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Effect of Water Stress on Growth and Yield of Alfalfa (*Medicage stavia* L.)

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A B S T R A C T

A field experiment was conducted at the Demonstration Farm of the Faculty of Agriculture, University of Khartoum, Sudan during the period January 2009 to June 2010 to study the effect of water stress on forage and seed production of alfalfa (*Medicago Sative* L.) A split-plot design with three irrigation intervals (7, 14 and 21 days) as main plots and three cutting intervals (21, 28 and 35days) as sub-plots was carried out. Parameters measured included: plant height, plant density, number of leave /plant, leaf area index, forage yield, dry matter production, yield components and final seed production. The results revealed that the shorter irrigation intervals (7 and 14 day) were statistically significant over the longer interval (21days). The yield production of the seed at 7 days irrigation interval were 88.05 Kg/ha and at 14 days interval were118.53 Kg/ha as the highest production. The cutting intervals (21, 28 and 35 days) showed a significant difference at all levels of comparisons for all the growth attributes and fresh weight and dry matter production as well as seed production. The 35 days cutting interval was the best cutting schedule as far as growth and yield were concerned

Keywords: *Cutting, Irrigation, Medicage stavia, Water Stress.*

INTRODUCTION

Alfalfa is grown over a wide range of soil and climatic conditions and plays an important role in crop rotation, throughout its positive effects on soil fertility, soil structure and reduces soil erosion. It's a versatile crop which can be used as pasture, hay and silage green, crop and cash crop. A dry hot climate is most suitable for Alfalfa but the crop does not thrive in hot humid conditions. In the Sudan, the crop was first introduced during the World War I when seeds of variety Hegazi were imported from Egypt for cultivation in North Khartoum (Agabawi, 1968). One of the problems of the crop in the Sudan was the increasing cost of seed due to the progressive increase in the cultivated area in response to the increased demand for dairy products. However, Nayle and Khidir (1995) found that the seed rate of 40kg/ha had given more fodder yield than either 30 or 50kg/ha. Marble (1984) stated that alfalfa is the chief irrigated fodder crop in the Sudan. Khair (1999) reported that the most important factors that should be taken into consideration when sowing Lucerne are adequate irrigation water to enable seeding growth and right time of sowing (long period of low temperature and free from weed competition).

Although alfalfa is a drought tolerant crop, it responds to permanent irrigation for short periods to obtain high yield and its requirements of water exceed the other irrigated crops (Khair 1999). Carpenter, (1996) showed that to obtain high yield of alfalfa and a less susceptible crop to root and crown diseases, light frequent irrigation and good drainage are needed.

This study was obtained to study the effect of different irrigation intervals and different cutting treatment on the growth, yield and yield components of alfalfa forage and seed production.

MATERIALS AND METHODS

The study was conducted in the Demonstration farm of the faculty of Agriculture, Shambat, Sudan, latitude 15˚ 40' N, longitude 32° 32'E, 380 m above sea level. The local variety (Hegazi) was used. The layout of the experiment was split – plot design with four replications. The main plots comprised the three watering treatment (7, 14 and 21 days) (I_1, I_2 and I_3 respectively) and the sub-plots were occupied by the three cuttings (21, 28 and 35 days) (C_1, C_1 and C_3 respectively).

The experimental site was disc ploughed, disc harrowed to crash clods and leveled out to maintain a well prepared seedbed, spacing between ridges was 0.7 m, the size of the plot was (4x4m) with 5 ridges each. A guard area of (5x5 m) from two sides was established. The seed rate was 59.4kg/ha. The whole experiment was sown by broadcasting method and irrigation was applied immediately after sowing. Second irrigation was after 7 days from the first irrigation to facilitate seedling emergence. Weeds were effectively controlled by hand throughout the growing season. The first cut was 100 days after sowing when the crop was 25-50% bloom. A sickle was used for clipping the plants 5-7 cm above the soil surface.

Data were collected at each cut (3 cuts) for the following parameters: plant density (population count), plant height, number of leaves per plant, leaf area and leaf area index (obtained by using the punch method), fresh yield (ton/ha) and dry matter (ton/ha). In addition to number of seeds/pod, total seed yield (Kg/ha) and thousand seed weight (g) in the end of the experiment. Data were statically analyzed using two-way ANOVA and the mean separated according to Duncan Multiple Range Test (DMRT) at 0.05 level of probability.

