

Nodulation and rooting pattern of summer greengram (*Phaseolus radiatus*) as influenced by irrigation variables

GAJENDRA PAL AND BANARASI LAL

Department of Agronomy, Govind Ballabh Pant University of Agriculture and Technology,
Pantnagar, Uttar Pradesh 263 145

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An experiment was conducted with greengram (*Phaseolus radiatus* L.) during spring seasons of 1985 and 1986 at Pantnagar. The soil of the experimental site was silty clay loam, having pH 7.4, organic carbon content 1.14%, available P 35.7 kg/ha and available K 297.1 kg/ha in 0-30 cm-soil depth. The treatments consisting of 4 greengram cultivars ('Pusa Baisakhi', 'PS 16', 'Pant Mung 1' and 'Pant Mung 2') in main plots and 5 irrigation schedules [no post-sowing irrigation, single irrigation at 25 days after sowing, irrigation at 20, 15 and 10 cm cumulative pan evaporation (CPE) values] in subplots were laid out in split-plot design, with 4 replications.

The crop was sown on 26 March 1985 and 15 March 1986 in rows, 30 cm apart. Plant spacing within the rows was maintained at 7.5 cm by thinning. The crop was harvested on 20 June during both the seasons. It received a basal dose of 150 kg diammonium phosphate/ha. Numbers of irrigation needed were 3, 4 and 6 under 20, 15 and 10 cm CPE treatments respectively, in 1985, and 2, 3 and 3 irrigations in 1986. The total rainfall received during the crop season was 11.1 cm in 1985 and 23.1 cm in 1986.

For study of root and nodulation, 3 continuous plants were selected and a soil

core (with 22.5 cm × 20.0 cm cross-section and 20 cm depth) was dug for this purpose at 45- and 60 day- stages. The acetylene reduction assay for nitrogenase activity (N_2 ase), modified method of Hardy *et al.* (1973), was used to determine the nitrogenase activity in the excised roots with intact nodules.

Number and dry weight of nodules/plant differed significantly due to cultivars only at 60 days after sowing during both the years (Table 1). Gupta (1982) reported that 'K 851' variety of greengram had maximum number of nodules, though the difference among genotypes were not significant. Cultivar effects with respect to root-dry weight/plant were significant only at 45-day stage when root-dry weight was highest in 'PS 16' (0.19 g) in 1985 and 'Pant Mung 12' (0.12 g) in 1986.

An increase in the nodule number, nodule and root-dry weight was obtained with improvement in moisture supply over no post-sowing irrigation treatment, being maximum under irrigation at 10 cm CPE (Table 1). Reduced carbohydrate supply from top due to suppressed growth under water stress possibly affected the root growth adversely and decreased the nodule number and nodule-dry weight. Root-dry weight was also lowest under no post-sowing

Table 1. Nodule number, nodule and root-dry weight/plant and specific nitrogenase activity of greengram as affected by cultivars and irrigation schedules

Treatment	Nodules/ plant				Nodule-dry weight(mg)/plant				Root-dry weight(g)/plant				Specific nitrogenase activity (μ moles C_2H_4 nodule weight/hr)			
	1985		1986		1985		1986		1985		1986		1985		1986	
	45 DAS	60 DAS	45 DAS	60 DAS	45 DAS	60 DAS	45 DAS	60 DAS	45 DAS	60 DAS	45 DAS	60 DAS	45 DAS	60 DAS	45 DAS	60 DAS
<i>Cultivars</i>																
'Pusa Baisakhi'	12.6	9.0	13.4	12.6	15.6	10.4	13.7	12.3	0.17	0.32	0.11	0.36	97.0	41.0	87.0	38.4
'PS 16'	12.4	14.9	11.6	15.0	21.0	14.1	17.3	13.4	0.19	0.36	0.09	0.42	105.0	54.2	94.6	52.6
'Pant Mung 1'	10.2	10.9	11.3	12.3	12.3	10.0	12.4	11.0	0.14	0.38	0.12	0.43	96.6	54.2	97.2	52.0
'Pant Mung 2'	12.2	12.2	12.9	13.0	16.5	12.6	14.7	13.1	0.18	0.35	0.09	0.37	96.8	56.2	97.0	58.0
CD (P=0.05)	NS	3.5	NS	NS	NS	2.8	NS	NS	0.03	NS	0.02	NS				
<i>Irrigation schedule</i>																
No post-sowing irrigation	8.3	6.9	8.0	8.9	10.4	6.1	9.2	6.4	0.13	0.27	0.08	0.32	81.5	43.5	76.8	40.3
Single irrigation at 25 DAS	9.4	10.0	11.5	11.9	12.9	9.4	12.5	10.5	0.16	0.34	0.10	0.38	91.8	49.5	91.0	48.5
Irrigation at 20 cm CPE	12.7	12.3	12.8	12.2	14.4	12.4	14.3	12.0	0.17	0.36	0.10	0.40	100.5	51.5	94.5	52.3
Irrigation at 15 cm CPE	13.3	14.2	12.8	13.2	17.5	13.3	15.5	13.3	0.18	0.36	0.11	0.40	107.6	55.6	97.0	53.3
Irrigation at 10 cm CPE	15.7	15.2	16.4	19.9	26.6	17.7	21.3	20.1	0.22	0.42	0.13	0.48	113.5	57.5	110.5	57.0
CD (P=0.05)	2.3	3.0	3.5	4.7	5.1	2.6	4.5	5.0	0.03	0.05	0.02	0.03				

DAS, Days after sowing; CPE, cumulative pan evaporation

irrigation treatment. The roots under such a situation have a tendency to penetrate deep into the soil in search of water. Development of thin and fibrous root under water stress causes lesser root-dry weight.

Specific nitrogenase activity was higher at 45 days after sowing, coinciding with flowering, than at 60 days after sowing (pod-development stage) in all cultivars (Table 1). At 45 days after sowing specific nitrogenase activity was the highest in 'PS 16' in 1985 and in 'Pant Mung 2' in 1986. Das (1982) reported the specific nitrogenase activity of root nodules of greengram plant was maximum at 30 days after sowing, i.e. just when flowering began. At later stages of crop growth, activity of root nodules decreased due to degeneration of nodules and decline in transfer of carbohydrates to roots.

Specific nitrogenase activity increased with improvement in moisture supply, being maximum under 10 mm CPE treatment

where moisture was not as limiting factor. Sprint (1972) suggested that water stress might affect nodule activity directly which may be aggravated by reduced supply of photosynthates from wilted leaves.

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Effect of phosphate-solubilizing bacteria at different levels of phosphate on blackgram (*Phaseolus mungo*)

SURENDRA S. TOMAR, M. A. PATHAN, K. P. GUPTA¹ AND U. R. KHANDKAR

College of Agriculture, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Mandsaur, Madhya Pradesh 458 001

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Phosphate-solubilizing bacteria, as medium enriched with readily available inoculant in root-zone at crop plants, partly carbon source, are important in phosphate solubilize the insoluble phosphate in liquid cycle in nature, improve the fertilizer-use

¹Present address: College of Agriculture, Gwalior, Madhya Pradesh 473 002