

Effect of moisture regimes and fertility levels on growth and yield of French bean, *Phaseolus vulgaris* under late sown condition

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ABSTRACT

A field experiment was conducted during the winter season of 1999-00 and 2000-01 at Kumarganj, Faizabad to study the effect of moisture regimes and fertility levels on growth and yield of French bean, *Phaseolus vulgaris* under late sown condition. Moisture regimes at 0.9 IW/CPE ratio was significantly better than other moisture regimes in terms of yield attributes and yield. However water use efficiency was lowest at 0.7 IW/CPE ratio. Fertilizer application of 150 kg N + FYM @ 5 tons/ha resulted in higher grain yield. Both irrigation and fertilizers improved the growth and yield parameters markedly.

Keywords: French bean; moisture regimes; fertility levels

INTRODUCTION

French bean is one of the precious and highly relished pulses of northern India. It is commonly used as cooked vegetable and is rich in protein, carbohydrates, vitamin A and minerals. French bean is very inefficient in biological nitrogen fixation owing to poor nodulation. It requires relatively higher dose of fertilizer N for enhanced productivity. Application of 90-120 kg N/ha has been found optimum for it (Nandan and Prasad 1998, Saxena and Verma 1995). French bean is the most responsive pulse

crop for irrigation due to its shallow root system and high nutrient requirement. Multi-location study showed that French bean needs 2-3 irrigations in NEPZ for achieving higher productivity. Irrigation at 25 days stage is the most critical. As regards irrigation schedule on climatological basis 0.6-0.8 IW/CPE ratio was found to be optimal (Shiv Dhar and Singh 1995). In view of this present experiment was conducted to assess the effect of moisture regimes and fertility levels on the performance of French bean under late sown condition.

MATERIAL and METHODS

The experiment was carried out at Agronomy Research Farm, Narendra Deva University of Agriculture and Technology, Kumarganj, Faizabad during winter season of 1999-00 and 2000-01. The soil of the experimental field was silt loam in texture with pH 7.4 having organic carbon 0.4 per cent, available N 19, P 14.5 and K 250 kg/ha. Eighteen treatment combinations consisting of three moisture regimes (irrigations at 0.5, 0.7 and 0.9 IE/CPE ratio) and six fertility levels (50 kg N with 5 tons FYM, 100 kg N with 5 tons FYM, 150 kg N with 5 tons FYM, 50 kg N without FYM, 100 kg N without FYM and 150 kg N/ha without FYM) were laid out in randomized block design with three replications. French bean variety PDR-14 was sown in lines in first week of December during both the years. The spacing adopted between row to row and plant to plant was 30 and 10 cm respectively. Other agronomic practices were adopted uniformly as per the recommendation of the crop.

RESULTS and DISCUSSION

Growth attributes: Various growth attributes viz plant height, number of branches, dry matter production, days taken to maturity and root growth (length, volume and weight) were greatly influenced by moisture regimes and fertility levels (Table 1). Plant height increased significantly with increasing levels of moisture over its lower

regimes. At harvest stage the tallest plant (54.0 cm) was recorded with 0.9 IW/CPE which was significantly taller than those under 0.5 and 0.7 IW/CPE ratios. Among the fertility levels 150 kg N with 5 tons FYM produced significantly taller plant (49.6 cm) than other treatments. The minimum plant height was recorded with lowest fertility level (50 kg N without FYM).

Every successive increase in moisture regime increased the number of primary and secondary branches significantly at harvest stage. The maximum primary (8.1) and secondary branches (7.4) per plant were recorded under moisture regime of 0.9 IW/CPE ratio. 150 kg N with 5 tons FYM being at par with 150 kg N/ha without FYM produced significantly higher number of primary and secondary branches/plant as compared to other treatments. Dry matter production/plant increased significantly with every increase in moisture regimes. It was noticed maximum at 0.9 IE/CPE ratio. Different fertility levels induced considerable increase in dry matter accumulation per plant at the harvest. 150 kg N with 5 tons FYM, 100 kg N with 5 tons FYM and 150 kg N without FYM being at par with each other produced significantly higher dry matter over other treatments.

There was a progressive delay in the maturity of the crop with the increasing number of irrigations. The crop grown at

0.9 IW/CPE ratio took maximum days (125.5) to mature. Increasing dose of nitrogen with and without FYM enhanced the maturity period of the crop. Application of highest dose of N (150 kg/ha) with and without FYM being at par with each other took maximum days to mature as compared to grown under lower dose of N with and without FYM. The lowest moisture regime of 0.5 IW/CPE resulted in significantly higher length of root than that obtained under 0.7 and 0.9 IW/CPE ratios. Different fertility levels influenced the root length significantly. The maximum root length was noticed under 150 kg N with 5 tons FYM which was at par with 150 kg N without FYM but significantly higher than other levels of fertility.

