

## Response of French bean (*Phaseolus vulgaris*) to Irrigation Schedules, phosphorus levels and Phosphorus solubilizer in Vertisols

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### ABSTRACT

A field study was carried out during 2003-04, 2004-05 and 2005-06 at Belvatgi in Karnataka, India to study the response of French bean (*Phaseolus vulgaris* L.) to irrigation schedules, phosphorus levels and phosphorus solubiliser application in Vertisols. Different treatment combinations significantly influenced pod yield of French bean during three years and their pooled mean. Scheduling of irrigation at IW/CPE 1.0 produced optimum mean yield of French bean. Application of recommended dose of phosphorus (RDF) (F<sub>1</sub>) and 75% RDP + phosphorus solublizing bacteria (F<sub>3</sub>) remained comparable and produced at par French bean pod yield. Mean value of consumptive use of water was maximum at IW/CPE of 1.2 and minimum at IW/CPE of 0.6.

**Key words:** French bean, irrigation, phosphorus, phosphorus solublizer, yield

### Introduction

French bean is an important leguminous short duration vegetable crop, highly proteinaceous in nature. It is commonly cultivated in northern part of India. Being a leguminous crop, it responds well to phosphorus application <sup>(1)</sup>. As it does not grow well in moisture deficient areas, assured irrigation is a pre-requisite for its successful cultivation <sup>(2)</sup>. Therefore, the present study was carried out to evaluate the response of French bean to irrigation scheduling, phosphorus levels and phosphorus solubiliser application in Vertisols.

### Materials and Methods

The experiment was conducted during the winter seasons (*rabi*) of 2003-04, 2004-05 and 2005-06 at Belvatgi in Karnataka under the aegis of All India Coordinated Research Project on Water Management. Water Management Research Centre (WMRC), Belvatgi is situated between 15°34'N latitude and 75°21'E longitude having altitude 578 m above MSL in Karnataka.

Soil of the experimental site belongs to fine montmorillonitic isohyperthermic family of Typic Haplusterts in Malaprabha irrigation Command Area. The Malaprabha river water is used for irrigation. The climate of the experimental site is semi-arid with an average annual rainfall of 525 mm. The rainfall is not assured and is unevenly distributed. About 80% rainfall is received during September and October months. April and February experience minimum temperature.

Soils of the study area was ealcareous having pH 8.2. Water retention at -33 kPa soil-water suction was 0.41 cm<sup>3</sup> cm<sup>-3</sup> and at -1500 kPa, it was 0.21 cm<sup>3</sup> cm<sup>-3</sup>. The soil had very high initial infiltration rate (8cm/hr), which upon wetting and closure of cracks reduced to 0.25cm/h. In general, the pH decreased with depth and the soluble salt concentration increased with depth. Calcium was the dominant cations on the exchange complex followed by magnesium. In lower horizons, exchangeable Na<sup>+</sup> was more than 15% in some low-lying areas.

The experiment was conducted during the winter seasons (*rabi*) of 2003-04, 2004-05 and 2005-06. The experiment was laid-out in a split plot design having four moisture regimes ( $I_1 = 1.2$ ,  $I_2 = 1.0$ ,  $I_3 = 0.8$  and  $I_4 = 0.6$  IW/CPE) and four phosphorus levels and PSB combination ( $F_1$  - Recommended dose of phosphorus, RDP,  $F_2$  - RDP + phosphorus solubilizing bacteria PSB,  $F_3$  - 75% RDP + PSB and  $F_4$  - 50% RDP + PSB) with three replications. Recommended dose of phosphorus was 40 kg  $P_2O_5$ /ha and the PSB was applied @ 500 g/ha.

