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PHYSIOLOGICAL VARIATIONS IN FRENCH BEAN (*PHASEOLUS VULGARIS*) CULTIVARS AS AFFECTED BY PLANT DENSITY AND NITROGEN

R. DHANJAL, OM PRAKASH AND I.P.S. AHLAWAT*

Department of Agronomy, Chaudhary Charan Singh University, Baraut, U.P.–250 611

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SUMMARY

The result of a field experiment conducted during 1996-97 and 1997-98 revealed that variety PDR 14 had more dry weight, leaf area index, relative growth rate, crop growth rate and seed yield. Varieties HUR 87 and VL 63 being at par also recorded significantly higher net assimilation rate. Leaf area index and crop growth rate were higher at higher plant density (500 x 10^3 plants ha^{-1}), whereas dry weight $plant^{-1}$, net assimilation rate and relative growth rate in general were higher at lower plant density (250 x 10^3 plants ha^{-1}). Increasing levels of N fertilizer up to 120 kg ha^{-1} increased dry weight, leaf area index, crop growth rate and relative growth rate, but net assimilation rate increased up to 60 kg N ha^{-1} only.

Key words: **Dry matter, french bean, net assimilation rate, nitrogen, plant density.**

INTRODUCTION

Climate has always been the most important factor governing the crop production. To get the maximum production a suitable variety specific for the region has to be identified. Traditionally french bean is cultivated in the hilly areas as a *kharif* crop due to its requirement of a cool and long growing season. However, it has become possible to introduce it as a non-traditional *rabi* (winter) crop in northern plains because of the development of photoinsensitive varieties suited to these conditions. Further, this crop is a poor nodulator or does not nodulate with native *Rhizobia*. Consequently, heavy dose of nitrogen is required to meet the needs of the crop and exploiting its yield potential. Besides nitrogen, plant density is one of the basic inputs in crop production and varies considerably depending upon genotypic characteristics and planting season (Ali 1989). One of the reasons of low average yields could be the adoption of improper planting geometry. Hence there is a need to optimize the use of production resources by selecting better variety and manipulating agronomic practices. Since yield depends on interactions of many physiological processes, growth analysis is an important tool in identifying the causes for yield variations.

MATERIALS AND METHODS

An experiment was conducted at Baraut during 1996-97 and 1997-98 on a sandy loam soil containing low available N (232 kg ha^{-1}), medium available P (13 kg ha^{-1}) and K (260 kg ha^{-1}) with pH 7.5. The treatments consisted of 3 varieties (HUR 87, PDR 14 and VL 63) and 3 planting densities (500 x 10^3, 333 x 10^3 and 250 x 10^3 plants ha^{-1}) as main plots, and 3 N levels (0, 60 and 120 kg ha^{-1}) as sub-plots replicated thrice in a split plot design. The plant densities were maintained by adopting the spacing pattern of 20 x 10 cm, 30 x 10 cm and 40 x 10 cm respectively. During both the years, crop was sown in the last week of October and irrigated thrice at 25, 75 and 100 days after sowing (DAS). Plant sampling for dry matter and leaf area were done at 30 days interval till harvest commencing from 30 days after sowing of the crop and growth parameters were computed.

*Corresponding author's address: Division of Agronomy, IARI, New Delhi - 110012.