Different moisture regimes influenced the volume of root significantly at 100 DAS. The volume of root increased significantly with increasing levels of moisture regime from 0.5 to 0.9 IW/CPE ratio. Increasing levels of fertility also increased the volume of root. Moisture regimes influenced the dry weight of root significantly. It increased with increase in moisture regimes from 0.5 to 0.7 IW/CPE ratio. Increasing fertility levels from 50 to 150 kg N with and without FYM increased the dry weight of roots.

Yield attributes: A perusal of the data (Table 2) obviously show the differences in number of pods per plant between successive levels of moisture regimes. The

number of pods per plant was recorded significantly higher under the moisture regime of 0.9 IW/CPE than that recorded under lower moisture regimes. The differences in number of pods due to successive levels of fertility were also significant. Increasing levels of irrigation increased the pod length significantly upto 0.7 IW/CPE ratio. Pod length also increased with increasing levels of fertility. Test weight (1000-seed weight) was not affected by moisture regimes. However increasing fertility levels increased the test weight.

Seed yield: Moisture regimes had significant impact on seed yield of French bean. Increasing moisture supply from 0.5 to 0.9 IW/CPE significantly increased the seed yield. The maximum seed yield of 22.64 q/ha was credited under the moisture regime of 0.9 IW/CPE followed by 0.7 IW/CPE and it was recorded minimum at 0.5 IW/CPE (driest regime). Wettest moisture regime (0.9 IW/CPE) where four irrigations were given registered an increase of 61.25 and 34.84 per cent. Different fertility levels influenced the seed yield of French bean significantly. Highest seed yield (20.68 q/ha) was recorded under the application of 150 kg N + FYM 5 tons/ha which was at par with 150 kg N without FYM and 100 kg N/ha with 5 tons FYM but significantly higher than other fertility levels.

Moisture depletion pattern: Total depletion of moisture increased with

Table 1. Growth attributes of French bean (mean of two seasons' data) as influenced by moisture regimes and fertility levels

Treatment	Plant height (cm)	Branches/plant		Dry matter/ plant (g)	Days to maturity	Root length (cm)	Root volume cm ³ /plant	Root weight g/plant
		Primary	Secondary					
Moisture regime (IW/CPE ratio)								
0.5	41.9	5.6	4.3	33.70	118.5	24.97	5.36	1.66
0.7	48.8	6.9	6.4	39.48	123.7	23.82	5.83	1.90
0.9	54.0	8.1	7.4	43.47	125.5	22.68	6.51	2.18
CD _{0.05}	2.52	0.41	0.53	0.91	3.05	0.97	0.38	0.18
Fertility level (kg/ha)								
50 kg N with FYM 5 tons/ha	39.3	5.8	4.9	33.30	120.1	21.45	4.63	1.46
100 kg N with FYM 5 tons/ha	48.4	7.3	6.4	42.56	124.4	24.71	6.37	2.12
150 kg N with FYM 5 tons/ha	49.6	8.0	7.2	43.05	125.2	26.47	7.58	2.51
50 kg N without FYM	38.7	5.3	4.8	33.22	119.0	20.49	4.27	1.26
100 kg N without FYM	44.5	7.0	5.9	38.50	122.0	23.62	5.82	1.86
150 kg N without FYM	48.8	7.8	6.9	42.65	124.0	26.15	6.73	2.27
CD _{0.05}	3.57	0.58	0.79	1.29	4.32	1.38	0.54	0.26

Table 2. Yield attributes, seed yield, consumptive use of water (CUW) and water use efficiency (WUE) of French bean (mean of 2 seasons' data) as influenced by moisture regimes and fertility levels

Treatment	# pods/plant	Pod length (cm)	Test weight (g)	Seed yield (q/ha)	CUW (mm)	WUE (kg/mm/ha)
Moisture regime (IW/CPE ratio)						
0.5	7.9	9.0	426.61	14.40	19.32	72.67
0.7	9.7	10.9	419.90	16.79	23.84	70.43
0.9	15.1	10.4	419.22	22.64	27.77	81.53
CD _{0.05}	0.56	0.49	N.S.	0.87	-	-
Fertility level (kg/ha)						
50 kg N with FYM 5 tons/ha	8.3	9.1	409.31	14.19	20.64	68.75
100 kg N with FYM 5 tons/ha	12.3	10.0	429.99	19.69	25.51	77.19
150 kg N with FYM 5 tons/ha	12.6	10.4	425.07	20.68	26.42	78.27
50 kg N without FYM	8.0	8.9	408.71	13.89	20.12	68.86
100 kg N without FYM	11.8	9.6	414.04	18.31	23.53	77.82
150 kg N without FYM	12.5	10.3	430.82	20.19	25.57	78.96
CD _{0.05}	0.79	0.69	18.64	1.22	-	-

Table 3. Soil moisture depletion pattern (cm) as influenced by moisture regimes and fertility levels