RESULTS AND DISCUSSION

Results

Plant height (cm): From results irrigation interval (7, 14and 21days) and time of cutting (21, 28 and 35 days) and their interaction significantly ($P \leq 0.05$) affected plant height except at the first cutting (Table 1). For all periods of cutting, I_1 had significantly ($P \leq 0.05$) higher mean of plant height as compared to I_2 and I_3. On the other hand, C_2 resulted in a significantly ($P \leq 0.05$) higher mean of plant height in comparison to I_2 for all period of cutting except at the first cutting. Plant height was significantly ($P \leq 0.05$) higher at C_3 (35days) as compared to C_1 and C_2 for all period of cutting except at the 1st cut. Moreover, C_2 significantly ($P \leq 0.05$) exceeded C_1 in plant height at the 2nd cut. Almost for all period of cutting I_1 x C_3 Interaction had a significantly ($P \leq 0.05$) higher mean of plant height.

Number of leaves per stem: Number of leaves/stem was significantly ($P \leq 0.05$) affected by irrigation interval, time of cuttings and their interaction for all period of cutting, except irrigation at the 1st and 2nd cuts (Table 2). Harvesting at 35 days (C_3) significantly ($P \leq 0.05$) increased number of leaves/stem as compared to 21 days (C_1) and 28 days (C_2) of harvest. In most cases I_1xC_3 interaction resulted in a significantly ($P \leq 0.05$) high mean of number of leaves/stem compared to most other interaction.

Leaf area per plant (cm^2): Table 3 shows that irrigation interval, time of cutting and their interaction significantly ($P \leq 0.05$) affected leaf area per plant except at the Ist cut. At all occasions, I_1 had significantly ($P \leq 0.05$) higher mean of leaf areas as compared to I_3 except at the 3rd cut, where the reverse was true. For all occasion, leaf area/plant varied among the different interactions, irrigation interval and time of cutting.

Leaf area index (L.A.I): In the 1st and 3rd cuts, I_1 had a significantly ($P \leq 0.05$) higher mean of leaf area index in comparison to both I_2 and I_3 (Table 4). C_3 gave significantly ($P \leq 0.05$) higher mean of leaf area index in comparison to C_1 at 2nd and 3rd cuts. Leaf area index varied among the interaction between irrigation and time of cutting for most occasions.

Plant density: Seven days irrigation interval resulted in significantly ($P \leq 0.05$) higher mean of plant density compared to I_2 and I_3 at the 1st cut (Tables 5). Plant density was significantly ($P \leq 0.05$) higher under C_3 as compared to C_2 only at the 3rd cut and as compared to C_1 at the 2nd and 3rd cuts. As for interactions, plant density showed different between all interaction, but I_1 xC_1 interaction relatively showed the higher significant ($P \leq 0.05$) mean in comparison to all other interactions.

Shoot fresh weight (g): Irrigation interval I_1 resulted in a significantly ($P \leq 0.05$) higher mean of shoot fresh weight as compared to both I_2 and I_3 at the 1st and 3rd cuts (Table 6). C_3 gave the significant ($P \leq 0.05$) higher mean of shoot fresh weight in comparison to C_1 and C_2 at the 1st and 3rd cuts. Interactions I_1xC_2 and I_1xC_3 relatively increased significantly ($P \leq 0.05$) the shoot fresh weight in comparison to most other interactions.

Shoot dry weight (g): At the 1st and 2nd cuts, I_1 showed a significantly ($P \leq 0.05$) higher mean of shoot dry weight as compared to I_2 and I_3 (Table 7). C_3 significantly ($P \leq 0.05$) increased shoot dry weight as compared to C_1 at all occasions. I_1xC_3 interaction showed a significantly ($P \leq 0.05$) higher mean of shoot dry weight compared to most other interactions.

Number of seeds/pod: I_2 treatment significantly ($P \leq 0.05$) increased number of seeds per pod compared to I_1 and I_3 (Table 8). Time of cutting and the interactions treatment irrigation interval and time of cutting, did not affect this character.

1000-seed weight (g): Neither irrigation interval nor time of cutting or their interaction significantly affected 1000-seed weight (Table 8).

Seed yield (Kg/ha): Both I_1 and I_2 treatment significantly ($P \leq 0.05$) increased mean of seed yield as compared to I_3 (Table 8). On the other hand, C_3 had a significantly ($P \leq 0.05$) higher mean of seed yield in comparison to C_1 and C_2. The interaction I_2xC_3 gave a significantly ($P \leq 0.05$) higher mean of seed yield compared to most other treatments.

