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Nutrient- and plant-population management in summer greengram (*Phaseolus radiatus*)

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ABSTRACT

A field experiment was carried out during 1989 and 1990 to study the response of summer greengram (*Phaseolus radiatus* L.) to *Rhizobium* inoculation, plant population and different levels of phosporus. *Rhizobium* inoculation delayed 50% flowering, whereas it increased the plant height, number of primary branches/plant, leaf-area index, net assimilation rate, dry-matter accumulation and ultimately seed yield. Among different row spacings (20, 30 and 40 cm), 30 cm exhibited its superiority to 20 and 40 cm. All the growth characters were increased significantly with the increasing levels of phosphorus up to 40 kg P_2O_5/ha. Flowering was delayed with increasing levels of row spacing and phosphorus.

Presence of efficient and specific strain of *Rhizobium* in the rhizosphere is one of the most important requirements for proper growth and establishment of grain legume plants (Subba Rao and Tilak, 1977). Changes in plant density within a certain range cause marked changes in yield components without influencing the yield. Phosphorus is also needed by nodule bacteria which ultimately affects the nitrogen fixation in leguminous crops (Balguravaiah, 1989). Keeping these in view an experiment was conducted to assess the effect of *Rhizobium* inoculation, plant population levels and different levels of phosphorus on growth characters and yield of greengram (*Phaseolus radiatus* L.).

MATERIALS AND METHODS

An experiment was conducted during 1989 and 1990 at Faizabad. The soil of the experimental field was sandy loam having available N 210 kg/ha, available P_2O_5 18.4 kg/ha and available K_2O 220 kg/ha, with pH 8.1. Experiment was laid out in split-plot design. The treatments of inoculation (*Rhizobium* inoculated and uninoculated), row spacings (20, 30 and 40 cm) and phosphorus levels (0, 20, 40 and 60 kg P_2O_5/ha) were assigned to the plots alloting inoculation and row spacing in the main plot and phosphorus levels in subplot, replicated to 3 times with 24 treatment combinations. Plant-to-plant spacing was 10 cm common for all treatments. Crop was sown on 17 and 20 March in 1989 and 1990 respectively. The basal dose of 18 kg N/ha was given to all the treatments. The variety 'Pusa Baiskhi' was used in the experiment during both the seasons. During the crop season,

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71.6 mm and 17.2 mm rainfall was recorded in 1989 and 1990 respectively.

RESULTS AND DISCUSSION

Rhizobium inoculation increased plant height, number of primary branches/plant and leaf-area index (LAI) (Table 1). Maximum LAI was noticed at 60 days after sowing (DAS). It was owing to higher light-absorption and photosynthetic activities at this stage (Yadav, 1985). Average increment in LAI due to *Rhizobium* inoculation was 7.0%.

Maximum net-assimilation rate (NAR) was noticed at 30–45 days interval, whereas minimum at 60–70 days interval. The higher NAR was associated with *Rhizobium* inoculation. The magnitude of NAR declines as plant advanced to maturity (Eagle, 1969).

On an average the dry matter produced at 30-day stage was 14.0% (Table 2) to its total production at harvest. At 45-day stage more than 3 times dry matter was accumulated compared with that at 30-day stage, whereas at 60-day stage it was nearly 2 times more than that at 45-day stage. *Rhizobium* inoculation increased the dry-matter accumulation significantly at all the growth stages during both the seasons. On an average inoculated seeds increased the dry matter by 12, 10, 10 and 10.5% at 30-, 45-, 60-day and harvest stages respectively over uninoculated seeds. The average rate of dry-matter accumulation was 15.2 kg/ha/day from 0–30 days, 63.5 kg/ha/day from 30–45 days, 102 kg/ha/day from 45–60 days and 57.5 kg/ha/day from 60–70 days crop.

Rhizobium inoculation increased the seed yield over uninoculated plots by 15%. The higher number of pods/plant (13.68), number of seeds/pod (6.41) and test weight (37.64 g) were the major attributes governing the yield.

Row spacing

The increment in plant height due to 40 cm-row spacing over 20 cm was 17.5%. The spacings of 30 and 40 cm were at par, but lower number of primary branches/plant were observed at 20 cm row spacing. This is because of less space available for the plant development, which resulted in less number of primary branches at this spacing. Maximum LAI was noticed with 30 cm row spacing, followed by 20 and 40 cm row spacings. With the increasing row spacing from 20 to 30 cm, LAI increased but it decreased at 40 cm row spacing. It is because of better growth and higher number of leaves under 30 cm row spacing than at 20 and 40 cm. The plants at 20 cm row spacing flowered earlier (1.3 day) than 40 cm owing to lesser accumulation of dry matter at vegetative phase. Among different row spacings the 40 cm showed maximum NAR, followed by 30 cm and 20 cm at 30–45 days interval. It is because of higher dry-matter accumulation and LAI, which ultimately resulted in higher NAR.

