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Effect of Irrigation, Methods of Sowing and Levels of Phosphorus on Growth and Yield of Lucerne (*Medicago sativa* L.)

R. M. Solanki* and R. G. Patel

Department of Agronomy, Gujarat Agricultural University, Sardar Krushinagar-385 506

ABSTRACT

A field experiment was conducted during the *rabi* season of 1992-93 and 1993-94 to study the effect of irrigation, methods of sowing and levels of phosphorus on growth and yield of lucerne. Crop irrigated with 60 mm depth of water at IW/CPE ratio of 1.25 showed its superiority with respect to green and dry fodder yields, plant height, number of tillers/m^2, green : dry fodder ratio and leaf : stem ratio. Line sowing at 25 cm row spacing gave numerically higher values of yield and yield attributes. Application of 120 kg P_2O_5/ha resulted in significantly highest green and dry fodder yields of 411.2 and 104.1 q/ha which were 18.4 and 33.5 per cent higher over 60 kg P_2O_5/ha, respectively. Yield attributing characters followed the same trend.

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INTRODUCTION

Irrigation water is a costlier input and therefore, its economic and efficient utilization becomes quite imperative. Thus, precise information on water requirement of lucerne is essential and inevitable. Proper scheduling of irrigation is must to maintain the optimum soil moisture level for better root and shoot development. Irrigation not only helps in increasing the green and dry fodder yields but also improves the quality of fodder (Kumar, 1976). Normally, lucerne is raised by broadcasting which is a common practice adopted by farmers. This method does not facilitate the operations like interculturing for loosening of soil, hoeing for weed control etc. Moreover, these operations are labourious and expensive. Lucerne is known to be a heavy consumer of plant nutrients (Griffith, 1974). Being a leguminous forage, almost in all type of soils, nitrogen is seldom a serious problem, but lucerne responds more to phosphatic fertilizer as compared to nitrogen and potassium fertilizers. Keeping in view the above consideration, comprehensive research work was undertaken to assertain judicious use of irrigation water, proper method of sowing and phosphorus fertilizer requirement of lucerne.

MATERIALS AND METHODS

The experiment was conducted at the Instructional Farm, C. P. College of Agriculture, Gujarat Agricultural University,

*Present address : Agril. Officer, Main Oilseeds Research Station, GAU, Junagadh.

Sardar Krushinagar during *rabi* season of 1992-93 and 1993-94. The soil was loamy sand in texture, low in total nitrogen (0.018%), medium in available phosphorus (39 kg P_2O_5/ha) as per Olsen's method (Jackson, 1967) and medium to high in available potash (288 kg K_2O/ha). The average values of field capacity, permanent wilting point, bulk density, pH and EC were 8.73%, 2.80%, 1.58 g/cm^3, 7.85 and 0.19 dSm^{-1}, respectively. Treatments consisted of three irrigation schedules based on IW/CPE ratios (I_1 : 0.75 I_2 : 1.00 and I_3 : 1.25) and two sowing methods (M_1 : Broadcast sowing and M_2 : Line sowing at 25 cm) as main plot treatments and four levels of phosphorus (60, 80, 100 and 120 kg P_2O_5/ha) as sub plot treatments tried in split plot design with four replications. The lucerne cv. Anand-2, was sown on November 25 and 20 in 1992-93 and 1993-94, respectively.

A basal dose of 15 kg N/ha in the form of urea and 40 kg K_2O/ha in the form of muriate of potash and phosphorus as per treatments in the form of single super phosphate was given either before sowing in previously opened furrows or broadcast as per the methods of sowing. Fertilizers were slightly mixed with soil immediately after application. Remaining 15 kg N/ha in the form of urea was applied as top dressing at 30 days after sowing. In broadcast sowing, two hand weedings were carried out, while in line sowing, interculture and hand weeding twice were carried out after 30-35 and 135-140 days after sowing. Except for the irrigation treatments, all other operations were followed as per recommendations. Besides, three common irrigations each of 60 mm depth were given to all the treatment plots, first immediately after sowing, second 5-6 days after sowing and third one 14-15 days after sowing for better germination and establishment of the crop. Five cuts of lucerne were taken during both the years.

