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INFLUENCE OF SOWING TIME AND PHOSPHORUS LEVELS ON YIELD AND YIELD ATTRIBUTES OF LUCERNE (*MEDICAGO SATIVA* L.) CV. ANAND-2 UNDER MIDDLE GUJARAT CONDITIONS

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SUMMARY

A field experiment was conducted at Regional Research Station Farm, Anand Agricultural University, Anand to quantify the effect of sowing time and phosphorus levels on yield and yield attributes of lucerne (*Medicago sativa* L.) cv. Anand-2 under middle Gujarat conditions during the year 2007-08. For said purpose, 16 treatments comprising combinations of four sowing times (1, 15, 30 November and 15 December) and four phosphorus levels (0, 25, 50 and 75 kg/ha) were tested in a split plot design with four replications. Results revealed that yield attributes viz., number of effective tillers/m row length, number of filled pods/raceme, number of seeds/pod and 1000-seed weight recorded maximum at harvest under treatment S_3 (15 November), while minimum values of these characters were registered under treatment S_1 (1 November).

Key words : Phosphorus, sowing time, yield attributes

Lucerne is the most versatile and important forage crop grown during **rabi** season in India and particularly in the milk shed area of Gujarat in about 60 to 80 thousand hectare. Lucerne is one of the best sources of green fodder during **rabi** season and a part of summer season. It offers 5 to 7 cuttings of green fodder per season, accounting for about 600 to 700 q/ha forage production per hectare. Lucerne contains about four to five times as much protein as forage sorghum. It also contains fair amount of Ca, K and phosphorus. Being a valuable leguminous fodder crop, its value as a soil fertility building cannot be overlooked. Lucerne is normally considered to be cross pollinated crop known for shy seed production. In India, an average seed yield of lucerne varied from 50 to 250 kg/ha as compared to 800 to 1000 kg/ha in Lebanon as reported by Abu-Shakra *et al*. (1969). Hence, there is a wide gap between requirement and availability of seed in the country. Successful seed production involves acceptable variety, adequate pollination, proper fertigation and proper insect-pest management and fitting of cultural and management practices under local conditions. Millar and Schonhorst (1968), Manninger *et al.* (1983) and Prasad *et al.* (1988) had done some earlier research work which corroborates to the said research. On the basis of above background, present study during the year 2007-08 was designed.

MATERIALS AND METHODS

The present study was carried out in split plot design at Regional Research Station Farm, Anand Agricultural University, Anand during **rabi** season of 2007-08 which lies about 70 km away from the Arabian Sea coast at 22°-35' N latitude and 72°-55' E longitude with an altitude of 45.1 m above mean sea level. The region experienced semi-arid and sub-tropical with fairly dry and hot summer. The soil of the experimental plot was loamy sand in texture having low in organic carbon and nitrogen and medium in available phosphorus and high in available potassium. We have applied 16 various treatment combinations of sowing dates and phosphorus levels i. e. 1 November and 0 kg P_2O_5/ha (S_1P_o), 1 November and 25 kg P_2O_5/ha (S_1P_1), 1 November and 50 kg P_2O_5 /ha (S_1P_2), 1 November and 75 kg P_2O_5/ha

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(S_1P_3), 15 November and 0 kg P_2O_5/ha (S_2P_0), 15 November and 25 kg P_2O_5/ha (S_2P_1), 15 November and 50 kg P_2O_5/ha (S_2P_2), 15 November and 75 kg P_2O_5/ha (S_2P_3), 30 November and 0 kg P_2O_5/ha (S_3P_0), 30 November and 25 kg P_2O_5/ha (S_3P_1), 30 November and 50 kg P_2O_5/ha (S_3P_2), 30 November and 75 kg P_2O_5/ha (S_3P_3), 15 December and 0 kg P_2O_5/ha (S_4P_0), 15 December and 25 kg P_2O_5/ha (S_4P_1), 15 December and 50 kg P_2O_5/ha (S_4P_2) and 15 December and 75 kg P_2O_5/ha (S_4P_3). Sowing was done on 1 November, 15 November, 30 November and 15 December with a spacing of 30 cm between the rows using seed rate of 7.5 kg/ha. The furrows were opened with the help of kudali and seeds were sown manually by drilling in furrows and slightly covered with soil immediately. Gap filling was done at 12 to 15 days after each sowing time to maintain optimum plant population.