Highest dry-matter accumulation (40.63 and 38.9 q/ha) at harvest was maintained by 30 cm row spacing during both the seasons. Maximum number of seeds per pod (6.95), pods/plant (13.90) and test weight (38.3 g) were recorded at 40 cm row spacing. Highest seed yield (94.6 and 7.46 q/ha) was recorded under 30 cm row spacing in 1989 and 1990 respectively. Higher LAI, NAR, dry-matter accumulation, and developmental attributes at 30 cm row spacing contributed higher seed yield. Although per plant performance was better at 40 cm row spacing, the yield per ha was significantly higher at 30 cm row spacing owing to more number

Table 1. Plant height, number of primary branches, leaf-area index (LAI) and yield attributes of greengram as influenced by inoculation, row spacing and phosphorus

Treatment	Plant height at harvest (cm)		Primary branches/plant		LAI (60 DAS)		Seeds/ pod		Pods/ plant		Test weight (g)	
	1989	1990	1989	1990	1989	1990	1989	1990	1989	1990	1989	1990
Inoculation												
Inoculated (I_1)	31.45	30.16	4.02	3.77	1.99	1.91	6.41	6.08	13.68	11.83	37.64	34.87
Uninoculated (I_2)	29.43	28.21	3.75	3.56	1.87	1.78	6.09	5.15	13.00	10.48	36.91	34.11
CD (P = 0.05)	0.57	0.26	0.11	0.13	0.04	0.06	0.18	0.29	0.33	0.31	0.44	NS
Row spacing												
20 cm (S_1)	27.22	26.47	2.88	2.74	1.93	1.89	5.05	4.50	12.18	8.65	36.19	33.20
30 cm (S_2)	31.92	30.08	4.38	4 40	2.24	2.09	6.75	5.93	13.94	12.13	37.34	34.13
40 cm (S_3)	32.17	31.00	4.00	4.22	1.63	1.55	6.95	6.41	13.90	12.69	38.30	36.14
CD (P = 0.05)	0.74	0.32	0.13	0.18	0.060	0.060	0.22	0.36	0.40	0.38	0.53	1.76
P_2O_5 (kg/ha)												
0 (P_1)	28.30	26.91	3.36	3.22	1.87	1.74	5.90	5.17	12.65	10.02	35.78	33.67
20 (P_2)	29.33	28.08	3.79	3.46	1.92	1.84	6.10	5.48	13.02	10.52	37.02	34.10
40 (P_3)	32.00	30.80	4.10	3.96	1.96	1.88	6.50	5.90	13.80	11.97	38.02	35.13
60 (P_4)	32.13	30.95	4.26	4.02	1.98	1.90	6.50	5.90	13.88	12.10	38.28	35.03
CD (P = 0.05)	0.43	0.39	0.14	0.14	0.04	0.04	0.20	0.16	0.40	0.32	0.54	0.82

DAS, Days after sowing

Table 2. Days taken to 50% flower, dry matter accumulation and grain yield of greengram as influenced by different treatments

Treatment	Days taken to 50% flower		Dry matter (q/ha) at								Grain yield (q/ha)	
			30 DAS		45 DAS		60 DAS		At harvest			
	1989	1990	1989	1990	1989	1990	1989	1990	1989	1990	1989	1990
Inoculation												
Inoculated	42.75	42.22	4.93	4.51	14.61	13.37	30.60	27.23	36.04	33.33	8.64	6.44
Uninoculated	41.94	41.33	4.30	4.09	12.99	12.19	27.57	24.88	32.47	30.32	7.73	5.99
CD (P = 0.05)	0.49	0.38	0.09	0.11	0.49	0.22	0.58	0.42	0.58	0.78	0.31	0.18
Row spacing												
20 cm	41.58	40.83	4.60	4.38	12.82	12.05	27.64	23.95	32.26	28.70	8.01	6.09
30 cm	42.75	42.12	5.31	5.07	16.63	15.63	34.86	32.22	40.63	38.90	9.46	7.46
40 cm	42.71	42.38	3.93	3.45	11.94	10.65	24.81	22.00	29.86	27.88	7.09	5.10
CD (P = 0.05)	0.60	0.47	0.09	0.13	0.60	0.20	0.71	0.53	0.71	0.96	0.40	0.22
P_2O_5 (kg/ha)												
0	41.06	41.22	4.04	3.85	12.30	11.41	26.33	23.33	31.05	28.60	7.45	5.54
20	42.00	41.61	4.30	4.15	13.12	12.25	27.98	25.07	32.96	30.77	7.93	5.95
40	43.11	42.11	5.00	4.56	14.85	13.63	30.97	27.72	36.47	33.47	8.55	6.63
60	43.22	42.16	5.11	4.64	14.93	13.82	31.13	28.12	36.53	34.49	8.80	6.73
CD (P = 0.05)	0.52	0.36	0.13	0.10	0.71	0.24	0.58	0.50	0.65	1.09	0.26	0.14

