Indian J. Agron. **38** (2) : 244–248 (June 1993)

Effect of soil-moisture regime, seed rate and phosphorus fertilizer on water use, P uptake and economics of late-sown lentil (*Lens culinaris*)

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Received: December 1991

ABSTRACT

A field experiment was conducted with late-sown lentil (*Lens culinaris* Medikus) during the winter seasons of 1984–85 and 1985–86 on a sandy-loam soil at New Delhi. Seasonal and daily consumptive use of water, water-use efficiency, total P uptake and net returns increased with increasing frequency of irrigation, being the maximum with irrigation at 0.60 irrigation water depth : cumulative pan evaporation (IW : CPE) ratio. Lower soil profile of 30–60 cm contributed the maximum mositure in unirrigated plots, whereas soil profiles of 15–30 cm and 0–15 cm contributed more moisture in irrigated plots during 1984–85 and 1985–86 respectively. Higher seed rate of 60 kg/ha recorded higher total and daily water use, water-use efficiency, P uptake and net returns than of 40 kg/ha. Lower soil profile of 30–60 cm contributed relatively more moisture in the case of 60 kg seed/ha. P application up to 35 kg P_2O_5/ha increased the total and daily water use, and that up to 70 kg P_2O_5 /ha increased the water-use efficiency P uptake and net returns. Phosphobacterial inoculation alone or with 35 kg P_2O_5/ha recorded higher water-use efficiency and net returns in both the seasons, and total P uptake during 1985–86 compared with no P and 35 kg P_2O_5 alone respectively.

Lentil (*Lens culinaris* Medikus) is generally grown as rainfed or with supplemental irrigation wherever available. The crop responds invariably to irrigation and P fertilizer (Saxena and Wassimi, 1980; Nema *et al.*, 1984). The productivity of the crop could be substantially improved by these 2 inputs along with optimum plant density. Irrigation water and P fertilizer are expensive and scarce inputs and their optimum use is important to obtain maximum use efficiency under the limited resource conditions. The present investigation was conducted for optimization of irrigation, plant density and P fertilizer in lentil, and the paper deals with water use, P uptake and economics as affected by these inputs in lentil.

MATERIALS AND METHODS

The detials of the experiment are as per Venkateswarlu and Ahlawat (1993). Consumptive use of water was computed by pan-evaporation method and daily soil-moisture use was worked by dividing the seasonal cunsumptive use of water with crop duration. Soil-moisture depletion was worked out for soil depth up to 60 cm for the periods between 2 successive soil sampling in the crop cycle.

RESULTS AND DISCUSSION

Effect of soil-moisture regime

Seasonal and daily consumptive use of

Table 1. Moisture use by lentil as affected by soil-moisture regime, seed rate and P appliction

Treatment	Seasonal consumptive use (mm)		Soil-moisture-use rate (mm/day)		Water-use efficiency (kg/ha/mm)	
	1984–85	1985–86	1984–85	1985–86	1984–85	1985–86
IW : CPE ratio						
No post-planting irrigation	160.0	175.4	1.45	1.53	2.18	4.67
0.35	203.4	218.6	1.85	1.91	3.65	6.63
0.60	207.7	222.9	1.88	1.95	4.23	7.09
Seed rate (kg/ha)						
40	188.0	203.4	1.71	1.78	3.28	6.03
60	193.2	207.8	1.75	1.82	3.61	6.44
P_2O_5 (kg/ha)						
0	186.4	200.4	1.69	1.76	2.32	4.79
Phosphobacterial inoculation	187.5	200.2	1.70	1.75	2.51	5.20
35	192.6	208.8	1.75	1.83	3.81	6.50
35 + phosphobacterial inoculation	194.2	210.8	1.76	1.85	4.00	6.90
70	192.8	208.0	1.75	1.82	4.51	7.71