RESULTS AND DISCUSSION

Effect of Sowing Time on Yield Attributes

Various yield attributing characters in lucerne seed crop at harvest viz., number of effective tillers/m row length (Table 1), number of filled pods/raceme (Table 2), number of seeds/pod and 1000-seed weight (Table 3) significantly decreased under treatments S_1 (1 November) and S_2 (15 November) as compared to treatments S_3 (30 November) and S_4 (15 December). Millar and Schonhorst (1968) studied the relationship between environment and fertilization of lucerne. They indicated that numbers of filled pods/plant were positively correlated with the pollen tube length. Under the delayed sowing (30 November and 15 December), the crop was exposed to comparatively higher temperature (36°C to 40°C) during flowering period as compared to earlier sowing time (1 November and 15 November) might have increased the pollen tube length and autotripping of flowers consequently led to increase in all the yield attributes. Hence, the temperature prevailing during flowering period in terms of longer day length and better sun light under the treatments of later sowing times (S_3–30 November and S_4–15 December) might be optimum for better fertilization and seed setting of lucerne cv. Anand-2 due to diversification of more plant energy to the development of reproductive organ. Among the different sowing times, treatments S_3 (30 November) and S_4 (15 December) produced significantly higher harvest index which was outcome of higher seed yield and restricted vegetative growth (Table 4). Significantly the highest straw yield was observed under the treatments S_1 (1 November) and S_2 (15 November), which reduced the harvest index to a greater extent. Delayed sowing time (30 November and 15 December)

TABLE 1
Number of effective tillers of lucerne seed crop recorded at harvest as influenced by sowing time and phosphorus levels

Treatment	No. of effective tillers/row length
Sowing time (S)	
S_1 : 1 November	39.41
S_2 : 15 November	44.18
S_3 : 30 November	47.57
S_4 : 15 December	45.84
S. Em±	1.04
C. D. (P=0.05)	3.33
C. V. (%)	9.43
Phosphorus levels (P)	
P_0 : 0 kg/ha	39.31
P_1 : 25 kg/ha	42.67
P_2 : 50 kg/ha	46.98
P_3 : 75 kg/ha	48.03
S. Em±	0.65
C. D. (P=0.05)	1.87
Interaction (S x P)	NS
C. V. (%)	5.90

NS–Not Significant.

TABLE 2
Number of filled pods/raceme at the time of harvest of lucerne seed crop as influenced by sowing time and phosphorus levels

Treatment	No. of filled pods/raceme
Sowing time (S)	
S_1 : 1 November	9.54
S_2 : 15 November	11.45
S_3 : 30 November	11.73
S_4 : 15 December	10.31
S. Em±	0.21
C. D. (P=0.05)	0.70
C. V. (%)	8.14
Phosphorus levels (P)	
P_0 : 0 kg/ha	9.10
P_1 : 25 kg/ha	10.38
P_2 : 50 kg/ha	11.93
P_3 : 75 kg/ha	11.61
S. Em±	0.14
C. D. (P=0.05)	0.41
Interaction (S x P)	Sig.
C.V. (%)	7.38

Sig.– Significant.

TABLE 3

Number of seeds/pod and 1000-seed weight recorded at harvest of lucerne seed crop as influenced by sowing time and phosphorus levels

Treatment	No. of seeds/pod	1000-seed weight (g)
Sowing time (S)		
S_1 : 1 November	5.97	3.16
S_2 : 15 November	6.42	3.17
S_3: 30 November	7.07	3.36
S_4 : 15 December	6.90	3.32
S. Em±	0.13	0.04
C. D. (P=0.05)	0.42	0.13
C. V. (%)	8.03	5.32
Phosphorus levels (P)		
P_0 : 0 kg/ha	5.94	3.08
P_1 : 25 kg/ha	6.44	3.19
P_2 : 50 kg/ha	6.85	3.33
P_3 : 75 kg/ha	7.13	3.42
S. Em±	0.10	0.04
C. D. (P=0.05)	0.29	0.12
Interaction (S x P)	Sig.	Sig.
C. V. (%)	6.29	5.27

