

Response of french bean (*Phaseolus vulgaris*) to irrigation schedule and phosphorus level in Vertisols

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Received: September 2000

ABSTRACT

A field study was carried out during 1996–97, 1997–98 and 1998–99 at the experimental farm of Agricultural Research Station, Kota, to study the response of French bean (*Phaseolus vulgaris* L.) to irrigation scheduling and phosphorus levels in Vertisols. Scheduling of irrigation at branching + flowering + pod-development stages was significantly better than 2 irrigations at branching + pod-development stages and found at par with IW : CPE ratio of 0.5 and 0.7 in terms of seed yield. Application of phosphorus influenced seed yield significantly up to 60 kg P_2O_5 /ha. Mean values of consumptive use of water and Et:Co were maximum at IW : CPE of 0.7 (4 irrigations), whereas water-use efficiency was minimum at this scheduling of irrigation. Consumptive use of water and Et:Co increased with the increasing levels of phosphorus up to 80 kg P_2O_5 /ha, whereas WUE was the maximum at lowest level (20 kg P_2O_5 /ha).

Key words : French bean, Irrigation, Phosphorus, Yield

French bean is highly protein rich and precious grain legume of northern India. Though the French bean crop has a higher yield potential, its average yield is very low in plains. Being a leguminous crop, it responds well to phosphorus application (Ahlawat and Sharma, 1989). As it does not grow well in moisture-deficient areas, assured irrigation is a pre-requisite for its successful cultivation (Sushant *et al.*, 1999). Therefore the present study was carried to evaluate the response of French bean to irrigation scheduling and phosphorus application in Vertisols.

MATERIALS AND METHODS

The experiment was conducted during the winter season (*rabi*) of 1996–97, 1997–98 and 1998–99 at Agricultural Research Station, Kota. The soil was clay loam in texture, low in organic carbon (0.44%) and available N (192.8 kg/ha), medium in available P (14.9 kg/ha) and available K (258.7 kg/ha), having pH 7.77. The field capacity and permanent wilting point values were 28 and 15% respectively. The experiment was laid out in randomized block design having 4 irrigation schedules (irrigation at branching + pod development,

at branching + flowering + pod development, at IW:CPE ratio 0.5 and at IW:CPE ratio 0.7) and 4 phosphorus levels (20, 40, 60 and 80 kg P_2O_5 /ha) with 3 replications. The variety 'PDR 14' was sown with 30 cm $\times$ 15 cm spacing. The entire quantity of P (as per treatment) and K @ 40 kg K_2O /ha and half quantity of N (60 kg N/ha) were applied at sowing as basal dose and remaining N (60 kg N/ha) was top-dressed at the time of first irrigation. Pre-sowing and post-sowing irrigations were applied at the depth of 100 and 60 mm respectively.

RESULTS AND DISCUSSION

The seed yield of Frenchbean was significantly influenced by irrigation regimes in 1996–97 and 1998–99, whereas it did not differ significantly to irrigation application in winter 1997–98 (Table 1). The maximum pooled seed yield was observed when crop was irrigated at branching + flowering + pod-development stages. At this schedule

of irrigation, the seed yield was higher by 19.60% over 2 irrigations at branching + pod-development stages, whereas IW:CPE of 0.5 and 0.7 had at par yields with irrigation at branching + flowering + pod development. The increase in yield at more irrigations might be due to increase in cell turgidity, better opening of stomata and finally increasing the partitioning of photosynthates to sink. Similar results were recorded by Sushant *et al.* (1999).

Application of phosphorus significantly increased the seed yield during 1996–97 and 1998–99, whereas in 1997–98 it did not differ significantly. Pooled analysis of 3 years showed that on application of phosphorus influenced the seed yield significantly up to 60 kg P_2O_5 /ha (Table 1). This treatment resulted in maximum seed yield which was significantly superior to 20 and 40 kg P_2O_5 /ha and at par with 80 kg P_2O_5 /ha. The differences between 20 and 60 kg P_2O_5 /ha and 40 and 60 kg P_2O_5 /ha doses

Table 1. Effect of irrigation schedule and phosphorus level on seed yield of French bean