## Results and Discussion

The seed yield of French bean was significantly influenced by irrigation regimes, phosphorus levels and phosphorus solubilizer in 2003-04, 2004-05 and 2005-06. Highest pod yield of 5.8 t/ha was obtained when the crop was irrigated at IW/CPE 1.0 ( $I_2$ ) and the lowest (4.9

t/ha) was obtained under IW/CPE 0.6. Increase in the yield due to frequent irrigation might be due to increase in cell turgidity, better opening of stomata and finally increasing the partitioning of photosynthates to sink. Similar results were reported by Sushant *et al* (1999).

Application of phosphorus and phosphorus solubilizer significantly increased the seed yield of French bean during 2004-05 and 2005-06, while in 2003-04, the yield did not differ significantly. Among the phosphorus levels, crop receiving nutrition at the recommended level along with phosphorus solubiliser,  $F_2$  (RDP + PSB) resulted in higher yield (6.4 t/ha). However, application of RDP ( $F_1$ ) and 75% RDP + PSB ( $F_3$ ) remained on-par with each other. Phosphorus application might have increased the photosynthetic activities and translocation of photosynthates to sink, which might be resulted in higher seed yield. These results are in agreement with the findings of Verma and Saxena (1995) and Meso *et al* (2004).

**Table 1.** Effect of irrigation schedules, phosphorus levels and phosphorus solubilizer on French bean pod yield

Irrigation schedules IW/CPE	Phosphorus levels	French bean pod yield (t/ha)			
		2003-04	2004-05	2005-06	Pooled
$I_1$ (1.2)	RDP	5.29	5.27	5.07	5.21
	RDP + PSB	6.18	6.65	6.76	6.53
	75% RDP + PSB	5.11	5.35	4.95	5.14
	50% RDP + PSB	4.17	4.53	4.46	4.38
	Mean (t/ha)	5.19	5.45	5.31	5.32
$I_2$ (1.0)	RDP	5.51	5.64	5.66	5.60
	RDP + PSB	7.27	7.47	7.18	7.31
	75% RDP + PSB	5.44	5.43	5.64	5.50
	50% RDP + PSB	4.69	4.88	4.96	4.84
	Mean (t/ha)	5.72	5.86	5.86	5.81
$I_3$ (0.8)	RDP	5.07	5.20	5.26	5.17
	RDP + PSB	5.87	6.00	5.85	5.91
	75% RDP + PSB	5.05	5.16	5.35	5.18
	50% RDP + PSB	4.39	4.60	4.55	4.51
	Mean (t/ha)	5.09	5.24	5.35	5.19
$I_4$ (0.6)	RDP	4.79	5.02	4.94	4.42
	RDP + PSB	5.61	5.77	5.87	5.75
	75% RDP + PSB	4.76	5.02	5.08	4.95
	50% RDP + PSB	3.37	3.77	3.85	3.66
	Mean (t/ha)	3.37	3.77	4.93	4.82
CD <sub>(0.05)</sub>	Irrigation	0.54	0.33	0.23	0.11
	Phosphorus	0.22	0.45	0.26	0.11
	Interaction	0.44	NS	0.49	0.21

Interaction of irrigation in and phosphorus levels also proved significant with highest yield of 7.3 t/ha at I<sub>1</sub>F<sub>2</sub> level (1.0 IW/CPE and RDP + PSB). A reduction in both water/ irrigation supply and crop nutrition below recommended dose significantly reduced the crop yield.

### *Consumptive Use and Water-use Efficiency*

Consumptive use of water increased with a frequency of irrigation. Maximum value of consumptive use of water was registered when crop was irrigated at IW/CPE 1.2, while the minimum value was recorded with the least irrigation. This increase is attributed to more evapotranspiration loss due to better canopy development under frequent irrigation regimes. The results are in confirmation with the findings of (4). Water-use efficiency was higher with minimum level of irrigation and decreased with frequency regimes of irrigation and registered the lowest value of water-use efficiency at IW/CPE 1.2. 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 also increased, but the value of water-use efficiency decreased. Similar results are reported by Singh and Singh (1999).