RESULTS AND DISCUSSION

Effect of Irrigation

The two years data indicate that the green fodder yield increased progressively with increase in the irrigation levels (Table-1). The number of post sowing irrigations were 14, 19 and 23 in 1992-93 and 12, 17 and 21 during 1993-94 at 0.75, 1.00 and 1.25 IW/CPE ratio, respectively. On pooled basis the maximum green fodder yield was recorded under IW/CPE ratio of 1.25 (430.3 q/ha), followed by ratio of 1.00 (398.3 q/ha) and 0.75 (321.9 q/ha). The percentage increase in the green fodder yield under 1.25 and 1.00 ratios were 33.7 and 23.7 per cent over 0.75 ratio. Similar trend was observed for dry fodder yield. The plots irrigated more frequently with IW/CPE ratio of 1.25 gave considerably higher yields of green and dry fodder (Table-1) owing to taller plants (52.8 cm), maximum number of tillers /m^2 (98.6), green : dry fodder ratio (4.39) and significantly lowest leaf : stem ratio (1.00) (Table-2). The increase in fodder yield of lucerne under higher moisture content might be due to easy availability of moisture to lucerne within the suction range of 2 to 8 bars during the crop growth season which resulted in better growth and development of the crop (Taylor *et al.*, 1959). Significantly lower yields under IW/CPE ratio of 0.75 (I_1) could be explained on the basis that this treatment received irrigation at longer interval which created adverse effect of moisture stress condition on root development, photosynthesis and other physiological processes resulting in poor growth. Reduction in yield under moisture stress condition was observed by Abu-Shakra *et al.*(1969) and Patel (1992). Green : dry fodder ratio increased with increasing irrigation frequency. Moisture stress condition (IW/CPE ratio 0.75) resulted in significant increase in leaf : stem ratio, while it was lowest in higher

TABLE 1

Total green and dry fodder yields (q/ha) as well as average plant height (cm) as influenced by IW/CPE ratios, sowing methods and phosphorus levels.

Treatment	Green fodder yield (q/ha)			Dry fodder yield (q/ha)			Plant height (cm)		
	1992-93	1993-94	Pooled	1992-93	1993-94	Pooled	1992-93	1993-94	Pooled
IW/CPE ratio									
I_1 (0.75)	321.9	321.9	321.9	81.1	80.9	81.0	43.3	47.1	45.2
I_2 (1.00)	396.3	400.4	398.4	92.2	95.5	94.9	46.7	52.4	49.6
I_3 (1.25)	423.3	436.3	430.3	98.0	100.5	99.2	49.5	56.1	52.8
C. D. (P = 0.05)	11.10	18.02	10.14	3.81	5.63	3.26	1.00	1.52	4.27
Sowing method									
M_1 Broadcasting	374.1	386.7	377.4	89.0	90.9	90.0	45.7	51.2	48.5
M_2 Line sowing at 25 cm	387.5	391.8	389.6	93.2	93.7	93.5	47.3	52.5	49.9
C. D. (P = 0.05)	9.07	NS	NS	3.11	NS	NS	0.81	NS	1.01
Phosphorus (kg/ha)									
P_1 (60)	346.0	348.6	347.3	77.8	78.1	78.0	43.0	48.7	45.8
P_2 (80)	369.5	376.8	373.2	86.6	88.5	87.5	45.7	51.1	48.4
P_3 (100)	399.4	405.3	402.3	96.4	98.1	97.2	48.3	53.5	50.9
P_4 (120)	408.3	414.2	411.2	103.6	104.6	104.1	49.0	54.1	51.5
C. D. (P = 0.05)	5.55	7.65	4.68	1.67	1.98	1.28	0.66	0.66	0.46

TABLE 2

Number of tillers/m², green : dry and leaf : stem ratio as influenced by IW/CPE ratios, sowing methods and phosphorus levels (Average of five cuts).