Discussion

Most of the growth parameters studied in the present study were significantly influenced by irrigation interval, time of cutting and their interaction. The amount of water required for irrigation is largely affected by length of the growing season, the time and number of cuttings and the climatic factors such as temperature, evaporation, soil precipitation and wind velocity. In this study, alfalfa plant height was significantly taller under the shorter irrigation interval (7>14>21) almost at all occasions. This may be attributed to the effect of frequent irrigation on both number of nodes and internodes length. Plant height in this study, was also significantly increasing with increasing time of cutting, mainly 35 days. This may be due to the fact that the longer period of cutting especially at shorter period of irrigation (7days) allowed the sufficient time for the stem to lengthen (produced more node).similar results were also reported by Marble (1984) and Ali (2000) who observed that the plant height of alfalfa was significantly decreased with number of cutting.

Frequent irrigation, (7 days followed by 14 days) significantly increased number of leaves per stem this may be attributed to the effect of these treatment on stem length as mentioned later on as well as number of stem/plant. This finding is in line with that reported by Chumakov (1980). Halim (1987) found that number of leaves per stem of alfalfa was significantly reduced at 65% of field water capacity compared to 100% of field capacity. Similarly, Joshi (1985) showed that under water stress (I month irrigation), number of leaves of poapratensis was significantly reduced compared to either one or two weeks irrigation interval. Number of leaves per stem in present study was significantly increased with time of cutting (35>28>21). This may be due to the longer period of growth under these treatments which allowed for production of taller plant as well as much production of stems.

Generally, leaf area and leaf area index were significantly increased with the decreasing of irrigation interval and increasing cutting interval. This may be attributed to the effect of these treatments on cell division and cell elongation. Halim (1987) showed that water stress reduced leaf per stem of alfalfa by about 25-38% as compared to the control. In Vigna radiata, Costa et al. (1999) observed that frequent irrigation during the vegetative stage significantly increased L.A.l. Light irrigation applied at short interval of 7 days increased leaf to stem to stem ratio of alfalfa plant. Lodge (1986) indicated that increasing the intervals between successive harvests resulted in decreasing the leaf to stem ratio.

Plant density, on the other hand, was significantly higher with time of cutting. This may be due to the fact that the longer period of harvest was more significant to permit the growth of more branches. The effect of cutting on plant population in alfalfa was also reported by Ali (2000).

Frequent irrigation (7 days followed by 14 days) significantly increased shoot fresh and dry weight per plant. This may be due to the effect of these treatments on the canopy development (stem plus leaves) as the result of well establishment of root system. EI Hag (1988) believed that for higher dry matter of alfalfa under Sudan condition, 7days is better. The others attributed this to the effect of water stress on nodule production. Shoot fresh and dry weights in the present study were significantly increased with time of cutting under moist treatment. This may be attributed to the effect of longer harvest interval on production of high number of stems. This finding in agreement with that reported by Nayel and Khidir (1995) and Ali (2000).

Irrigation interval significantly influenced number of seeds per pod and seed yield per area, whereas 1000 seed weight was not affected by this treatment. The former parameters were significantly higher under shorter irrigation intervals. Longer harvest interval only significantly increased seed yield in the present study. This may be due to the effected of longer interval of time of cutting on one or more of seed yield components. Similar results were also reported by Taylor (1998) and Ahmed (2000).

Table 1. Effect of irrigation interval, duration of cutting and their interaction on plant height (cm) of alfalfa obtained from 1st, 2nd and 3rd cuts

Cutting / irrigation	1st cut				2nd cut				3rd cut			
	C_1	C_2	C_3	Mean	C_1	C_2	C_3	Mean	C_1	C_2	C_3	Mean
I_1	46.08^{a}	46.13^{a}	49.38^{a}	47.20^{a}	44.28^{bc}	46.15^{ab}	48.70^{a}	46.38^{a}	45.05^{b}	37.15^{d}	40,48^{c}	40.89^{a}
I_2	40.33^{a}	37.23^{a}	42.65^{a}	40.07^{b}	29.83^{e}	40.98^{cd}	43,38^{bcd}	38.06^{b}	34.90^{e}	31.28^{f}	48.68^{a}	38.29^{b}
I_3	39.75^{a}	42.30^{a}	42.80^{a}	41.62^{b}	24.18^{f}	28.40^{e}	41.30^{cd}	31.29^{c}	25.55^{h}	31.30^{g}	45.73^{b}	34.19^{c}
Mean	42.05^{a}	41.89^{a}	44.94^{a}		32.76^{c}	38.51^{b}	44.46^{a}		35.17^{b}	32.24^{c}	44.96^{a}	

Means followed by similar letters are not significantly different at 0.05 level of probability according to Duncan Multiple Range test (DMRT).

