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Water Use Studies in Onion (*Allium cepa* L.) as Influenced by Irrigation Schedules and Sulphur Nutrition in Alfisols of Northern transitional Tract of Karnataka*

Onion (*Allium cepa* L.) is extensively grown as a cash crop in northern transitional zone of Karnataka and it requires several irrigations at frequent intervals due to its shallow root systems. Narang and Dastane (1969) reported as many as 18 irrigations from transplanting to harvest on sandy loam soils. The pungency in onion is attributed to allyl propyl disulphide which contain 43.6 per cent sulphur. The crop is known to respond well to higher levels of sulphur application (Rajas *et al*., 1993). Its low productivity is mainly due to its cultivation in rainfed condition, can be enhanced to a great extent by successfully growing in *rabi* and summer seasons under irrigated conditions but water for irrigation is a scare resource, therefore water use optimization is fundamental to water resource use. It permits better utilization of all other production factors thus, leading to increased yield per unit area and time. However, information on irrigation scheduling and sulphur requirement of the crop on light soil of Northern Karnataka is limiting. Therefore, the present investigation was undertaken keeping these points in view.

A field experiment was conducted during *rabi* 2002-03 at Saidapur farm, University of Agricultural Sciences, Dharwad . The experiment was laid out in split-plot design with three replications. There were 16 treatment combinations consisting of four irrigation schedules (0.9, 1.1, 1.3 and 1.5 IW/CPE ratio) assigned to main plots and four sulphur levels (0, 20, 40 and 60 kg S ha^{-1}) to sub plots. The soil was red loam with pH 6.93 having field capacity of 20.5 per cent, wilting percentage of 9.1 per cent and bulk density was 1.4 Mg/m^3. Onion cv. Bellary red was sown in 19^{th} November 2002. A uniform fertilizer dose of 125 kg N, 50 kg P_2O_5 and 125 kg K_2O was applied. Scheduling of irrigation was done based on IW/CPE ratio with 50 mm depth of water in each irrigation. Sulphur was applied in the form of elemental sulphur, calculated quantities of sulphur was added to the respective plots. The soil moisture was estimated by gravimetric method in one replication only. The ground water table was below 2 m from soil surface during experimental period. The irrigation water was measured Parshall flume (7.5 cm) consumptive use was computed as suggested by Dastane (1967).

Seasonal consumptive use of water is closely related to the amount of water applied through irrigation and also varies with number of irrigations. Irrigation scheduled at 1.5 IW/CPE ratio recorded higher seasonal consumptive use of water (637 mm) closely followed by 1.3 IW/CPE ratio (601 mm) and 1.1 IW/CPE ratio (567 mm) and the lowest was in 0.9 IW/CPE ratio (541 mm). The highest seasonal consumptive use of water in 1.5 IW/CPE ratio was attributed to higher number of irrigations with 55 cm depth of water application which maintained relatively wet condition in the surface layers resulting in maximum evapotranspiration. Similar results were reported by Rana and Sharma (1994). The lowest seasonal consumptive use of 541 mm was observed in 0.9 IW/CPE ratio which was is due to less availability of soil moisture for evapotranspiration in surface soil owing to least number of irrigations applied to this treatment (Table 1). The sulphur application at 40 kg ha^{-1} recorded highest (606 mm) seasonal consumptive use of water and closely (594 mm) followed by 60 kg S ha^{-1} is attributed to maximum uptake of sulphur in bulb and leaf leading to better growth of crop resulting in maximum evapotranspiration.

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Table 1. Seasonal consumptive use of water and water use efficiency of onion as influenced by irrigation schedules and sulphur levels

Treatments	Sulphur levels									
Irrigation schedules	Seasonal consumptive use of water (mm)					Water use efficiency (kg ha^{-1} mm)				
	S_0	S_1	S_2	S_3	Mean	S_0	S_1	S_2	S_3	Mean
I_1	517	534	576	536	541	20.66	21.66	23.90	23.08	22.33
I_2	545	562	573	588	567	22.30	23.59	27.06	24.66	24.40
I_3	585	590	614	615	601	22.71	25.96	28.72	27.27	26.17
I_4	624	630	661	635	637	25.77	27.31	32.25	33.27	29.65
Mean	568	579	606	594	-	22.86	24.80	27.98	27.07	

