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Effect of plant and row spacing on dryland gram (*Cicer arietinum*) yield, nodulation and water-use efficiency

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ABSTRACT

A field experiment was conducted from 1986–87 to 1988–89 with dryland gram or chickpea (*Cicer arietinum* L.) to find out effect of inter- and intra-row spacings on yield, nodulation and water-use efficiency. The chickpea was seeded during winter season of 1986–89 on sandy soil at Kharagpur in row spacings of 20, 35 and 50 cm and within row spacings of 10, 15 and 20 cm. The yields were least from the 20 cm row width. However intra-row spacings had no significant effect on seed yield. Under adequate water supply wider rows did not show any yield advantage over narrow rows. Wider row spacings helped in increasing the dry weight of nodule/plant.

Soil water depletion was generally confined to 80 cm soil depth. The water use was not significantly influenced by plant spacing, however it was more with 20 cm spacing. Water-use efficiency was minimum for 20 cm row spacing. Results on water-use indicated that close planting enhanced water use before flowering. This increased early-season water utilization under restricted water supply created less water available for grain filling, and ultimately seed yield was reduced significantly.

The effect of narrow spacing has often been explained by the fact that the close canopy that results may intercept a larger percentage of the solar radiation, thereby increasing photosynthesis and reducing soil evaporation losses (Petal *et al.*, 1985). The question of water availability and water-use rate, as affected by planting geometry, becomes of more significance to gram (*Cicer arietinum* L.) production under rainfed conditions. In such conditions, water availability may assume greater importance than availability of solar radiation in limiting the growth of most crops. The present investigation was undertaken to study the effect of inter- and intra-row spacings on the performance of rainfed gram.

MATERIALS AND METHODS

A field experiment was conducted at Kharagpur in randomized block with 3 replications. The experimental soil was a sandy clay loam of pH 7.4, containing 0.045% total N, and 8 and 200 kg/ha of available P and K respectively. The soil-moisture content on gravimetric basis at field capacity (1/3 bar) and wilting point (15 bars) was 19.24 and 6.9% (by weight) respectively. The bulk density in the upper profile ranged from 1.44 to 1.46 g/cm^3. Treatments consisted of 2 crop geometries comprised each 3 inter (20, 35 and 50 cm)- and intra-row spacings

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(10, 15 and 20 cm).

Chickpea cv. 235 was sown on 6, 11 and 4 November in 1986, 1987 and 1988 respectively. Pre-sowing irrigation of 60 mm was given 6–7 days before sowing to all the plots to ensure uniform germination. A basal dose of nitrogen, phosphorus and potassium @ 20 kg N, 40 kg P_2O_5 and 30 kg K_2O/ha was applied in all the plots at the time of sowing. The total rainfall during the crop season in 1986–87, 1987–88 and 1988–89 was 9.4, 9.8 and 17.6 cm respectively. The N content of the nodules, seed and stover was determined by the microkjeldahls method. Soil-water content was determined with gravimetric sampling from midway between the 2 rows, and soil water was measured approximately monthly in 30 cm depth increment to the 120 cm soil depth. The total water use was calculated by subtracting current soil content from water content at earlier sampling date, and adding precipitation during that period. Run-off and deep percolation were negligible. Water-use efficiency (WUE) was determined by dividing seed yield by respective value for total water use.

RESULTS AND DISCUSSION

Effect of inter-row spacing

Among the inter-row spacings the seed yields were least from 20 cm row during all the years (Table 1). The reduction in yield under widest row spacing than the moderate (35 cm) may have been due to lesser plant population compared with moderate spacing. Even the significant increase in yield components with wider spacing of 50 cm failed to compensate for the lower number of plants per unit area. Pods and seeds/plant were significantly reduced by decreasing the inter-row spacing.