Treatment	Number of tillers/m²			Green : dry fodder ratio			Leaf : stem ratio		
	1992-93	1993-94	Pooled	1992-93	1993-94	Pooled	1992-93	1993-94	Pooled
IW/CPE ratio									
I_1 (0.75)	84.7	90.6	87.6	4.06	4.03	4.05	1.10	1.12	1.11
I_2 (1.00)	92.9	96.4	94.7	4.24	4.24	4.24	1.02	1.07	1.05
I_3 (1.25)	97.9	99.4	98.6	4.38	4.40	4.39	0.99	1.01	1.00
C. D. (P = 0.05)	2.34	2.08	6.74	0.13	0.11	0.08	0.04	0.02	0.02
Sowing method									
M_1 Broadcasting	91.3	94.2	92.8	4.24	4.23	4.23	1.03	1.06	1.05
M_2 Line sowing at 25 cm	92.3	96.8	94.5	4.21	4.23	4.22	1.04	1.07	1.06
C. D. (P = 0.05)	NS	1.70	NS	NS	NS	NS	NS	NS	NS
Phosphorus (kg/ha)									
P_1 (60)	86.7	90.8	88.8	4.50	4.49	4.50	0.98	1.01	1.00
P_2 (80)	90.9	94.4	92.6	4.29	4.29	4.29	1.02	1.04	1.03
P_3 (100)	93.8	97.2	95.5	4.14	4.15	4.15	1.07	1.08	1.08
P_4 (120)	95.9	99.5	97.7	3.97	3.98	3.97	1.09	1.12	1.10
C. D. (P = 0.05)	1.67	1.88	1.24	0.09	0.04	0.05	0.02	0.02	0.01

moisture regimes (IW/CPE ratio of 1.25). The increase in leaf : stem ratio under moisture stress condition was probably due to decrease in stem length thereby increasing the leaf portion. Halim *et al.* (1989) reported decrease in percentage of leaves at low moisture stress condition which was associated with taller plants having longer internodes and larger stem diameter.

Effect of Sowing Method

Line sowing method recorded higher green fodder yield of 387.5, 391.8 and 389.6 q/ha and dry fodder yield of 93.2, 93.7 and 93.5 q/ha during 1992-93 and 1993-94 on pooled basis, respectively over broadcast sowing. The more green and dry fodder yields in line sown crop might be due to more availability of soil surface, moisture and solar energy which might have improved the yield attributes viz., plant height, number of tillers / m^2 leaf : stem ratio and lower green : dry fodder ratio (Table-2) which ultimately resulted in improvement in yield. Vittum *et al.* (1958) also obtained increased green fodder yield of lucerne in line sowing method. Marginally higher dry fodder yield in line (sown) crop as compared to broadcast, though not significant when pooled seemed to be due to more green fodder yield in this treatment. Similar results were also observed by Dev *et al.* (1974).

Effect of Phosphorus

Green and dry fodder yields increased progressively with increase in phosphorus levels from 60 to 120 kg P_2O_5/ha during both the year and in pooled analysis (Table-1). On pooled data basis, the increase in green fodder yield due to 120, 100 and 80 kg P_2O_5/ ha were 18.4, 15.8 and 7.5 per cent, respectively over 60 kg P_2O_5 per hectare. Similar results were also observed in case of dry fodder yield. The remarkable increase in yields with higher levels of phosphorus may be attributed to favourable effect on yield attributing characters. Tomer *et al.* (1974) observed that improvement in yield with the application of phosphorus is mainly due to improved growth, fresh and dry weight and better plant population which might have resulted into increase in cell division, better root development and high microbial activity. The results are in accordance with those reported by Patel (1992).

Increasing the levels of phosphorus from 60 to 120 kg P_2O_5/ha increased leaf : stem ratio whereas a reverse trend was observed in case of green : dry fodder ratio (Table-2). Phosphorus plays crucial role in photosynthesis. It increased the photosynthetic efficiency of leaves and thus increased the availability of photosynthates. Increase in leafiness, dry matter production and succulency with phosphorus fertilization resulted in increased leaf : stem ratio and reduction in green : dry fodder ratio. These findings are in accordance with those reported by Parson and Davis (1960).

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