

# INFLUENCE OF SCHEDULING OF IRRIGATIONS ON WATER USE, WATER USE EFFICIENCY AND MOISTURE EXTRACTION PATTERN OF CHICKPEA IN VERTISOLS

S. R. KATAGERI AND M. N. SHEELAVANTAR

College of Agriculture  
University of Agricultural Sciences, Dharwad - 580 005

## ABSTRACT

Under limited water supply scheduling of one irrigation at 45 DAS was found most effective ( $20.2 \text{ q ha}^{-1}$ ) for chickpea (Cv A-1) with maximum water use efficiency ( $6.51 \text{ kg ha}^{-1} \text{ mm}$ ) than scheduling of irrigation either at 30 or 60 DAS on medium black clay loam soil. If water is available for two irrigations, higher yields could be obtained ( $23.7 \text{ q ha}^{-1}$ ) with water use efficiency of  $5.28 \text{ kg ha}^{-1} \text{ mm}$  by scheduling irrigation at 30 and 60 DAS. Under unlimited water supply, maximum yield of chickpea ( $27.0 \text{ q ha}^{-1}$ ) could be obtained by scheduling of irrigation at 30, 45 and 75 DAS with water use efficiency of  $5.27 \text{ kg ha}^{-1} \text{ mm}$ .

Maximum moisture was extracted (31.2%) from deeper layers (61-90 cm) when one irrigation was scheduled at 45 DAS followed by two (29.3%) and three (27.8%) irrigation schedules. As the frequency of irrigation increased from one (35.2%) to three (37.1%), the moisture extracted from top layer (0-30 cm) increased and consequently water use efficiency declined.

## INTRODUCTION

One of the major reasons for low productivity of chickpea is that it is generally cultivated under rainfed conditions on conserved soil moisture or soil moisture left after summer crops. As a consequence, crop experiences progressively increased moisture stress during its life cycle leading to yield reduction. Maximum benefits of irrigation have been obtained when scheduled one at pod development. (Sharma et al. 1974) or two at 45 and 75 days after sowing (Raikhelkar et al. 1977). Saxena and Krishnamurthy (1979) reported 126 per cent increase in chickpea yield when four irrigations were scheduled at 31, 43, 65 and 92 days after sowing in deep black soils. However, detailed information on the consequences of irrigations at different stages of crop growth on water use, water use efficiency and moisture extraction pattern in medium black soils is meagre which is necessary for evolving suitable water management practices under limited water supply situations to derive maximum benefit with limited water supply.

## MATERIAL AND METHODS

A field experiment was conducted at Agricultural College Farm, Dharwad, Karnataka state during the winter season of 1981-82. The experiment was laid out with three replications in split plot design having nine irrigation treatments. Soil of the experimental site was vertisol with pH 7.5. Total nitrogen, available  $P_2O_5$  and  $K_2O$  were 0.051, 0.004 and 0.25 per cent, respectively.

The moisture at field capacity (%), wilting point (%) and bulk density (g/cc) respectively at a depth of 0-30, 31-60 and 61-90 cm were 33.8, 34.76, 34.78, 15.88, 16.76, 16.75; 1.23, 1.35, 1.31.

Seeds of Annigere-1 variety of chickpea were sown in plots of 2x3 m with a spacing of 30x10 cm. A dose of 25 kg N and 50 kg  $P_2O_5$  per ha in the form of urea and superphosphate were applied at the time of sowing. One common irrigation (4.5 cm deep) was applied uniformly to ensure better germination. Depth of water applied at each irrigation was based on deficit in the 0-90 cm soil depth. Measured quantities of irrigation water were applied to make up the soil moisture deficit with the help of Parshall flume with throat size of 7.5 cm. During crop growth period no rainfall was received. Total consumptive use of water was worked out based on soil moisture depletion and moisture left after harvest of the crop.

## RESULTS AND DISCUSSION

### Influence of irrigations on chickpea yield

Among the irrigations scheduled at 30 or 45 or 60 days after sowing (DAS), the irrigation scheduled at 45 DAS was found more beneficial ( $20.01 \text{ qha}^{-1}$ ) giving about 22 per cent higher grain yield over irrigation scheduled either at 30 or 60 DAS (Table-1). Singh et al. (1980) at Hisssar in sandy loam soil and Raghu and Choubey (1983) in Jabalpur on clay loam soil, also noticed the beneficial effect of irrigation at 45 DAS in chickpea. Improvement in grain yield with one irrigation scheduled at 45 DAS was mainly noticed in the increased number of pods (41) and seeds (43) per plant. Grain yield of chickpea was further increased to  $23.0 \text{ per qha}^{-1}$  when two irrigations were scheduled at 30 and 60 DAS, and it was 15 per cent higher than the grain yield realised with only one irrigation at 45 DAS. With two irrigations scheduled at 30 and 60 DAS, there was further improvement in the number of pods or seeds produced per plant and hence the grain yield. Irrigations scheduled either at 45 DAS or at 30 and 60 DAS, might have created favourable soil moisture conditions during branching period and enabled chickpea to produce more fruiting points and pods or/seeds per plant. Yadav (1972) reported beneficial effects of irrigations either

Table 1. Influence of Scheduling of irrigations on chickpea crop.