Effect of intra-row spacing

Number of pods and seeds/plant were significantly increased with an increase in intra-row spacing from 10 to 20 cm. The fewer pods and seeds/plant indicate that these were dictated primarily by competition with neighbouring plants for available water under restricted water supply. However, seed yield was not significantly influenced by the intra-row spacing (Table 1). The relationship between the seeds/plant and seed yield was significant in all years (r = 0.96,

Table 1. Effect of inter- and intra-row spacings on yield attributes of chickpea

Spacing (cm)	Pods/plant			Grains/plant		
	1986–87	1987–88	1988–89	1986–87	1987–88	1988–89
Inter-row						
20	30.07	32.47	47.07	45.60	49.03	78.27
35	37.67	39.87	56.00	58.60	61.07	92.47
50	41.97	42.73	57.97	60.97	57.83	99.23
CD (P = 0.05)	1.49	1.66	1.77	1.15	1.52	1.94
Intra-row						
10	28.20	29.50	42.93	42.20	42.90	73.33
15	36.13	38.67	56.20	55.10	56.73	92.30
20	45.37	46.90	61.90	67.87	68.30	104.33
CD (P = 0.05)	1.49	1.66	1.77	1.15	1.52	1.94

Table 2. Interaction effect of inter- and intra-row spacings on pods, grains and grain yield (kg/ha) of chickpea

Row spacing (cm)		Pods/plant			Seeds/plant			Grain yield (kg/ha)		
Between	Within	1986–87	1987–88	1988–89	1986–87	1987–88	1988–89	1986–87	1987–88	1988–89
20	10	24.2	26.8	38.2	36.2	38.3	63.2	365	376	945
	15	29.6	32.2	49.4	44.0	49.6	78.4	418	450	970
	20	36.4	38.4	53.6	56.6	59.2	93.2	443	469	995
35	10	28.0	31.4	44.4	45.0	47.4	75.8	610	700	1,005
	15	36.3	39.2	58.2	58.6	60.8	96.2	642	715	1,040
	20	48.7	49.0	65.4	72.2	75.0	105.4	651	735	1,083
50	10	32.4	30.3	46.2	45.4	43.0	81.0	603	595	806
	15	42.5	44.6	61.0	62.7	59.8	102.3	590	575	840
	20	51.0	53.3	66.7	74.8	70.7	114.4	550	542	830
CD (P = 0.05)		2.58	2.88	3.06	1.99	2.64	3.36	2.46	1.89	NS

0.94 and 0.98 in 1986–87, 1987–88 and 1988–89 respectively).

Interaction effect

The interaction of inter- and intra-row spacing had significant effect on seed yield during 1986–87 and 1987–88, whereas in 1988–89 there was no significant effect. Inter-row spacing of 35 cm and intra-row spacing of 20 cm gave significantly higher yield, followed by 35 and 15 cm inter- and inter-row spacing. On the other hand, in 1988–89 interaction effect of inter- and intra-row spacing had no significant effect on the seed yield (Table 2).

Nodulation

In general, the dry weight of nodules/plant increased up to 75th day and thereafter decreased. The dry weight of nodules was significantly more under wider row than narrow rows. However, intra-row spacing had no significant effect on dry weight of nodules (Table 3). In wider spacing, adequate soil moisture was remained for a relatively longer period than the narrow spacing which might have provided congenial condition for efficient nodulation. The N content of nodule was not influenced either by inter- or intra-row spacing.

Table 3. Nodule dry weight (mg/plant) at 75th day of growth stage as influenced by inter- and intra-row spacings

Treatment	1986–87	1987–88	1988–89
Inter-row (cm)			
20	115.90	144.30	202.53
35	230.20	248.70	364.63
50	231.57	247.93	367.87
CD (P = 0.05)	4.72	5.07	5.30
Intra-row (cm)			
10	187.97	208.47	312.73
15	193.23	214.27	308.73
20	196.47	218.20	313.57
CD (P = 0.05)	4.72	5.07	NS

Water use and water-use efficiency

The cumulative water use during each of the 3 growing seasons was greater for 20 cm rows (252, 244 and 295 mm in 1986–87.

1987–88 and 1988–89 respectively) than for the moderate and wider spacings. Soil-water content was lowest for the 20 cm inter-row spacing. This might have resulted from higher plant population and leaf area in the narrow spacing than in the wider spacing.

Water-use efficiency (WUE) was least with 20 cm row spacing in 1986–87 and 1987–88 (16 and 18 kg seed/ha-cm). However, in 1988–89 the WUE was lowest with wider row spacing. The highest WUE of 27, 31 and 57 kg seed/ha-cm was obtained with moderate (35 cm) spacing in 1988–87, 1987–88 and 1988–89 respectively. Reduced WUE under narrow spacing indicates that narrow planting of gram or chickpea is not suitable where the water supply is greatly restricted.

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