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EFFECT OF SOWING DATE AND NITROGEN ON THE PRODUCTIVITY, ENERGY RELATIONSHIPS AND ECONOMICS OF SEWAN (*LASIURUS SINDICUS*) GRASS IN HOT ARID ECOSYSTEM OF RAJASTHAN

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SUMMARY

The field experiment was conducted at Bikaner (Rajasthan) during **kharif** season of 2010 to find out the proper time of sowing and optimize the nitrogen requirement of sewan grass (*Lasiurus sindicus*) in hot arid region. Results indicated that first date of sowing i. e. first week of July (4^{th}) resulted significantly in higher fresh forage yield (172.2 q/ha), dry matter (59.9 q/ha) yields, CP content (8.71%), CP yield (525.3 kg/ha), net returns (Rs.14,278/ha) and B : C ratio (2.47) over other dates of sowing viz., first week of August and first week of September. While in case of nitrogen, although forage productivity and quality were improved up to the highest dose i. e. 60 kg N/ha and recorded fresh forage yield (98.6 q/ha), dry matter yield (35.4 q/ha), CP content (8.95%) and CP yield (320.8 kg/ha) but significantly increased only up to 40 kg N/ha and maximum values of net returns (Rs. 4,737.0/ha) and B : C ratio (1.51) were also recorded with 40 kg N/ha. Interaction effect of date of sowing and nitrogen on forage and CP yield was significant and data showed that values recorded with first date of sowing under 40 and 60 kg N/ha were at par but significantly higher over rest of the treatment combinations. Maximum values of energy ratio and energy productivity were recorded with the sowing in first week of July (12.7 and 702.8 g/MJ) and nitrogen applied @ 20 kg N/ha (7.3 and 402.8 g/MJ). Overall, it was concluded that for getting higher and economic forage yields, sewan grass should be sown in first week of July and fertilized with 40 kg N/ha in hot arid region of Rajasthan.

Key words : Sowing date, nitrogen, productivity, forage yield, protein, sewan grass

Due to frequent occurrence of droughts, the animal rearing especially small ruminants' production plays an important role in sustenance of rural population of western Rajasthan. As small ruminant animals like sheep and goat are mostly dependent on grazing, but at present pastures of this region are not capable to feed even for the maintenance of animals. It happened mainly because of continuous over-exploitation of grazing lands, erratic rainfall distribution and human negligence. This is also a fact that the improvement in the productivity of animal husbandry in hot arid zone can directly be correlated with the improvement of native degraded pastures and establishment of new grasslands and pastures on the land lying as cultivable wastelands. Sewan (*Lasiurus sindicus*) is the most important perennial grass of this region and has good drought tolerance capacity. Like other arable crops, proper time of sowing of grasses is of prime importance and success is dependent on it, whether it is renovation of old degraded pastures or establishment of new grasslands. Further, due to poor fertility status of arid region soils, nitrogen nutrition plays an important role on the grass establishments and its productivity. Systematic research work on these aspects is still meagre. Hence, this trial was undertaken.

MATERIALS AND METHODS

The field experiment was conducted at Research Farm of CSWRI, Arid Region Campus, Bikaner during **kharif** season of 2010 to find out the proper time of sowing and optimize the nitrogen requirement of sewan grass (*Lasiurus sindicus*) in hot arid region. The soil of experimental field was sandy having pH 8.58, EC 0.71 dS/m, low in organic carbon (0.21%), available N (128.4 kg/ha), P (8.20 kg/ha) and K (138.5 kg/ha). Total 12 treatment combinations of three dates of sowing viz., first week of July (D_1), first week of August (D_2) and first week of September (D_3) and four nitrogen levels viz., 0 (N_0), 20 (N_{20}), 40 (N_{40}) and 60 (N_{60}) kg/ha were tested in randomized block design with three replications during **kharif** season of 2010. Sewan cultivar 'CAZRI-mutant-30-5' was sown at 50 cm apart rows on 4th of July, August and September as per treatment by using seed @ 8 kg/ha. A basal dose of 20 kg each of P and K/ha through single super phosphate and muriate of potash, respectively, was applied to each plot at the time of sowing. While nitrogen was applied in two splits (half at sowing + remaining half at 4-week crop stage) as per treatment. Sewan seed was used after overnight soaking in fresh water. Irrigation was applied once just after sowing for assured germination. The crop of grass was harvested once at maximum growth and flowering stage. Observations were taken on growth and forage yield at harvest. Plant samples were also collected from each plot for dry matter yield and analysis of crude protein content. Energy attributes were worked as suggested by Panesar and Bhatnagar (1987) and Devasenapathy *et al.* (2009). Total rainfall received during crop growth period was 290.3 mm.