TABLE 4

Seed yield and harvest index of lucerne seed crop as influenced by sowing time and phosphorus levels

Treatment	Seed yield (q/ha)	Harvest index (%)
Sowing time (S)		
S_1 : 1 November	3.21	10.10
S_2 : 15 November	3.67	11.18
S_3 : 30 November	4.25	15.27
S_4: 15 December	3.97	14.52
S. Em±	0.09	0.32
C. D. (P=0.05)	0.29	1.04
C. V. (%)	9.44	10.24
Phosphorus levels (P)		
P_0 : 0 kg/ha	3.25	11.76
P_1 : 25 kg/ha	3.63	12.19
P_2 : 50 kg/ha	4.06	13.26
P_3 : 75 kg/ha	4.17	13.85
S. Em±	0.05	0.23
C. D. (P=0.05)	0.15	0.67
Interaction (S x P)	Sig.	NS
C. V. (%)	5.35	7.29

Sig.–Significant, NS–Not Significant.

significantly increased seed yield of lucerne. Among various sowing times, treatment S_3 (30 November) established significantly higher seed yield (4.25 q/ha) over the treatment S_1 and S_2 except S_4 (15 December). Treatments S_3 (30 November) and S_4 (15 December) significantly recorded higher values of all the yield attributing characters (Tables 1, 2 and 3), might have helped to increase seed yield. These results corroborate the findings of Abu-Shakra *et al.* (1969) and Andrews *et al.* (1977). Data presented on green forage and dry matter yields (Tables 5 and 6) indicated that there were significant differences in green as well as dry matter yields due to different sowing times. The green forage as well as dry matter yields in first, second and total of both the cuts were recorded significantly higher under treatment S_1 (1 November) as compared to treatments S_3 (30 November) and S_4 (15 December), but these were at par with the treatment S_2 (15 November). Maximum green forage as well as dry matter yields in first, second and total of both the cuts in treatments S_1 (1 November) and S_2 (15 November) might be due to optimum temperature prevailed during the crop growth period, favoured for better root and vegetative growth and ultimately resulted in more green forage and dry matter yields. The higher green forage and dry matter yields in early sowing time were also attributed to the environmental conditions. Patel *et al.* (1987) reported that higher green forage and dry matter yields were obtained when lucerne was sown at last week of October.

TABLE 5

Green forage yield of lucerne seed crop as influenced by sowing time and phosphorus levels

Treatment	Green forage yield (q/ha)		
	First cut	Second cut	Total
Sowing time (S)			
S_1 : 1 November	70.41	84.63	155.05
S_2 : 15 November	67.58	80.22	147.81
S_3 : 30 November	62.01	71.92	133.92
S_4 : 15 December	57.02	64.96	121.98
S. Em±	1.59	1.52	3.01
C. D. (P=0.05)	5.09	4.87	9.65
C. V. (%)	9.91	8.08	8.64
Phosphorus levels (P)			
P_0 : 0 kg/ha	56.57	68.44	125.01
P_1 : 25 kg/ha	62.32	73.43	135.75
P_2 : 50 kg/ha	68.31	78.93	147.25
P_3 : 75 kg/ha	69.82	80.94	150.76
S. Em±	0.88	0.97	1.88
C. D. (P=0.05)	2.55	2.80	5.40
Interaction (S x P)	Sig.	Sig.	NS
C. V. (%)	5.54	5.18	5.39

Sig.–Significant, NS–Not Significant.

TABLE 6
Dry matter yield of lucerne seed crop as influenced by sowing time and phosphorus levels

Treatment	Green forage yield (q/ha)		
	First cut	Second cut	Total
Sowing time (S)			
S_1: 1 November	10.56	22.16	32.71
S_2: 15 November	10.18	21.22	31.39
S_3: 30 November	9.35	19.19	28.54
S_4: 15 December	9.08	15.70	24.78
S. Em±	0.19	0.35	0.47
C. D. (P=0.05)	0.61	1.14	1.52
C. V. (%)	7.72	7.25	6.46
Phosphorus levels (P)			
P_0: 0 kg/ha	8.90	17.74	26.64
P_1: 25 kg/ha	9.35	19.25	28.60
P_2: 50 kg/ha	10.22	20.36	30.57
P_3: 75 kg/ha	10.69	20.92	31.61
S. Em±	0.17	0.28	0.38
C. D. (P=0.05)	0.48	0.82	1.10
Interaction (S x P)	Sig.	Sig.	NS
C. V. (%)	6.85	5.91	5.23

Sig.–Significant, NS–Not Significant.