water, water-use efficiency, P uptake and net returns increased with increasing frequency of irrigation (Table 1). The effect was, however, more conspicuous at an IW : CPE ratio of 0.35 than at no post-planting irrigation. The values of seasonal and daily consumptive use were higher during 1985–86 because of higher amount of rainfall received in this season. These findings confirm the hypothesis that water used by a crop depends mainly upon the evaporative demand of the climate when moisture is not limiting factor. But, it depends upon moisture supply from the soil as well as crop-growth period when moisture is limited. Singh (1980) and Murari (1982) also reported higher consumptive use of water with increased application of water. This was natural because in relatively less moisture-stress condition the moisture content in soil was high and there was no restriction on the movement of water in response to evapotranspiration. Under moisture-stress (no irrigation) conditions, the upward water flux was low due to low unsaturated hydraulic conductivity and thus the consumptive use of water was less.

As expected, lower soil profile of 30–60 cm contributed the maximum soil moisture under unirrigated plots. However, contribution of this soil profile was more duirng 1984–85 — a dry year. In irrigated plots, first 2 layers, (0–15 cm and 15–30 cm) contributed more because of availability of more moisture in these layers (Fig. 1).

Irrigation increased P uptake by grain and straw and total P uptake by crop (Table 2). The increased availability of P to the plant due to greater rate of fertilizer dissolution under favourable moisture conditions might

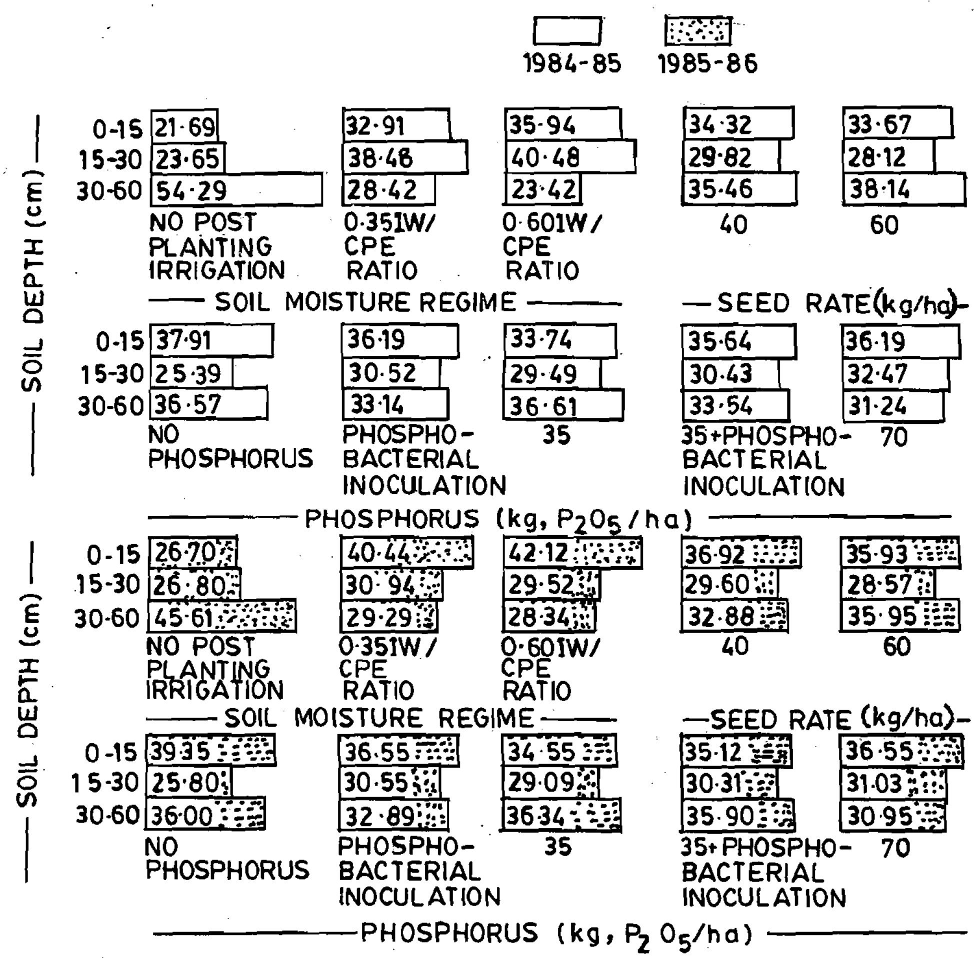

Fig. 1. Soil-moisture-depletion pattern (%) as affected by soil-moisture regime, seed rate and phosphorus

have resulted in more of P uptake (Rizk, 1979). Crop irrigated twice at an IW : CPE of 0.60 fetched the highest total net returns and returns per rupee invested owing to favourable response of crop in terms of yields up to this level of water supply.

