 and 1997/98 respectively. At each seed harvest, pods were collected when 90 %or more of them were dry. They were then sun dried, hand threshed and weighed.

Data on forage and seed yield of each year were statistically analyzed as for a split plot design: Cutting months (in the case of forage) and SPCs (in the case of seed yield) were considered main plots, whereas the seed rates were considered sub-plots in both cases.

RESULTS

Forage yield

The differences in the dry matter yields among the various seed rates as well as among the cuts (over all seed rates) with the advancement in crop age (Table l) were either non-significant or significant in an inconsistent trend. The inconsistency resulted from the lack of a specific yielding trend of the seed rates, although they were equally spaced over a range of five levels. In eight out of the 24

cuts (cumulative of both years), the differences among the seed rates were not significant. In only three cuts، however, did the highest seed rate (12 kg/ha) give the highest forage yield. The differences among the other seed rates in those three cuts were, however, not significant. In the remaining 13 cuts, no specific trend was observed, but the highest forage yield was associated with both 9.6 and 12.0kg/ha in some cuts and with 4.8-12.0 kg/ha in others.

The monthly and the annual cumulative dry matter yields of the various rates are shown in Table l. In 1996/97, the seed rate of 4.8 kg/ha

Table 1. The time course effect of seed rate on dry matter yield(t/ha) of alfalfa during the period Feb. 1996-Jan.1997 and the period Feb. 1997-Jan. 1998 at Hudieba Research Station.

Seed rate (kg/ha)	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Monthly mean	Annual total
							Feb. 1996 – Jan. 1997							
2.4	1.3	1.9	1.3	2.5	1.7	2.5	1.6	2.1	1.7	1.6	2.5	2.7	2.0	24.0
4.8	1.5	2.0	1.6	2.4	1.6	2.3	1.5	1.3	1.4	1.4	2.5	2.4	1.8	21.6
7.2	1.7	2.2	1.7	2.6	2.0	2.4	1.4	1.7	1.9	1.5	2.2	2.5	2.0	24.0
9.6	1.6	2.4	1.5	2.7	1.9	2.5	2.0	2.0	2.1	1.9	2.1	2.9	2.1	25.2
12	2.3	2.3	1.5	2.5	1.9	2.6	1.5	2.2	2.1	2.1	2.2	3.2	2.2	26.4
SE ±							0.14						0.04	0.48
Mean	1.7	2.2	1.5	2.5	1.8	2.5	1.6	1.8	1.9	1.7	2.3	2.7		
							Feb. 1997- Jan. 1998							
2.4	2.6	3.4	2.4	2.7	1.8	1.6	1.8	2.0	0.7	0.8	1.1	1.5	1.9	22.8
4.8	2.5	3.1	3.0	2.9	1.9	1.8	1.9	2.1	0.7	0.7	1.1	1.4	1.9	22.8
7.2	2.6	3.1	2.6	2.8	1.9	2.0	2.4	2.2	0.9	1.0	1.2	1.6	2.0	24.0
9.6	2.9	3.5	3.0	2.9	2.0	2.2	2.5	2.5	1.1	1.1	1.6	1.7	2.3	27.6
12	3.0	4.1	3.3	2.7	2.2	2.4	2.7	2.4	1.5	1.3	1.8	2.0	2.4	28.8
SE ±							0.2						0.1	1.20
Mean	2.7	3.4	2.9	2.8	1.9	2.0	2.2	2.2	1.0	1.0	1.4	1.6		

resulted in significantly the lowest monthly mean and annul cumulative dry matter yields. The respective yields of the 12 kg/ha on the other hand، was significantly higher than those of all other seed rates except of 9.6 kg/ha. Likewise, in 1997/98, 9.6 and 12 kg/ha significantly outyielded both 2.4 and 4.8 kg/ha.

Seed yield

As in the case of forage yields, the seed yield resulting from the different seed rates varied considerably with the advance in crop age (Table 2). In the first SPC of 1996, which occurred during the first 5 months of the crop age, and the second SPC of 1997, the lowest seed

rate (i.e., 2.4 kg/ha) resulted in the highest seed yield. In other advanced SPCs, differences among the seed rates, even-though significant in some cases, were non consistent among the SPCs. What was consistent however, was the superiority of the lowest seed rate (2.4 kg/ha) in the high seed yielding SPCs, *viz* the first in 1996 and the second in 1997. The annual cumulative (total) seed yields of both years, however, revealed limited differences among the seed rates.

DISCUSSION

The effective forage production age of alfalfa, in this study, i.e., the first cut, as well as in those of Nayel and Khidir (1995) and Khair (1997), was staffed when the crops were 2-3 months of age. It is, therefore, the population of alfalfa at this stage and onwards which crucially contribute to the forage and seed yields. In an earlier study (Khair, 1997), when an average of 42 kg/ha of seeds were sown, the persisting plants at 3 and 10 months of age represented about 7-8 and 3-4 kg/ha, respectively. Despite the reduction in the plant population, the time course forage yield either remained more or less constant or increased in some cases (Khair, 1997) This agrees with an on-farm survey in Khartoum Nonh (Khair *et. al*، ،(1998which revealed that the productive plants of alfalfa which persisted after one year could have resulted from sowing about 1.5 kg/ha of seeds (2.8%ofthe sown seeds).