Treatment	Depth of soil (cm)			Total moisture depletion (cm)
	0-15	15-30	30-45	45-60
Moisture regime (IW/CPE ratio)				
0.5	5.51 (35.76)	4.20 (27.26)	3.06 (19.85)	2.64 (17.13)
0.7	7.91 (40.79)	6.39 (32.96)	2.79 (14.39)	2.30 (11.86)
0.9	9.52 (42.69)	7.67 (34.39)	2.95 (13.23)	2.16 (9.69)
Fertility level (kg/ha)				
50 kg N with FYM 5 tons/ha	5.85 (39.69)	4.55 (30.87)	2.39 (16.21)	1.95 (13.23)
100 kg N with FYM 5 tons/ha	7.42 (38.89)	5.83 (30.56)	3.18 (16.67)	2.65 (13.89)
150 kg N with FYM 5 tons/ha	7.61 (38.42)	6.01 (30.35)	3.38 (17.07)	2.80 (14.14)
50 kg N without FYM	4.74 (37.86)	4.15 (33.15)	2.24 (17.89)	1.39 (11.10)
100 kg N without FYM	6.88 (39.38)	5.41 (30.86)	2.85 (16.31)	2.33 (13.44)
150 kg N without FYM	7.50 (40.04)	5.83 (31.13)	3.28 (17.51)	2.12 (11.32)

increasing levels of moisture and it was maximum under 0.9 IW/CPE (Table 3). As the crop received more irrigation under 0.9 and 0.7 IW/CPE it utilized comparatively more moisture from upper two layers (0-15 and 15-30 cm) than lower ones. However the depletion from deeper layers decreased with increasing levels of irrigation. The contribution of two deeper layers (30-45 and 45-60 cm) were found in the decreasing order of 19.86 and 17.13 per cent under 0.5 IW/CPE (driest regime) 14.39 and 11.86 per cent under 0.7 IW/CPE and 13.23 and 9.69 per cent under wettest moisture regime of 0.9 IW/CPE. The maximum moisture depletion of 22.30 cm was noticed under 0.9 IW/CPE while it was minimum (15.41 cm) under 0.5 IW/CPE. Treatments with lower IW/CPE ratios accounting less number of irrigations resulted in more contribution of water from lower layers whereas higher IW/CPE ratios having more irrigations contributed more from upper layers.

Application of fertility levels also influenced the moisture depletion considerably from different depths of soil viz 0-15, 15-30, 30-45 and 45-60 cm. Total moisture depleted (19.80 cm) at 150 kg N with FYM 5 tons/ha which was 7.28, 2.33, 5.06, 1.07 and 0.72 cm more than that of 50 kg N, 100 kg N, 50 kg N with FYM 5 tons, 150 kg N and 100 kg N with FYM 5 tons/ha respectively. The application of N up to 100 kg with FYM 5 tons /ha increased the moisture extraction from 30-

90 cm soil profile due to better growth and development of roots in these layers.

Consumptive use of water: Consumptive use of water increased with increasing levels of moisture regimes. The maximum and minimum consumptive use of water was recorded under the wettest and driest moisture regime respectively. The wettest moisture regimes (0.9 IW/CPE) recorded a consumptive use of 27.77 cm which registered an increase of 8.45 and 3.93 cm over 0.5 and 0.7 IW/CPE respectively. Consumptive use of water increased markedly with increasing fertility levels. Application of 150 kg N with FYM 5 tons/ha resulted into the highest consumption of water (26.42 cm) while it was minimum (20.17 cm) under 50 kg N/ha.

Water use efficiency (WUE): Water use efficiency markedly increased with increasing levels of moisture up to 0.9 IW/CPE. The maximum water use efficiency of 81.53 kg/ha/cm was noted under 0.9 IW/CPE which was 11.10 and 8.86 kg/ha/cm higher than those obtained under 0.7 and 0.5 IW/CPE respectively. Higher water use efficiency in these treatments might be due to production of relatively higher grain yield with minimum water use. The results confirm the findings of Ahlawat and Sharma (1989).

Fertility levels markedly increased the water use efficiency. Increasing fertility levels increased the water use efficiency up

to 150 kg N/ha only and reduced at 150 kg N with FYM 5 tons/ha. Water use efficiency increased with increasing levels of N up to 100 kg/ha with and without FYM. It might be due to increased yield at higher levels of nitrogen. Hegde and Srinivas (1989) also reported similar results. Irrigation applied at 0.9 IW/CPE and fertility levels 150 kg N/ha recorded the higher water use efficiency of 83.87 kg/ha/cm. The minimum water use efficiency (62.55 Kg/ha/cm) was recorded at 0.5 IW/CPE with 50 kg N/ha. It may be concluded that French bean variety PDR-14 irrigated at 0.9 IW/CPE ratio alongwith 100 kg N with 5 tons FYM/ha may give higher yield.

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