Note: I_1 - 0.9 IW/CPE ratio S_0 - 0 kg S ha^{-1}
I_2 - 1.1 IW/CPE ratio S_1 - 20 kg S ha^{-1}
I_3 - 1.3 IW/CPE ratio S_2 - 40 kg S ha^{-1}
I_4 - 1.5 IW/CPE ratio S_3 - 60 kg S ha^{-1}

Irrigation at 1.5 IW/CPE ratio with 40 kg S ha^{-1} recorded the highest (661 mm) seasonal consumptive use of water and was closely (635 mm) followed by 1.5 IW/CPE ratio and 60 kg S ha^{-1} and lowest (517 mm) in 0.9 IW/CPE ratio and no sulphur application treatment.

The highest water use efficiency (29.65 kg ha^{-1} mm) (Table 2) was recorded in 1.5 IW/CPE ratio and closely followed by 1.3 (26.17 kg ha^{-1} mm) and 1.1 IW/CPE ratio (24.40 kg ha^{-1} mm) and the lowest water use efficiency in 0.9 IW/CPE ratio (22.33 kg ha^{-1} mm) (Table 1). Highest water use efficiency in 1.5 IW/CPE ratio can be attributed to relatively more yield increases rather than increase in seasonal consumptive use of water. Lowest water use efficiency in 0.9 IW/CPE ratio was due to relative moisture stress during critical growth period which resulted in reduced bulb yield. These results were in agreement with those of Chopade *et al.* (1998). The sulphur application at 40 kg ha^{-1} recorded the highest water use efficiency (27.98 kg ha^{-1} mm) closely followed by 60 kg S ha^{-1}. This was due to maximum sulphur uptake reflecting in more bulb yield. Irrigations at 1.5 IW/CPE ratio with 40 kg S ha^{-1} recorded the highest water use efficiency closely followed by 1.5 IW/CPE ratio and 60 kg S ha^{-1} treatment combination.

Generally onion crop extracted higher (41.99 per cent) soil moisture from the (Table 3) surface layer (0-15 cm) irrespective of the irrigation schedules followed by 15-30 cm (32.29 per cent) and the least (25.71 per cent) was from 30-45 cm layer. Among the irrigation schedules, 1.5 IW/CPE ratio extracted relatively more soil moisture (42.94 per cent) from the surface (0-15 cm) layer. With decrease in irrigation frequency (0.9 IW/CPE ratio) the lower soil layer (30-45 cm) contributed relatively more moisture (26.32 per cent) than frequently irrigated treatments (1.5 IW/CPE ratio). Generally, sulphur levels had no marked influence on soil moisture extraction from different soil layers. Higher moisture extraction from top 15

Table 2. The soil moisture extraction pattern of onion as influenced by irrigation schedules and sulphur levels

Irrigation schedules	Soil layers (cm)		
	0-15	15-30	30-45
I_1	41.11	32.57	26.32
I_2	41.53	32.41	26.06
I_3	42.40	32.20	25.40
I_4	42.94	32.01	25.05
Mean	41.99	32.29	25.71
Sulphur levels			
S_0	42.07	32.07	25.86
S_1	42.25	32.12	25.63
S_2	42.56	31.82	25.62
S_3	41.72	32.19	26.09
Mean	42.15	32.05	25.80

Note : I_1 - 0.9 IW/CPE ratio S_0 - 0 kg S ha^{-1}
I_2 - 1.1 IW/CPE ratio S_1 - 20 kg S ha^{-1}
I_3 - 1.3 IW/CPE ratio S_2 - 40 kg S ha^{-1}
I_4 - 1.5 IW/CPE ratio S_3 - 60 kg S ha^{-1}

cm layer was attributed to higher concentration of roots in surface layers due to frequent irrigations (1.5 IW/CPE ratio) resulting in relatively higher moisture extraction from surface layer (Rana and Sharma, 1994). Under relatively drier soil moisture regimes (0.9 IW/CPE ratio) higher root density was observed in deeper soil layers. Thus higher seasonal consumptive use of water, water use efficiency and soil moisture extraction pattern were observed in 1.5 IW/CPE ratio.

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