Table 2. Time course of alfalfa seed yield (kg/ha)as affected by seed rate

	Seed production cycle					
Seed rate (kg/ha)	Mar-May 1996		Jun.-Jul. 1996	Aug.-Sep. 1996	Oct. -Dec. 1996	Annual Total
2.4	349		169	150	2	672
4.8	303		163	114	6	586
7.2	331		51	172	3	567
9.6	264		147	136	5	552
12.0	257		129	232	11	629
SE(±)			5			
	Jan-Feb. 1997	Feb-May 1997	June-Aug. 1997	Sep.-Oct. 1997	Dec.-Jan. 1998	Annual total
2.4	42	263	208	34	11	558
4.8	48	237	206	74	11	576
7.2	45	225	236	58	10	574
9.6	29	235	209	112	4	589
12.0	30	225	196	95	15	561
SE(±)			2			

Based on the foregoing discussion‹ the limited or even enatic differences among the seed rates used in this study (Table l) were usual. The lack of significant differences in the forage yields among the seed rates of some cuts, along with the non-consistent differences in some others, might indicate that the initial population in each seed rate was reduced and that certain population equilibrium was attained in all seed rates. A similar observation was reported by Khair (1997) where no significant differences were found among the forage yields of several seed rates which ranged from 12-72 kg/ha. The theoretical initial population of the lowest seed rate of this study (i.e, 2.4 kg/ha) was about 1,056,000 plants/ha. The profusely growing new stems from the crown of a 3 months old alfalfa plant make the alfalfa canopy resembles that of clitoria, a popular forage legume in Sudan. It is, therefore, logical to assume that the optimum plant population for both clitoria and alfalfa at 3months of age would be comparable. The optimum for clitoria (264,000 plants/ha) (Khair, 1999), however, constitutes 25% of the initial population of the alfalfa even when sown at 2.4 kg/ha. Despite the relatively lower seeds rates this study, the

time course monthly average forage yield of this study (Table 1) was even higher than that repotted for higher seed rates (Khair 1997) and compared closely with that reported for the extremely high seed rates reported by Nayel and Khidir (1995). Likewise, the annual total yields even in the lowest seed rate (2 4 kg/ha) of this study were higher than those reported by Khair‹ (1997)and comparable with those reported by Nayel and Khidir (1995). Even in the case of the few significant differences, the magnitude of the differences were not high enough to justify the use of higher rates of such expensive seeds.

The highest seed rate (i.e., 12 kg/ha) outyielded the other seed rates in few cuts and both 12 kg/ha and 9.6 kg/ha outyielded the other seed rates in the cumulative annual total forage yields (Table l). Those two seed rates however, compared closely with 11 kg/ha which is recommended for the northern parts of the United Sates (Tesar and Jackobs, 1972) and with 8-15 kg/ha which is recommended for Australia (McDonald and Waterhouse, 1989). On the other hand, they are a little lower than 20 kg/ha recommended for pans of the United States (Miller, 1984).

The progressive reduction in the plant population of alfalfa with the advancement in the crop age (Khair, 1997 and Khair *et al*., 1998), confines the differential response of forage and seed yields to varying seed rates, to the early ages of the crop. In agreement with that, the lowest seed rate (i.e. 2.4 kg/ha) resulted in the lowest forage yield in the first cut (Table l) but in the highest seed yield in the first SPC (Table 2). In contrast, 9.6 and 12 kg/ha resulted in the lowest seed yield. This is consistent with the observation of Decker, (1972) that relatively higher seed rates are usually used for forage than for seed production. Furthermore, the high seed yield of the lowest seed rate in the firs SPC of this study (Table 2) agrees with the 1-3 kg/ha of seeds recommended for the seed production (Heath *et al*., 1985). The tendency of the farmers in Sudan to grow alfalfa for forage production during the first two-three years the produce the seeds in the third-fourth year could be attributed to the optimum population which

resulted from the continuous reduction in the plant population for the seed production.

As the case in the forage yields (Table1), lack and/or non consistent differences among the seed yields of the various seed rates in several SPCs were obtained. This could be due to the time course reduction of population which in turn might have nan-owed the differences among plant populations of the various seed rates. The relatively lower seed rates of this study had enabled the harvest of seed during the establishment year. This implies that farmers in the northern parts of Sudan, where forage is not highly needed, can use low seed rate to specialize in alfalfa seed production. The cumulative seed yield of this study, (Table 2) is higher than the 500 kg reported for California (Heath، *et al*., 1985).

In conclusion, the highest seed rate (12 kg/ha) produced the highest forage yield in only few cuts. The time course monthly forage yield of the various seed rates over the two years were either non-significant or enatic. The cumulative annual total forage yield resulting from 9.6 and 12 kg/ha were higher than those of the other seed rates. For seed yield، the lowest seed rate (i.e. 2.4 kg/ha) resulted in the highest seed yield in the high seed yielding SPCs as well as in annual totals. Differences among the seed yields of the various seed rates in other SPCs were either lacking or enatic.

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