RESULTS AND DISCUSSION

Variety PDR 14 had higher dry matter than VL 63 and HUR 87. This might be due to genetic nature of the variety (Sreelatha *et al.* 1997, Ali and Tripathi 1988). Leaf area index was low in the beginning (30 DAS) and reached the peak by 60 DAS followed by a sharp decline towards harvest. PDR 14 also recorded higher leaf area index at all successive growth stages, VL 63 and HUR 87 being next in order. The reduction of leaf area index at harvest was due to leaf shedding. The increase in net assimilation rate between 60-90 DAS was due to less leaf area expansion at this stage (Wallace and Munger, 1965). Varieties HUR 87 and VL 63 being at par showed higher net assimilation rate than PDR 14 in 1996-97. All the varieties were, however, at par in net assimilation rate between 60-90 DAS in 1997-98. The seed yield showed significant variations among the varieties, PDR 14 recorded the highest yield. The higher seed yield in PDR 14 might be attributed to higher values of yield attributes. The highest relative growth rate was recorded during early stage of the crop growth and this rate decreased steadily with advancement in age of the crop. Sreelatha *et al.* (1997) also observed similar behaviour in respect of relative growth rate in french bean. Relative growth rate exhibited considerable variation among the varieties during different growth stages during both the years. The cumulative effect of these variations was reflected in the yield level of different varieties under the investigation. Crop growth rate between 90 days and at harvest was higher in PDR 14. Crop growth rate was slow at the early vegetative phase and reached a maximum between 60 and 90 days after sowing followed by sharp decline towards harvest. The decrease in crop growth rate at later stages might be due to abscission of older leaves, which were not accounted in total dry weight. Similar observation was also made by Rao and Singh (1986).

Table 1. Dry matter, leaf area index and seed yield of french bean as affected by variety, plant density and nitrogen fertilizer

Treatment	Total dry matter (g plant^{-1})		Seed yield (q ha^{-1})		Leaf area index 30 DAS		Leaf area index 60 DAS		Leaf area index 90 DAS	
	1996-97	1997-98	1996-97	1997-98	1996-97	1997-98	1996-97	1997-98	1996-97	1997-98
Variety										
HUR 87	10.57	9.64	6.48	4.71	0.45	0.54	1.29	1.41	0.84	0.93
PDR 14	11.86	11.72	11.14	9.60	0.55	0.68	1.61	1.82	0.96	1.18
VL 63	11.29	10.65	6.69	4.99	0.49	0.57	1.40	1.57	0.86	1.01
CD (P=0.05)	0.69	0.62	0.46	0.40	0.036	0.030	0.082	0.078	0.049	0.053
Plant density (x 10^3 plants ha^{-1})										
500	9.33	9.09	7.60	6.00	0.70	0.82	1.75	2.06	1.13	1.34
333	11.21	10.55	8.63	6.90	0.48	0.56	1.42	1.52	0.87	0.99
250	13.18	12.36	8.07	6.40	0.31	0.40	1.14	1.22	0.67	0.79
CD (P=0.05)	0.69	0.62	0.46	0.40	0.036	0.030	0.082	0.078	0.049	0.053
Nitrogen (kg ha^{-1})										
0	8.45	7.83	6.52	4.98	0.48	0.57	1.28	1.38	0.79	0.91
60	11.88	11.28	8.30	6.55	0.50	0.59	1.46	1.64	0.91	1.07
120	13.38	12.90	9.49	7.78	0.51	0.63	1.57	1.77	0.97	1.15
CD (P=0.05)	0.58	0.56	0.048	0.39	NS	0.039	0.071	0.078	0.052	0.054

DAS=Days after sowing

Table 2. Net assimilation rate, relative growth rate and crop growth rate of french bean as influenced by variety, plant density and nitrogen fertilizer