RESULTS AND DISCUSSION

Growth Attributes and Forage Yield

Results revealed that both experimental variables brought about significant effect on the growth parameters viz., grass height, number of tussocks/ha, number of tillers/tussock and tussock diameter (Table 1). Maximum values of above growth attributes viz., plant height (130.2 cm), number of tussock (95.7 thousand/ha), number of tillers per tussock (129.2) and tussock diameter (71.8 cm) were observed in the sowing done on first week of July (D_1) and these values were significantly higher over rest of the dates of sowing viz., D_2 (4th of August) and D_3 (4th of September). Third date of sowing i. e. 4th September recorded minimum values of above growth attributes. Increased values of growth attributes under D_1 might be due to favourable weather parameters and longer growth period. The greater values of growth attributes under first date of sowing i. e. 4th of July resulted significantly in higher fresh forage (172.2 q/ha) and dry matter (59.9 q/ha) yields over other dates of sowing. These forage yields were almost double than the yields recorded in second date of sowing i. e. first week of August. While fodder yields obtained with third date of sowing were almost negligible due to poor germination and stunted tussock growth. Yadav (1995), Singh and Gupta (1995) and Sharma *et al.* (2006) also recommended proper sowing time after onset of monsoon in the month of June-July.

In case of nitrogen application, growth parameters as well as forage productivity were increased up to the highest level of nitrogen i. e. 60 kg/ha but significant response was observed only up to the level of 40 kg N/ha. Maximum grass growth attributes viz., tussock height (85.7 cm), no. of tussock (61.8 thousand/ha), no. of tillers/tussock (80.3) and tussock diameter (47.7 cm); and yields viz., fresh forage (98.6 q/ha) and dry matter (35.4 q/ha) yields were obtained at 60 kg N/ha. These forage yields were higher by 0.61 and 1.14, 8.35 and 12.0 and 43.9 and 60.2 per cent over 40, 20 and 0 kg N/ha, respectively. Higher values of growth attributes under increased levels of N might be due to adequate availability of N to the crop that being a constituent of amino acids and chlorophyll enhanced the chlorophyll formation leading to increased photosynthetic activity with the eventual improvement in the growth attributes. Singh and Gupta (1995) also reported 80 per cent improvement in pasture grass productivity due to application of 50 kg urea/ha.

Interaction effect of date of sowing and nitrogen on fresh forage and dry matter yields was found significant (Table 2) and data showed that first date of sowing exhibited the significant influence in increasing the fresh forage and dry matter yields only up to the level of 40 kg N/ha and thereafter increase was non-significant. While in second date of sowing, significant response of nitrogen on forage yields was noted only up to the level of 20 kg N/ha and thereafter differences were statistically non-significant. Whereas there was no specific trend or effect due to graded levels of nitrogen application in the forage yields of third date of sowing. Overall, although interaction $D_1 \times N_{60}$ recorded maximum grass yields (fresh forage yield 191.7 q/ha and dry matter yield 69.6 q/ha), but these yields were statistically at par with $D_1 \times N_{40}$ (Fresh forage 188.7 q/ha and dry matter yield 67.9 q/ha) and significantly higher over rest of the treatment combinations. It was also interesting to note that forage yields observed at $D_1 \times N_0$ were significantly higher over all N levels and interaction of second or third dates of sowing (D_2 and D_3).