Table 2. Effect of irrigation interval, duration of cutting and their interaction on number of leaves/stem of alfalfa obtained from 1st, 2nd and 3rd cuts

Cutting / irrigation	1st cut				2nd cut				3rd cut			
	C_1	C_2	C_3	Mean	C_1	C_2	C_3	Mean	C_1	C_2	C_3	Mean
I_1	8.73^{c}	10.65^{b}	$12,38^{a}$	10.59^{a}	9.88^{c}	10.73^{c}	13.00^{a}	11.20^{a}	9.70^{bc}	9.05^{cd}	10.53^{a}	9.76^{b}
I_2	10.00^{b}	10.65^{b}	12.00^{a}	10.88^{a}	8.70^{d}	10.45^{c}	13.30^{a}	10.82^{a}	11.73^{a}	10.45^{b}	12.30^{a}	11.49^{a}
I_3	8.80^{c}	10.85^{b}	12.73^{a}	10.79^{a}	8.35^{d}	11.80^{b}	12.33^{ab}	10.83^{a}	8.38^{d}	10.20^{bc}	9.58^{bc}	9.39^{b}
Mean	9.18^{c}	10.72^{b}	12.37^{a}		8.98^{c}	10.99^{c}	12.88^{a}		9.94^{b}	9.90^{b}	10.80^{a}	

Means followed by similar letters are not significantly different at 0.05 level of probability according to Duncan Multiple Range test (DMRT)

Table 3. Effect of irrigation interval, duration of cutting and their interaction on leaf area per plant of alfalfa obtained from 1st, 2nd and 3rd cuts

Cutting / irrigation	1st cut				2nd cut				3rd cut			
	C_1	C_2	C_3	Mean	C_1	C_2	C_3	Mean	C_1	C_2	C_3	Mean
I_1	36.18^{a}	24.14^{ef}	27.84^{cde}	29.39^{a}	34.82^{bcd}	35.72^{bc}	32.84^{cde}	34.46^{b}	35.50^{c}	33.90^{c}	67.58^{e}	45.66^{c}
I_2	28.42^{cd}	25.79^{def}	30.30^{bc}	28.17^{a}	26.94^{f}	36.82^{b}	56.52^{a}	40.09^{a}	23.27^{c}	57.08^{b}	52.71^{b}	49.02^{b}
I_3	33.09^{ab}	33.48^{ab}	23.61^{f}	30.06^{a}	31.24^{de}	30.93^{def}	30.21^{ef}	30.79^{c}	39.87^{c}	66.35^{a}	55.73^{b}	53.98^{a}
Mean	32.56^{a}	27.80^{b}	27.25^{b}		31.00^{c}	34.49^{b}	39.86^{a}		37.55^{c}	52.44^{b}	58.67^{a}	

Means followed by similar letters are not significantly different at 0.05 level of probability according to Duncan Multiple Range test (DMRT)

Table 4. Effect of irrigation interval, duration of cutting and their interaction on leaf area index of alfalfa obtained from 1st, 2nd and 3rd cuts

Cutting / irrigation	1st cut				2nd cut				3rd cut			
	C_1	C_2	C_3	Mean	C_1	C_2	C_3	Mean	C_1	C_2	C_3	Mean
I_1	0.454^{a}	0.188^{b}	$0,217^{b}$	0.286^{b}	0.233^{dc}	0.339^{bc}	0.314^{bc}	0.292^{b}	0.231^{d}	0.270^{cd}	0.644^{a}	0.382^{a}
I_2	0.204^{b}	0.171^{bc}	0.255^{b}	0.200^{b}	0.177^{dc}	0.284^{b}	0.617^{a}	0.360^{a}	0.322^{cd}	0.409^{bc}	0.624^{a}	0.452^{a}
I_3	0.197^{b}	0.230^{b}	0.182^{b}	0.203^{b}	0.175^{c}	0.284^{b}	0.331^{bc}	0.263^{b}	0.293^{cd}	0.555^{ab}	0.399^{c}	0.416^{b}
Mean	0.285^{a}	0.196^{b}	0.208^{b}		0.192^{c}	0.303^{b}	0.421^{a}		0.282^{b}	0.411^{ab}	0.556^{a}	