Effect of Phosphorus Levels on Yield Attributes

Phosphorus levels showed significant influence on yield attributes viz., number of effective tillers/m row length (Table 1), number of filled pods/ raceme (Table 2), number of seeds/pod and 1000-seed weight (Table 3). Treatment P_3 (75 kg P_2O_5/ha) recorded significantly the highest values of all yield attributes viz., number of effective tillers/m row length, number of seeds/pod and 1000-seed weight followed by treatment P_2 (50 kg P_2O_5/ha), except number of filled pods/raceme that was significantly higher under the treatment P_2 (50 kg P_2O_5/ha), followed by treatment P_3 (75 kg P_2O_5/ha). Phosphorus played a primary role in photosynthesis by way of energy transfer and thereby increased the photosynthetic efficiency and thus increased the availability of photosynthates. Application of phosphorus enhanced the activity of growth and development owing to functional activity of phosphorus in plant metabolism. These all together resulted in overall increase in all yield attributes. Similar results were also observed by Ovsyannikov (1973), Bhatti *et al*. (1975), Solanki (1987) and Prasad *et al.* (1988).

Different levels of phosphorus recorded significant influence on seed yield of lucerne. Application of phosphorus @ 75 kg/ha (P_3) outyielded the rest of phosphorus treatments except treatment P_2 (50 kg P_2O_5/ha) recorded significantly the highest value of seed yield (4.17 q/ha). Higher seed yield of lucerne under the treatment P_3 was evidently resulted from higher number of effective tillers/meter row length (Table 1), number of filled pods/raceme (Table 2), number of seeds/pod and 1000-seed weight (Table 3). Phosphorus is known to play beneficial role in legume growth by promoting extensive root development and nodulation and improves the supply of nutrients and water from the deeper soil layers for higher photosynthetic activity and translocation of photosynthates to the sink of the site of their requirement consequently increases seed yield. These results are in accordance with the results of Solanki (1987) and Prasad *et al.* (1988). Harvest index (Table 4) was significantly influenced due to phosphorus levels and it was recorded the highest under higher level of phosphorus (75 kg P_2O_5/ha) followed by the treatment P_2 (50 kg P_2O_5/ha). This might be due to the proportional effects of seed and dry matter yields which turned out the harvest index to be significant. With regards to green forage and dry matter yields (Tables 5 and 6), treatment P_3 (75 kg $P_2O_{5/}$ha) being at par with treatment P_2 (50 kg P_2O_5/ha) registered significantly higher green forage as well as dry matter yields in first, second and total of both the cuts than rest of the treatments. The magnitude of increase in green forage and dry matter yields in first cut under the treatment P_3 over the treatments P_0 and P_1 was to the extent of 23.42, 20.11 and 12.03, 14.33 per cent and in second cut 18.23, 17.92 and 10.22, 8.6 per cent, respectively. The total green forage as well as dry matter yields increased in treatment P_3 to the tune of 20.59, 18.65 and 11.04, 10.51 per cent, respectively, over the treatments P_0 and P_1. Higher green as well as dry matter yields in first, second and total of both the cuts under treatments P_3 and P_2 ascribed to its role in the constitution of ribonucleic acid, deoxyribonucleic acid and ATP which regulate vital metabolic processes in the plant, helping in cell division, better root development, nitrogen fixation and high microbial activity. Increase in growth and height of the plant was also due to enhanced application of phosphorus which increased the yield. Similar results were also reported by Patel *et al.* (1990), Pawar and More (1996), and Solanki and Patel (1999).

CONCLUSION

Lastly it can be concluded that yield attributes viz., number of effective tillers/m row length, number of filled pods/raceme, number of seeds/pod and 1000-seed weight recorded at harvest were maximum under treatment S_3 (15 November), while minimum values of these characters were registered under treatment S_1 (1 November). In addition to that sowing of lucerne seed crop on 30 November gave 32.39 per cent higher seed yield than early sowing on 1 November.

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