Crude Protein Yield

Data on crude protein content (%) and CP yields indicated that both treatment variables were found

TABLE 1

Growth attributes, forage yields and quality of sewan grass as influenced by treatment variables

Treatment	Tussock height (cm)	No. of tussocks (x 10^3/ha)	No. of tillers/ tussock	Tussock diameter (cm)	Fresh forage yield (q/ha)	Dry crude matter yield (q/ha)	Crude protein content (%)	Crude protein yield (kg/ha)
A. Dates of sowing								
D_1	130.2	95.7	129.2	71.8	172.2	59.9	8.71	525.3
D_2	80.2	57.4	73.0	47.5	86.1	30.2	8.70	264.5
D_3	31.4	15.6	13.3	11.7	8.8	3.0	8.29	24.8
S. Em±	2.02	1.40	2.74	1.27	2.74	0.91	0.07	7.70
C. D. (P=0.05)	6.02	4.10	8.17	3.79	8.18	2.71	0.20	22.59
B. Nitrogen levels (kg/ha)								
N_0	72.0	47.2	60.8	36.6	68.5	22.1	8.13	181.1
N_{20}	79.5	55.4	66.9	42.9	91.0	31.6	8.47	271.0
N_{40}	85.2	60.5	79.4	47.6	98.0	35.0	8.73	313.3
N_{60}	85.7	61.8	80.3	47.7	98.6	35.4	8.95	320.8
S. Em±	2.33	1.60	3.16	1.47	3.16	1.05	0.08	8.89
C. D. (P=0.05)	6.96	4.70	9.43	4.37	9.45	3.13	0.24	26.08

D_1–First week of July, D_2–First week of August, D_3–First week of September, N_0–No nitrogen (control), N_{20}–20 kg N/ha, N_{40}–40 kg N/ha and N_{60}–60 kg N/ha.

instrumental and significantly influenced the content and CP yields. First date of sowing (D_1) recorded maximum values of CP content (8.71%), which was at par with D_2 and significantly higher over D_3. Higher values of CP content in forage grown under D_1 and D_2 might be due to more absorption of nitrogen from soil in longer period of time of growth, which converted to crude protein. CP contents of forage were gradually increased with each increase in N levels up to the highest dose of N viz., 60 kg/ha. However, CP contents significantly increased only up to the level of 40 kg N/ha. Nitrogen application was found instrumental and due to readily available to plant it increased the CP content of the forage.

CP yields were the multiplied values of CP contents and dry matter yields and results were in the same tune of dry matter yields. Maximum CP yield (525.3 kg/ha) recorded with D_1 was higher by 98.6 per cent over D_2 and almost 21.2 times greater than D_3 treatment. Decrease in CP yields under second and third dates of sowing was the combined effect of lower CP content (%) and poor dry matter yields. Nitrogen application significantly increased the CP yields up to 40 kg /ha and thereafter improvement was non-significant.

Interaction effect of date of sowing and nitrogen on CP yield was also found significant and results revealed that CP yields recorded with interaction D_1 x N_{40} and D_1 x N_{60} were at par but significantly higher over rest of interactions. It was also noted that significant response of nitrogen on CP yield was observed only up to 40 and 20 kg N/ha under D_1 and D_2, respectively. Whereas, N levels did not exert any special effect on CP

TABLE 2

Interaction effect of date of sowing x nitrogen levels on fresh & dry forage and crude protein yields of sewan grass

Date of sowing	Nitrogen levels (kg/ha)			
	N_0	N_{20}	N_{40}	N_{60}
Fresh forage yield (q/ha)				
D_1	138.4	170.0	188.7	191.7
D_2	60.1	93.3	96.7	94.5
D_3	7.1	9.8	8.6	9.7
S. Em±	5.48			
C. D. (P=0.05)	16.38			
Dry matter yield (q/ha)				
D_1	42.9	59.3	67.9	69.6
D_2	21.1	32.3	34.1	33.4
D_3	2.4	3.3	2.9	3.3
S. Em±	1.82			
C. D. (P=0.05)	5.42			
Crude protein yield (q/ha)				
D_1	353.4	502.2	614.9	630.8
D_2	170.5	283.9	300.8	302.9
D_3	19.5	26.8	24.2	28.6
S. Em±	15.40			
C. D. (P=0.05)	45.17			

yields under D_3 dates of sowing.