Means followed by similar letters are not significantly different at 0.05 level of probability according to Duncan Multiple Range test (DMRT)

Table 5. Effect of irrigation interval, duration of cutting and their interaction on plant density of alfalfa obtained from 1st, 2nd and 3rd cuts

Cutting / irrigation	1st cut				2nd cut				3rd cut			
	C_1	C_2	C_3	Mean	C_1	C_2	C_3	Mean	C_1	C_2	C_3	Mean
I_1	1435.7^{a}	734.3^{b}	631.4^{bc}	933.8^{a}	655.7^{e}	889.9^{a}	737.1^{a}	760.9^{a}	677.1^{e}	890.0^{abc}	910.0^{ab}	825.7^{a}
I_2	722.9^{b}	620.0^{bc}	625.7^{bc}	656.2^{b}	750.0^{cd}	744.3^{cd}	824.3^{ab}	772.9^{b}	748.6^{dc}	69.0^{a}	964.3^{a}	800.0^{a}
I_3	677.3^{bc}	635.7^{bc}	597.1^{c}	636.7^{b}	681.4^{de}	790.0^{bc}	890.0^{b}	787.1^{a}	865.7^{bc}	812.9^{cd}	744.3^{dc}	807.6^{a}
Mean	945.3^{a}	663.3^{b}	618.2^{b}		695.7^{b}	808.7^{b}	817.1^{a}		763.8^{b}	797.6^{b}	872.9^{a}	

Means followed by similar letters are not significantly different at 0.05 level of probability according to Duncan Multiple Range test (DMRT)

Table 6. Effect of irrigation interval, duration of cutting and their interaction on shoot fresh weight (g) of alfalfa obtained from 1st, 2nd and 3rd cuts

Cutting / irrigation	1st cut				2nd cut				3rd cut			
	C_1	C_2	C_3	Mean	C_1	C_2	C_3	Mean	C_1	C_2	C_3	Mean
I_1	7.68^{b}	10.83^{a}	10.47^{a}	9.66^{a}	5.84^{cd}	9.42^{a}	6.60^{e}	7.29^{a}	3.77^{c}	5.56^{b}	7.81^{a}	5.71^{ab}
I_2	7.11^{b}	5.18^{c}	7.05^{b}	6.45^{b}	4.36^{de}	6.08^{c}	8.13^{ab}	6.19^{ab}	5.53^{bc}	4.13^{a}	8.97^{a}	6.21^{a}
I_3	5.32^{c}	6.63^{b}	11.03^{a}	7.66^{c}	3.56^{e}	6.97^{bc}	6.25^{c}	5.59^{b}	4.71^{bc}	5.08^{bc}	5.25^{bc}	5.01^{b}
Mean	6.70^{c}	7.55^{b}	9.52^{a}		4.59^{b}	7.49^{a}	6.99^{a}		4.67^{b}	4.92^{b}	7.34^{a}	

Means followed by similar letters are not significantly different at 0.05 level of probability according to Duncan Multiple Range test (DMRT)

Table 7. Effect of irrigation interval, duration of cutting and their interaction on shoot dry weight (g) of alfalfa obtained from1st, 2nd and 3rd cuts

Cutting / irrigation	1st cut				2nd cut				3rd cut			
	C_1	C_2	C_3	Mean	C_1	C_2	C_3	Mean	C_1	C_2	C_3	Mean
I_1	1.35^{cd}	1.83^{bc}	2.68^{a}	1.95^{a}	2.24^{a}	$2.\ 09^{ab}$	2.39^{a}	2.24^{a}	1.35^{cd}	1.83^{bc}	2.68^{a}	1.95^{a}
I_2	1.75^{c}	1.59^{c}	2.63^{a}	1.99^{a}	1.52^{bc}	2.07^{a}	2.08^{ab}	1.89^{a}	1.75^{c}	1.59^{c}	2.63^{a}	1.99^{a}
I_3	1.04^{d}	1.40^{cd}	2.31^{ab}	1.58^{b}	1.29^{c}	1.27^{e}	2.09^{ab}	1.55^{c}	1.04^{d}	1.40^{cd}	2.31^{ab}	1.58^{b}
Mean	1.38^{b}	1.61^{a}	2.54^{a}		1.68^{b}	1.81^{ab}	2.19^{a}		1.38^{b}	1.61^{a}	2.54^{a}	