DAS, Days after sowing

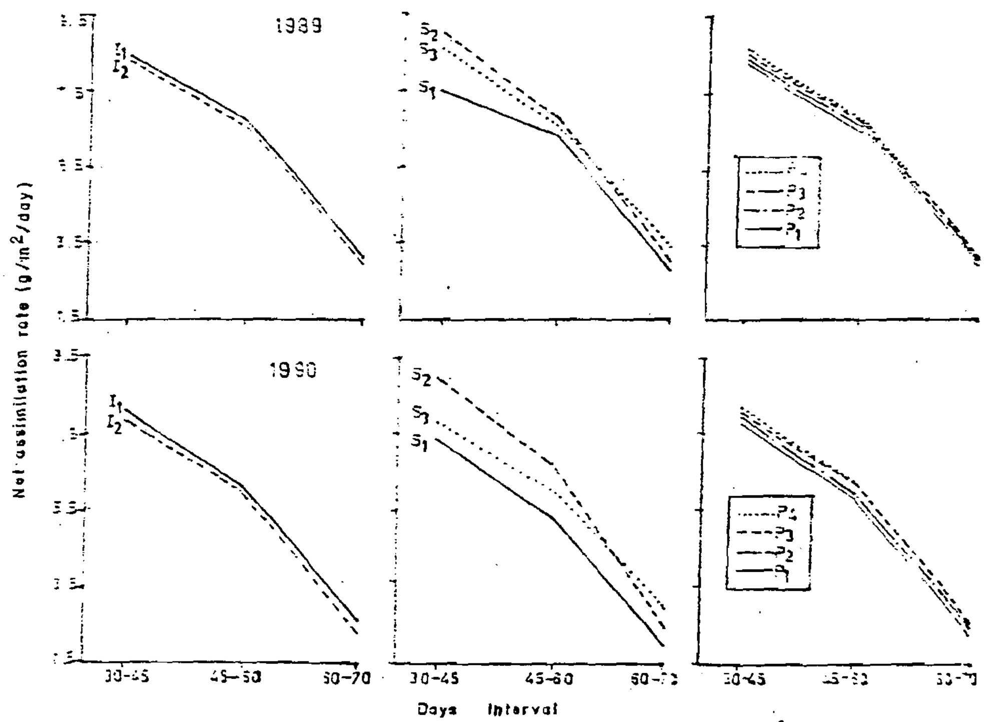

Fig. 1. Net assimilation rate in greengram as influenced by different levels of rhizobium inoculation, plant population and phosphorus levels during the 2 seasons

of plants per unit area. However, further decrease in row spacing (20 cm) resulted in sharp decline in the grain yield.

Effect of P

The plant height with 40 kg P_2O_5/ha increased from 28.3 to 32.00 cm and 26.91 to 30.80 cm from unfertilized control during first and second seasons respectively. Increasing levels of P_2O_5 increased the number of primary branches/plant. LAI, NAR and dry-matter accumulations increased significantly up to 40 kg P_2O_5/ha. Application of P increased nodulation owing to better root growth, by which N uptake in plant was increased. As a result the increase in N uptake increases nucleic acid, amides and amino acids and hence cell multiplication which increases LAI (Borde *et al.*, 1983). Earliest flowering was noticed at zero level of phosphorus, followed by 20 and 40 kg P_2O_5/ha, owing to lesser dry-matter accumulation at vegetative phase.

Application of phosphorus increased the vigour of the plant resulting in more dry-matter production. Yield attributes such as number of seeds/pod, number of pods/plant and test weight increased significantly up to 40 kg P_2O_5/ha. A linear increase in grain yield was recorded as the levels of phosphorus increases, indicating that highest yield was obtained with 60 kg P_2O_5/ha. However, grain yield increased significantly up to 40 kg P_2O_5/ha.

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