Effect of seed rate

Higher seed rate of 60 kg/ha recorded marginally higher seasonal and daily consumptive use of water than 40 kg/ha (Table 1). Higher water-use efficiency in 60 kg seed/ha was due to higher grain yield in this treatment. Similar was the case with P uptake, being higher with higher seed rate, because of more grain and straw yields. Higher yields with only marginally higher cost of 20 kg seed/ha in higher seed rate resulted in higher net returns/ha.

There were no large variations in soil-

Table 2. Phosphorus uptake by crop and economics as affected by soil-moisture regime, seed rate and P application

Treatment	P uptake (kg/ha)						Net returns (Rs/ha)		Net returns/ rupee invested (Rs)	
	1984–85			1985–86			1984–85	1985–86		
	Grain	Straw	Total	Grain	Straw	Total			1984–85	1985–86
IW : CPE ratio										
No post-planting irrigation	1.40	1.23	2.63	3.20	1.98	5.18	265	2,615	0.18	1.76
0.35	2.82	1.55	4.37	5.36	2.37	7.73	2,138	5,667	1.35	3.59
0.60	3.25	1.55	4.80	5.70	2.52	8.22	2,718	6,238	1.62	3.73
CD (P = 0.05)	0.37	0.31	0.42	0.31	0.32	0.46				
Seed rate (kg/ha)										
40	2.40	1.48	3.88	4.66	2.04	6.70	1,580	4,631	1.05	3.07
60	2.72	1.97	4.69	5.09	2.66	7.75	1,839	5,049	1.11	3.05
CD (P = 0.05)	0.30	0.25	0.34	0.25	0.26	0.37				
P_2O_5 (kg/ha)										
0	1.56	0.96	2.52	3.55	1.53	5.08	800	3,437	0.58	2.51
Phosphobacterial inoculation	1.69	1.07	2.76	3.85	2.09	5.94	981	3,838	0.71	2.79
35	2.94	1.75	4.69	5.56	2.84	8.40	2,035	5,140	1.24	3.13
35 + phosphobacterial inoculation	3.18	1.90	5.09	5.96	3.14	9.10	2,243	5,626	1.36	3.41
70	3.65	2.08	5.73	6.74	3.37	10.11	2,490	6,160	1.34	3.31
CD (P = 0.05)	0.43	0.16	0.16	0.70	0.21	0.68				

moisture depletion from different soil profiles, however, contribution of deeper soil profile of 30–60 cm was more in higher seed rate of 60 kg/ha (Fig.1). It could be attributed to relatively intense competition among plants at higher plant density

Effect of P

The P application improved the water use and water-use efficiency, but phosphobacterial inoculation did not affect the water use. However, water-use efficiency showed some improvement by phosphobacterial inoculation. This could be attributed to the fact that phosphobacterial inoculation increased the grain yild without affecting the water use. P application did not show any definite trend in soil-moisture-depletion pattern. P uptake by grain and straw and total uptake by crop increased with increasing levels of P_2O_5 up to 70 kg/ha. Phosphobacterial inoculation with and without P also increased the P uptake during 1985–86. The increased and esay availablility of P to crop by fertilizer application could be attributed to higher uptake of this nutrient. The apparent P recovery was lower during 1984–85, being 14.2 and 10.5% with 35 and 70 kg P_2O_5/ha repectively, whereas the corresponding values during 1985–86 were 21.7 and 16.5%. The greater P recovery during the second year could be achieved due to favourable soil-moisture conditions. Higher level of 70 kg P_2O_5/ha fetched the maximum net returns.

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