Tomar *et al.* (2001) observed that the 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 of 0.5 and 0.7 in terms of seed yield. Tomar *et al.* (2001) further reported that the application of phosphorus influenced seed yield significantly up to 60 kg P<sub>2</sub>O<sub>5</sub>/ha. Mean values of consumptive use of water and Et:Et<sub>0</sub> were maximum at IW: CPE of 0.7, whereas water-use efficiency was minimum at this scheduling of irrigation. Consumptive use of water and Et:Et<sub>0</sub> increased with the increasing levels of phosphorus up to 80 kg P<sub>2</sub>O<sub>5</sub>/ha, whereas WUE was the maximum at lowest level (20 kg P<sub>2</sub>O<sub>5</sub>/ha).

**Table 2.** Effect of irrigation schedules, phosphorus levels and phosphorus solubilizer on consumptive use of French bean

Irrigation schedules IW/CPE	Phosphorus levels	Consumptive use (mm)			
		2003-04	2004-05	2005-06	Pooled
I <sub>1</sub> (1.2)	RDP	472	229	296	332
	RDP + PSB	480	233	327	347
	75% RDP + PSB	475	230	288	331
	50% RDP + PSB	469	228	344	347
	Mean (mm)	474	230	314	339
I <sub>2</sub> (1.0)	RDP	412	244	309	322
	RDP + PSB	420	241	298	320
	75% RDP + PSB	415	244	320	326
	50% RDP + PSB	409	247	318	325
	Mean (mm)	414	244	311	323
I <sub>3</sub> (0.8)	RDP	352	203	257	271
	RDP + PSB	360	200	252	271
	75% RDP + PSB	355	205	272	277
	50% RDP + PSB	349	199	254	267
	Mean (mm)	354	202	259	272
I <sub>4</sub> (0.6)	RDP	292	191	232	238
	RDP + PSB	300	188	238	242
	75% RDP + PSB	295	187	237	240
	50% RDP + PSB	289	186	241	239
	Mean (mm)	294	188	237	240

**Table 3.** Effect of irrigation schedules, phosphorus levels and phosphorus solublizer on water-use efficiency in French bean

Irrigation schedules IW/CPE	Phosphorus levels	Water-use efficiency (kg/ha-mm)			
		2003-04	2004-05	2005-06	Pooled
I <sub>1</sub> (1.2)	RDP	11.2	23.0	17.1	17.1
	RDP + PSB	12.9	28.5	20.7	20.7
	75% RDP + PSB	10.8	23.3	17.2	17.1
	50% RDP + PSB	8.9	19.8	14.4	14.3
	Mean (kg/ha-mm)	10.9	23.6	17.3	17.2
I <sub>2</sub> (1.0)	RDP	13.4	23.1	18.3	18.2
	RDP + PSB	17.3	30.9	24.1	24.1
	75% RDP + PSB	13.1	22.2	17.6	17.6
	50% RDP + PSB	11.5	19.7	15.6	15.6
	Mean (kg/ha-mm)	13.8	29.0	18.9	20.5
I <sub>3</sub> (0.8)	RDP	14.4	25.6	20.5	20.1
	RDP + PSB	16.3	30.0	23.2	23.1
	75% RDP + PSB	14.2	25.2	19.7	19.7
	50% RDP + PSB	12.6	23.1	17.9	17.8
	Mean (kg/ha-mm)	14.4	25.9	20.3	20.2
I <sub>4</sub> (0.6)	RDP	16.4	26.2	21.3	21.3
	RDP + PSB	18.7	30.6	24.7	24.6
	75% RDP + PSB	16.1	26.8	21.5	24.4
	50% RDP + PSB	11.7	20.2	16.0	15.9
	Mean (kg/ha-mm)	15.7	26.0	20.8	20.8

Based on the results of the present study it can be concluded that French bean must be irrigated at IW/CPE 1.0 and phosphorus nutrition may be provided at recommended dose along with phosphorus solublizer for obtaining higher seed yield in Vertisols.

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