Treatment	Net assimilation rate ($g\ dm^{-2}\ day^{-1}$)				Relative growth rate ($g\ g^{-1}\ day^{-1}$)						Crop growth rate ($g\ m^{-2}\ day^{-1}$)					
	30-60 DAS		60-90 DAS		30-60 DAS		60-90 DAS		90 - harvest		30-60 DAS		60-90 DAS		90 - harvest	
	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2
Variety																
HUR 87	0.0401	0.0369	0.0598	0.0490	0.0522	0.0565	0.0301	0.0299	0.0051	0.0051	3.11	3.07	5.73	5.24	1.65	1.50
PDR 14	0.0396	0.0325	0.0526	0.0466	0.0508	0.0510	0.0282	0.0302	0.0057	0.0057	3.69	3.46	6.06	6.31	2.01	1.92
VL 63	0.0414	0.0341	0.0571	0.0491	0.0494	0.0488	0.0292	0.0297	0.0054	0.0054	3.41	3.14	5.91	5.71	1.85	1.73
CD (P=0.05)	NS	0.0023	0.0033	NS	0.0028	0.0030	0.0019	NS	0.0003	0.0003	0.17	0.15	NS	0.33	0.11	0.10
Plant density (x 10^3 plants ha^{-1})																
500	0.0344	0.0306	0.0521	0.0448	0.0457	0.0480	0.0283	0.0295	0.0054	0.0052	4.39	4.22	7.65	7.62	2.36	2.34
333	0.0402	0.0341	0.0548	0.0471	0.0506	0.0510	0.0295	0.0297	0.0056	0.0054	3.20	3.06	5.57	5.37	1.80	1.59
250	0.0465	0.0388	0.0625	0.0528	0.0561	0.0571	0.0296	0.0307	0.0053	0.0056	2.62	2.39	4.48	4.27	1.35	1.22
CD (P=0.05)	0.0022	0.0023	0.0033	0.0030	0.0028	0.0030	NS	NS	NS	0.0003	0.17	0.15	0.36	0.33	0.11	0.10
Nitrogen (kg ha^{-1})																
0	0.0262	0.0229	0.0527	0.0442	0.0384	0.0397	0.0325	0.0335	0.0046	0.0049	1.98	1.83	4.87	4.58	1.16	1.14
60	0.0433	0.0376	0.0574	0.0491	0.0545	0.0554	0.0285	0.0286	0.0054	0.0055	3.71	3.55	6.20	6.04	1.96	1.82
120	0.0516	0.0430	0.0594	0.0514	0.0593	0.0611	0.0264	0.0277	0.0062	0.0058	4.52	4.29	6.63	6.64	2.39	2.20
CD (P=0.05)	0.0025	0.0020	0.0036	0.0032	0.0027	0.0029	0.0017	0.0016	0.0003	0.0003	0.18	0.16	0.37	0.32	0.10	0.10

DAS = Days after sowing; Y_1= 1996-97 and Y_2= 1997-98

Total dry matter accumulation plant^{-1} decreased at higher plant population because of the increased competition for the resource utilization (Ramachandra Rao *et al.* 1995). Leaf area index increased with increasing plant densities at all the stages. The net assimilation rate indicating the net photosynthetic efficiency of leaf was higher at lower plant density. Similarly, an increase in plant density brought about a decrease in relative growth rate. The higher plant density of 500x 10^3 plants ha^{-1} recorded 39.0-39.7% and 74.0-82.2% higher crop growth rate over 333 x 10^3 and 250x 10^3 plants ha^{-1} respectively (Table 2). The yield data showed that plant density of 333x 10^3 plants ha^{-1} recorded 7.2-14.2% higher yield over 500x 10^3 and 250x 10^3 plants ha^{-1} and appeared optimum from yield point of view. Ali and Tripathi (1988) also recorded similar observation.

Dry matter production increased with increasing doses of N up to 120 kg ha^{-1}. The higher leaf area with greater photosynthetic activity together resulted in increased dry matter accumulation at later stages of crop growth at higher level of nitrogen. The highest net assimilation rate was recorded with 120 kg N ha^{-1} between 60 and 90 days afer sowing in 1996-97. This could be attributed to higher photosynthetic activity from increased photosynthetic surface (mean LAI, 1.67). The relative growth rate is a complex physiological parameter and treatment differences in relative growth rate might be due to its interaction with leaf area, total dry matter and net assimilation rate (Wallace and Munger 1965). Crop growth rate was significantly affected by N fertilization at all the stages. Response of N at all the growth stages could be attributed to its basic requirement for plant growth and development. Seed yield was higher with application of 120 kg N ha^{-1}, which could be ascribed to higher values of yield attributes at this level of N. These results are in conformity with those of Ali and Tripathi (1988).

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