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Moisture-use pattern and yield of chickpea (*Cicer arietinum*) in relation to planting date, variety and irrigation

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ABSTRACT

A field experiment was conducted during the winter (*rabi*) seasons of 1985–86 and 1986–87 at Powarkheda, to study the effect of planting date, variety and irrigation on consumptive use and water-use efficiency (WUE) of chickpea (*Cicer arietinum* L.). The consumptive use and water-use efficiency were more, whereas moisture-use rate was less in timely sown crop (26 October–16 November). The consumptive use and moisture-use rate were higher under higher irrigation levels. The consumptive use and water-use efficiency were higher in 'Radhey' variety than in 'Ujjain 21'. Sowing of chickpea between 26 October and 16 November proved the best. Irrigation at an 0.8 irrigation water : cumulative pan-evaporation ratio (3 irrigations, i.e. at 32–35, 55–68 and 103–107 days after sowing), resulted in the highest yield and net return. Yield potential of 'Radhey' was more than that of 'Ujjain 21'. Soil-moisture extraction was maximum between 15 and 30 cm depths.

Planting of chickpea (*Cicer arietinum* L.) usually gets delayed due to several unavoidable reasons, which results in change of irrigation schedule of the crop. It is therefore essential to scrutinize how different varieties interact and utilize the applied irrigation water with these changes and scheduling of irrigation in relation to date of sowing to achieve maximum and economical production.

MATERIALS AND METHODS

The experiment was conducted during the winter (*rabi*) seasons of 1985–86 and 1986–87 at Powarkheda. The experimental soil was deep black Vertisol, having pH 7.6, organic carbon 0.66%, and available N, P_2O_5 and K_2O, 99.0 30.86 and 326.0 kg/ha respectively, with field capacity 34% and wilting point 16%. The total rainfall during the crop season was 70 and 107 mm during 1985–86 and 1986–87 respectively. The treatments comprised 5 dates of sowing (5 and 26 October, 16 November, 7 and 28 December) in combination with 4 irrigation levels [at 0, 0.4, 0.6 and 0.8 irrigation water : cumulative pan-evaporation ratio (IW : CPE), i.e. 0, 1, 2 and 3 irrigations respectively] as the main plot, and 2 varieties ('Ujjain 21' and 'Radhey') as the subplot treatments. These were laid out in split-lot design with 3 replications. The crop was sown by drilling the seed in rows 30 cm apart. One common irrigation was given

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uniformly to all the treatments for proper germination. The irrigation depth was maintained at 75 mm in each irrigation. A basal dose of 20 kg N, 80 kg P_2O_5 and 20 kg K_2O/ha was applied. The crop was harvested between 13 February and 30 March in both the seasons. Soil samples were taken layer-wise up to 60 cm depth at sowing, harvest and before and after each irrigation treatment to determine soil-moisture depletion.

RESULTS AND DISCUSSION

Moisture-use pattern

Consumptive use of water and water-use efficiency were more in timely (26 October–16 November) sown crop than that in early or late-sown crop (Table 1). However, moisture-use rate was less under timely sown crop due to long-crop duration available to the crop as compared to that of late-sown crop. Higher consumptive use of water in timely sown crop was due to effective utilization of better available soil moisture at each stage of crop growth. Water-use efficiency was high in case of timely sown crop due to higher yield.

The consumptive use of water and moisture-use rate increased with an increase in soil-moisture regime because of more availability of water for evapotranspiration. However, the water-use efficiency declined due to more utilization of water without proportionate increase in grain production. Higher consumptive use of water and lower water-use efficiency were recorded in more frequencies of irrigation, as also reported by Shinde *et al.* (1985). The consumptive use of water and water-use efficiency were higher in 'Radhey' than that of 'Ujjain 21', while the reverse was true with moisture-use rate. This was due to variation in yield potential and utilization of available soil moisture.

Soil-moisture depletion

Soil-moisture extraction by roots was recorded maximum (34.63–36.44%) between 15 and 30 cm-soil depth (Table 2). The soil-moisture extraction decreased with an increase in depth of soil, being minimum (12.20–14.31%) at 45–60 cm depth. The crop planted under different dates did not differ much for pattern of soil-moisture extraction.

The soil-moisture extraction was higher (41.33%) under no irrigation than that under irrigated condition (34.32–35.96%). This might be due to higher extraction of soil moisture by the highly expensive plant roots from the deeper layers. Mahey *et al.* (1988) reported deeper development of roots under less availability of soil moisture than higher availability of soil moisture. Singh *et al.* (1980) and Prasad and Singh (1987) also reported that under irrigated conditions, the higher proportion of moisture depletion was from upper soil profile, whereas under unirrigated conditions the higher moisture depletion was from the deeper soil profile. The soil-moisture extraction of different varieties from different soil layers was also different. At 15–30 cm depth both the varieties extracted almost the same amount of moisture. However, from the deeper layers, 'Radhey' extracted more moisture than 'Ujjain 21' (Table 2).