Means followed by similar letters are not significantly different at 0.05 level of probability according to Duncan Multiple Range test (DMRT)

Table 8. Effect of irrigation interval, duration of cutting and their interaction on number of seeds/pod, 1000 seed weight and seed yield

Cutting / irrigation	No. of seeds/pod				1000-seed weight (g)				Seed yield (kg/ha)			
	C_1	C_2	C_3	Mean	C_1	C_2	C_3	Mean	C_1	C_2	C_3	Mean
I_1	2.01^{a}	1.91^{a}	2.39^{a}	2.10^{b}	3.52^{a}	3.35^{a}	3.47^{a}	3.45^{a}	32.91^{de}	112.74^{a}	88.05^{b}	77.90^{a}
I_2	1.82^{a}	1.55^{a}	1.80^{a}	1.72^{a}	3.39^{a}	3.19^{a}	3.47^{a}	3.35^{a}	56.69^{c}	83.27^{b}	118.53^{a}	86.16^{a}
I_3	1.91^{a}	2.17^{a}	2.34^{a}	2.14^{b}	3.49^{a}	2.96^{a}	3.36^{a}	3.27^{a}	24.54^{e}	38.60^{d}	61.10^{c}	41.41^{b}
Mean	1.91^{a}	1.88^{a}	2.18^{a}		3.47^{a}	3.17^{a}	3.43^{a}		38.05^{b}	78.20^{c}	89.23^{a}	

Means followed by similar letters are not significantly different at 0.05 level of probability according to Duncan Multiple Range test (DMRT)

REFERENCES

Agabawi KA. 1968. Performance of some lucerne varieties under Shambat condition. *Sudan Agric. J.*, 3(1): 90-98.

Ahmed SA. 2000. Effect of *Rhizobium meliote* and VA Mycorrhiza inoculation on nodulation, growth and yield of alfalfa cultivars. M.Sc. thesis (Agric.) University of Khartoum, Sudan.

Ali BA. 2000. Effect of cutting management on seed production of two alfalfa cultivars. M.Sc. thesis (Agric.) University of Khartoum, Sudan.

Carpenter ZL and Johonson J. 1996. Alfalfa and Sweet Clover *Medicaga sativa* and *Melilotous indica*. Hand book. Horn, (A and M. eds). Texas Agric Ext. Serv. Texas Univ.

Chumakov VP. 1980. Peculiarities of yield formation of irrigated lucerne under different cuts. *Herb. Abst.*, 50 (8): 3119.

Costa WAJM-de, Shanmugathasan KN, Joseph KDSM and de-Costa. 1999. Physiology of yield determination of mung bean *(Vigna radiata* L.*)* Wilczek under various irrigation regimes in the dry and intermediate zones of Srilanka. *Field Crops-Research*, 61(1): 1-12.

Elhag AE. 1988. Significance of leaf area variation and season in the crop factor of Lucerne (*Medicaga sativa* L.) M.Sc. thesis (Agric.) University of Khartoum, Sudan.

Halim MRBA. 1987. Water stress effects on forage qualities of Alfalfa. Iowa State University, Ames, IA.50011, USA.

Joshi H. 1985. Influence of clipping and water stress on growth performance and nutrient value of *Poa pratensis*. Dep. Bot., Kuman University, Nainital 263002, Utta Pradesh ,India.

Khair MA. 1999. The principle of forage crop production. Agriculture Research Cooperation. Madani, sudan.

Lodge GM. 1986. Yield and persistence of irrigated Lucerne cut at different frequencies at Tamworth, New South Wales. *Aust. J. Exp. Agric.*, 26(2):162-192.

Marble VL. 1984. Report of consultancy on alfalfa Seed production Morocco, Sudia Arabia Yeman and Sudan AGPC: MICS PP.82-85 Rome, FAO.

Nayel BA and Khidir MO. 1995. Note in the effect of cutting management on seed production in Lucerne (*Medicago sativa* L.). *Univ. Khart. J. Agric. Sci.*, 3:163-166.

Taylor L. 1998. Alfalfa in: Herbal Secret of the Rain Forest, Prima Publishing Inc.USA.