Treatment	Seed yield (q/ha)			
	1996–97	1997–98	1998–99	Pooled
<i>Irrigation schedule</i>				
Branching + pod development (2)	21.06	17.78	15.84	18.23
Branching + flowering + pod development (3)	24.58	19.28	21.56	21.81
IW : CPE = 0.5(3)	25.14	19.58	20.14	21.62
IW : CPE (0.7 (4–5)	24.99	19.56	19.40	21.32
CD (P=0.05)	1.30	NS	0.26	1.12
<i>Phosphorus (kg P_2O_5/ha)</i>				
20	21.88	18.17	16.54	18.86
40	23.68	19.18	19.05	20.64
60	24.68	18.61	22.20	21.83
80	24.85	19.68	19.16	21.22
CD (P=0.05)	1.30	NS	0.26	1.12

Figures in parentheses indicate number of irrigations as per treatment.

Table 2. Effect of irrigation schedules and phosphorus levels on consumptive use, water-use efficiency and Et:Et₀ in frenchbean

Treatment	Consumptive use				Water-use efficiency				Et:Et ₀			
	1996- 97	1997- 98	1998- 99	Mean	1996- 97	1997- 98	1998- 99	Mean	1996- 97	1997- 98	1998- 99	Mean
<i>Irrigation schedule</i>												
Branching + pod development	182.3	180.2	178.1	180.2	11.55	9.87	8.89	10.10	0.39	0.50	0.46	0.45
Branching + flowering + pod development (3)	236.5	233.7	242.7	237.6	10.39	8.25	8.88	9.17	0.51	0.63	0.62	0.59
IW : CPE 0.5 (4)	250.8	245.3	244.6	246.9	10.02	7.38	8.23	8.74	0.54	0.66	0.63	0.61
IW : CPE 0.7 (4-5)	255.2	253.6	251.3	253.4	9.79	7.71	7.72	8.41	0.55	0.69	0.65	0.63
<i>Phosphorus (kg P₂O₅/ha)</i>												
20	196.4	193.5	182.7	190.9	11.14	9.39	9.05	9.86	0.42	0.53	0.47	0.47
40	215.0	212.4	213.7	213.7	11.01	9.31	8.91	9.74	0.46	0.58	0.55	0.53
60	230.7	227.6	250.6	236.3	10.70	8.18	8.86	9.25	0.49	0.62	0.65	0.59
80	238.9	240.6	252.2	243.9	10.40	8.16	7.60	8.72	0.51	0.65	0.66	0.61

Figures in parentheses indicate number of irrigation as per treatment

IW : CPE, Irrigation water : cumulative per evaporation

were higher by 15.75 and 5.77%, respectively. Phosphorus application increased the photosynthetic activities and translocation of photosynthates to sink, which resulted higher seed yield. The results are in close conformity with those of Verma and Saxena (1995).

Consumptive use, water-use efficiency and Et:Et₀

Consumptive use of water and Et:Et₀ ratio increased with increasing irrigation regimes. Maximum values of consumptive use of water and Et:Et₀ were registered when crop was irrigated at IW:CPE of 0.7 (4 irrigations), whereas the minimum values were with lower level of irrigation schedule (Table 2). This increase is attributed to more evapotranspiration loss due to better canopy development at increased irrigation regimes. The results are in conformity with the findings of Singh and Singh (1999). Water-use efficiency was higher with minimum level of irrigation (2 irrigations at branching + pod development) and decreased with the increased regimes of irrigation and registered lowest values of water-use efficiency at 4–5 irrigations applied at an IW:CPE ratio of 0.7. This might be due to fact that the increase in yield was not proportionate to the increase in consumptive use of water. The results confirm

the findings of Ahlawat and Sharma (1989).

With the increasing levels of phosphorus, the consumptive use of water and Et:Et₀ ratios were also increased whereas the values of water-use efficiency decreased (Table 2). Similar results were also reported by Singh and Singh (1999).

It was concluded that French bean must be irrigated at branching + flowering + pod-development stages and fertilized with phosphorus at 60 kg P₂O₅/ha for obtaining higher seed yield in Vertisols of south-east Rajasthan.

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