Yield and net return

Straw and grain yields and net profit were maximum when chickpea varieties were planted between 26 October and 16 November (Table 1). This is due to optimum climatic factors. Earlier or late sowing caused drastic reduction in yield and net profit compared with timely sowing 26 October–16 November. Warmer temperature hastens senescence, forces the

Table 1. Moisture-use pattern and yield of chickpea in relation to different planting dates and irrigation scheduling (pooled data of 2 seasons)

Treatment	Consumptive use (mm)	Moisture-use rate (mm/day)	Water-use efficiency (kg/mm/ha)	Straw yield (q/ha)	Grain yield (q/ha)	Harvest index (%)	Net profit (Rs/ha)
Sowing date							
Oct	209	1.60	7.22	24.34	15.11 (17.2–27.0)	30.88	3,663
Oct	238	1.76	7.97	29.24	18.98 (19.5–21.5)	28.63	5,294
Nov	230	1.93	8.37	29.61	19.25 (19.7–21.0)	30.28	5,199
Dec	216	1.98	6.67	20.82	14.41 (18.2–24.7)	29.09	3,338
Dec	210	2.25	5.19	17.30	10.90 (16.7–29.0)	25.58	1,961
CD (P = 0.05)				1.50	1.24	4.14	
*Irrigation (IW : CPE)**							
0.0	132	1.21	8.52	16.11	11.25	30.10	2,418
0.4	184	1.65	8.44	22.35	15.54	30.57	3,766
0.6	225	2.09	6.86	26.69	17.50	28.05	4,542
0.8	310	2.48	6.02	31.69	18.66	27.34	5,014
CD (P = 0.05)				2.09	1.24	2.61	
Variety							
'Ujjain 21'	218	1.94	6.86	22.96	14.96	29.76	3,554
'Radhey'	228	1.85	7.46	25.57	16.50	29.27	4,228
CD (P = 0.05)				2.45	0.74	NS	

Figures in parentheses are mean temperature (°C) at the time of maturity

DAS, Days after sowing

*0.4 IW : CPE, 1 irrigation at 65–77 days after sowing; 0.6 IW : CPE, 2 irrigations — first at 35–46 and second at 70–84 days; 0.8 IW : CPE, 3 irrigations — first at 32–35 days, second at 55–68 days and third at 103–107 days after sowing

Table 2. Soil-moisture extraction under different dates of sowing and levels of irrigation in chickpea (pooled data of 2 seasons)

	Soil-moisture extraction (%) from different soil layers (cm)					
	0–15	15–30	Total	30–45	45–60	Total
Sowing date						
5 Oct	32.22	35.76	67.78	18.30	13.72	32.02
26 Oct	33.27	36.41	69.68	18.12	12.20	30.32
16 Nov	30.76	36.44	67.20	20.00	12.80	32.80
7 Dec	31.71	34.63	66.34	19.35	14.31	33.66
28 Dec	31.88	35.38	67.26	19.57	13.17	32.74
Irrigation (IW : CPE)						
0.0	19.82	41.33	61.15	21.95	16.90	38.85
0.4	31.18	35.96	67.14	18.72	14.14	32.86
0.6	31.82	34.59	66.41	19.20	14.39	33.55
0.8	33.10	34.32	67.42	18.74	13.84	32.58
Variety						
'Ujjain 21'	29.02	37.51	66.53	19.29	14.18	33.47
'Radhey'	27.27	37.17	64.44	20.42	16.13	36.55

maturity and reduces grain yield in chickpea (Hunda and Virmani, 1987; Summerfield *et al.*, 1987).

The higher straw and grain yields (31.69 and 18.66 q/ha) and profit (Rs 5,014/ha) were recorded at irrigation level of 0.8 IW : CPE ratio (3 irrigations, i.e. at 32–35, 55–68 and 103–107 days after sowing) compared with only 16.11 and 11.25 q/ha and Rs 2,418/ha respectively at 0 level of irrigation. This was due to optimum soil-moisture regime at various growth and development stages of the crop. Patel *et al.* (1985) reported significantly higher yield with irrigation at 0.8 IW : CPE ratio than that at 0.3 IW : CPE ratio. 'Radhey' chickpea gave 2.61 and 1.54 q/ha higher straw and grain yields respectively than 'Ujjain 21'. The net return was also higher in 'Radhey'. The results confirm the finding of Yadav *et al.* (1985). Significant decrease in harvest index was under 28 December sowing, which was due to lower grain yield. This parameter was also decreased with the increase of irrigation water which was due to proportionately more increase in straw yield compared with grain yield under these levels of irrigation. The varieties did not show perceptible difference in harvest index.

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