Protective Irrigation at	Crop duration (days)	Grain yield (q/ha)	Number of pods/plant	Number of seeds/plant	100-seed weight (g)
I <sub>1</sub> 30 days	80.8	16.42	26.07	31.88	18.83
I <sub>2</sub> 45 days	89.2	20.02	41.57	43.48	19.68
I <sub>3</sub> 60 days	97.0	16.47	22.73	23.03	20.84
I <sub>4</sub> 30 & 60 days	88.5	23.07	46.43	48.76	18.99
I <sub>5</sub> 45 & 60 days	97.0	21.95	35.30	36.88	20.02
I <sub>6</sub> 45 & 75 days	96.3	20.30	33.67	35.93	20.54
I <sub>7</sub> 30, 45 & 75 days.	99.5	27.04	46.30	49.73	20.07
I <sub>8</sub> 45, 60 & 75 days	103.0	25.30	54.50	51.67	19.42
I <sub>9</sub> 30, 45, & 60	103.0	27.35	56.40	57.80	19.67
Mean	94.3	21.99	40.28	42.09	19.78
CD 5%	0.53	4.14	12.95	9.03	0.29

Table 2. Influence of scheduling of irrigations on consumptive of use water.

Protective Irrigation at	Consumptive use (mm)			Total Consumptive use (mm)	Mean daily Consumptive use (mm)	Water use efficiency (kg ha <sup>-1</sup> mm)
	0-30 cm	31-60 cm	61-90 cm			
I <sub>1</sub> 30 days	89.6	80.9	78.1	248.6	3.52	5.77
I <sub>2</sub> 45 days	106.8	106.5	94.4	307.7	3.46	6.51
I <sub>3</sub> 60 days	116.1	102.0	105.4	335.5	3.43	4.94
I <sub>4</sub> 30 & 60 days	164.8	145.6	135.4	445.8	5.04	5.18
I <sub>5</sub> 45 & 60 days	174.4	156.4	141.5	472.3	4.87	4.65
I <sub>6</sub> 45 & 75 days	165.0	153.1	121.8	439.9	4.56	4.46
I <sub>7</sub> 30, 45 & 75 days	206.6	174.2	133.2	513.0	5.15	5.27
I <sub>8</sub> 45, 60 & 75 days	186.9	188.7	160.1	535.7	5.19	4.71
I <sub>9</sub> 30 45, 60 & 75 days	239.4	204.0	142.2	585.6	5.69	4.66
Mean	161.1	147.7	126.6	435.4	4.54	5.12

at 45 DAS (Pre-flowering) or at 70 DAS (flowering stage). Grain yield of chickpea was further increased to 27.0 qha<sup>-1</sup> when three irrigations were scheduled at 30, 45 and 75 DAS. Improvement in grain yield with three irrigations (at 30, 45 and 75 DAS) was 35 and 17 per cent higher, respectively over the grain yield recorded under one (45 DAS) and two (30 and 60 DAS) irrigations. Higher grain yields obtained with three irrigations (30, 45 and 75 DAS) was mainly brought by improvement in 100-grain weight (20 g) over two irrigations and 30 and 60 DAS (19.9 g). Improvement in 100-grain weight under three irrigations (30, 60 and 75 DAS) was quite obvious because irrigations applied at 75 DAS provided better soil moisture conditions during pod development and seed filling stage and it might have increased 100-seed weight. However, there was no further response of chickpea to four irrigations scheduled at 30, 45 and 75 DAS.

### Consumptive use of water

Consumptive use of water (Table 2) increased as the frequency of irrigations increased from one (248.6 to 333.5 mm) to two (439.9 to 472.3 mm); two to three (513.0 to 535.7 mm); and three to four (585.6 mm). It is obvious because loss of water through evapotranspiration would be more from well watered plants having high leaf water potential than those having lower leaf water potential under similar evaporation demand (Sinha and Singh 1977). Besides, duration of chickpea was considerably increased as the frequency of irrigations were increased from one (80.8 days) to four (103.0 days) which might have increased the consumptive use of water. There were considerable variations in consumptive use of water under each frequency when applied at different times. Among one, two and three irrigations, scheduled at 45 DAS (307.7 mm), 30 and 60 DAS (445.8 mm) and 30, 45 and 60 DAS (513.0 mm) were respectively found most effective considering water used and grain yield produced. Water use efficiency was maximum ( $6.51 \text{ kg ha}^{-1} \text{ mm}$ ) when one irrigation scheduled at 45 DAS. Singh et al. (1980) also reported maximum water use efficiency when first irrigation was scheduled at 45 DAS. Water use efficiency was reduced when frequency of irrigations were increased to two and three. Among two and three irrigations, irrigation at 30 and 60 DAS ( $5.2 \text{ kg ha}^{-1} \text{ mm}$ ) 30, 45 and 75 DAS ( $5.3 \text{ kg ha}^{-1} \text{ mm}$ ) were respectively found most effective with higher water use efficiency with increase irrigation supply may be attributed higher evaporation and application losses. Raghu and Chaubey (1983) also reported reduced water use efficiencies with increase in water supply. Effectiveness of timing of irrigation depends upon the physiological stage of the crop. Irrigation at 45 DAS has taken care of branching; irrigation at 30 and 60 DAS has taken care of branching and flowering; and irrigation at 30, 45 and 75 DAS has taken care of branching, flowering and seed filling periods and hence the maximum productivity of crop.

### Moisture extraction pattern

Moisture extraction pattern was different with different frequencies of irrigations and their timings as well. On an average, one irrigation extracted more moisture from deeper layer of 61-90 cm (31.2%) when compared to the moisture extracted from same layer with two (29.3%), three (27.8%) and four (24.3%) irrigations. It is obvious because, when moisture was limited by one irrigation, crop forced its roots to extend to the deeper layer and extract moisture for survival. There was no considerable difference in the moisture extracted from 31-60 cm with respect to one (33.6%) and two (33.5%) irrigations. Crop receiving three irrigations extracted more moisture from middle layer of 31-60 cm (34.6%). Maximum percentages of moisture was extracted from top layer of 0-30 cm (40.9%) when four irrigations were given.

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