Response Functions

Response of nitrogen on forage dry matter yields under different dates of sowing as well as on mean data basis was quadratic and equations computed were as given below :

$$D_1 – Y=42.945+0.99475\ x–0.0091875\ x^2$$
$$D_2 – Y=21.445+0.63975\ x–0.0074375\ x^2$$
$$D_3 – Y=2.505+0.03025\ x–0.003125\ x^2$$

Mean data basis-$Y=22.255+0.55775\ x–0.0056875\ x^2$
Where, Y is the dry matter yield (q/ha) and x is the nitrogen dose (kg/ha).

On the basis of above equations, maximum yield doses of nitrogen viz., 54.1, 43.0, 4.84 and 49.0 kg/ha; and maximum expected yields viz., 69.9, 35.2, 2.58 and 35.9 q/ha were worked out under D_1, D_2, D_3 and on mean data basis, respectively. Above equations clearly indicate that date of sowing had its great effect on grass yields and even at N_0 level grass yields were greater than D_2 and D_3 levels with highest dose i. e. 60 kg of N.

Energy Relationships

Computation of various energy related attributes viz., energy input, energy output, energy ratio and energy productivity (Table 3) showed that despite of little differences in usage of energy inputs, the maximum values viz., energy output (107.9 thousand/ha), energy ratio (12.7) and energy productivity (702.8 g/MJ) recorded with D_1, were almost double than the values obtained with D_2.

Whereas above values were higher by 20 times than the values recorded under third date of sowing (D_3). The main reason of above values was drastic reduction in forage yields due to delay in sowings and comparatively lesser differences in usage of energy inputs. In case of nitrogen application, the values of energy inputs and energy outputs were gradually increased with each increase in N levels from 0 to 60 kg/ha. But energy ratio and energy productivity values did not show similar trend and maximum values of above attributes (7.3 and 402.8 g/MJ) were obtained with 20 kg N/ha and thereafter improvements were decreased with increase in N levels as compared to control (no nitrogen). It was because of proportionately lesser increase in output energy values than increased values of input energy used. Sharma (2009) also reported higher values of energy attributes due to nitrogen application in oats.

Economics

Economic evaluation of the study showed that first date of sowing i.e. 4th July gave maximum net returns (Rs.14,278/ha) and B : C ratio (2.47) as compared to other dates of sowing. It was mainly because of higher

TABLE 3
Energy relationships and economics of sewan cultivation as influenced by treatment variables

Treatment	Energy relationships				Economics			
	Energy input (x 10^3 MJ/ha)	Energy output (x 10^3 MJ/ha)	Energy ratio	Energy productivity (g/MJ)	Cost of cultivation (Rs./ha)	Gross returns (Rs./ha)	Net returns (Rs./ha)	Benefit : cost ratio
A. Dates of sowing								
D_1	8.52	107.9	12.7	702.8	9,682	23,960	14,278	2.47
D_2	8.44	54.4	6.4	357.6	9,146	12,080	2,934	1.32
D_3	8.37	5.37	0.6	35.6	8,612	1,200	-7,412	0.14
B. Nitrogen levels (kg/ha)								
N_0	6.64	39.8	6.0	332.6	8,806	8,840	34	1.00
N_{20}	7.84	57.0	7.3	402.8	9,029	12,640	3,611	1.40
N_{40}	9.04	62.9	6.9	386.9	9,263	14,000	4,737	1.51
N_{60}	10.24	63.8	6.2	345.5	9,499	14,160	4,661	1.49

Labour wages Rs. 107/manday and forage prices Rs. 400/q dry forage.

grass yields and almost similar input costs on cultivation. Regarding nitrogen levels, net returns and B : C ratio increased with increase in N dose up to the level of 40 kg N/ha (Rs. 4,737.0/ha) and B : C ratio (1.51) and thereafter values of both traits were decreased due to comparatively higher costs of cultivation and proportionately lower increase in forage yields. Similar results have also been reported by Sharma and Chander (2007).

Thus, it may be inferred that sowing of sewan (*Lasiurus sindicus*) grass in first week of July along with application of 40 kg N/ha in two splits (at sowing+4 week crop stage) holds promise to provide higher, energy efficient and economical forage production in hot arid region of Rajasthan.

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