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Response of onion (*Allium cepa* L.) to different levels of irrigation and sulphur in alfisols of northern transitional tract of Karnataka

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ABSTRACT

A field experiment was carried out during *rabi* 2002-03 at Saidapur farm, University of Agricultural Sciences, Dharwad to study the response of onion to different levels of irrigation and sulphur in alfisols. The experiment was laid out in split-plot design with three replications. The treatments comprised of four irrigation schedules (0.9, 1.1, 1.3 and 1.5 IW/CPE ratios) as main plots and four sulphur levels (0, 20, 40 and 60 kg S ha^{-1}) as sub plots. It revaled that 1.5 IW/CPE ratio Irrigation schedules showed significantly higher results for bulb yield (189.29 q ha^{-1}), yield components (like bulb length and bulb diameter) and growth components (*viz.*, Number of leaves, leaf area index, leaf area duration and total dry matter production per plant. Application of 40 kg S ha^{-1} recorded significantly higher bulb yield (170.60 q ha^{-1}) compared to other sulphur levels but was at par with application of 60 kg S ha^{-1}.But significantly higher TSS (12.26 per cent) and pyruvic acid (3.1 µm/g) content in onion bulb were recorded in 60 kg S ha^{-1} compared to other sulphur levels but was at par with 40 kg S ha^{-1}. Irrigation scheduled at 1.5 IW/CPE ratio recorded higher seasonal consumptive use of water (637 mm) and lowest in 0.9 IW/CPE ratio (541 mm). 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}. The highest water use efficiency (29.65 kg ha^{-1} mm) was recorded in 1.5 IW/CPE ratio and closely followed by 1.3 (26.17 kg ha^{-1} mm). 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}.Among irrigation schedules 1.5 IW/CPE ratio extracted relatively more soil moisture (42.94 per cent) from the surface (0-15 cm) layer. Sulphur levels had no marked influence on soil moisture extraction from different soil layers.

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Onion (*Allium cepa* L.) ranks first in area and production among the various vegetable crops grown in India. In Karnataka, onion is being cultivated in about 0.85 lakh hectares. The productivity of onion in the country (10.06 tones per hectare) including Karnataka (6.69 tones per hectare) is very low compared to world average productivity (17.10 tones per hectare). The reasons for low productivity are mainly attributed to improper irrigation scheduling and inadequate supply of nutrients, particularly sulphur. Onion being a succulent crop, its productivity is highly related with irrigation and sulphur (Jana and Kabir,1990). Water being a natural resource input and now a scare and costly input in the production of agricultural crops, has direct influence on the availability of nutrients from the soil. The response of onion to irrigation is a function of season, soil type and genetic make up. Sulphur has been recognized as an important nutrient for higher yield and quality of onion bulbs (Thippeswamy,1993). Pungency in onion is attributed to presence of an alkaloid "Allyl propyl disulphide" which is chief component of sulphur. Therefore, the present experiment was undertaken to find out the study the response of onion to different levels of irrigation and sulphur in alfisols with cv. BELLARY RED in *rabi* season in northern transitional zone of Karnataka.

MATERIALS AND METHODS

A field experiment was conducted during *rabi* 2002-03 at Saidapur Farm, University of Agricultural Sciences, Dharwad (Karnataka). The experiment was laid out in split plot design with three replications. There were 16 treatment combinations consisting of four irrigation levels (0.9, 1.1, 1.3 and 1.5 IW/CPE ratios) assigned to main plots and four sulphur levels (0, 20, 40 and 60 kg S ha^{-1}) to sub plots. The soil was red loamy having 6.93 pH, field capacity of 20.5 per cent, wilting coefficient of 9.1 per cent and bulk density of 1.4 Mg/m^3. Onion cv. BELLARY RED was transplanted on 19th 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 approach with 50 mm depth of water in each irrigation. Sulphur was applied in the form of elemental sulphur. Calculated quantities of sulphur were 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 with using Parshall flume (7.5 cm) and consumptive use was computed as suggested by Dastane (1967).

RESULTS AND DISCUSSION

The results revealed that the significantly higher (Table 1) number of leaves (8.61), leaf area index (2.54), leaf area duration (108.25 days) and total dry matter (5.93 g) per plant were recorded in 1.5 IW/CPE ratio over rest of the irrigation schedules (0.9, 1.1 and 1.3 IW/CPE ratio). This is attributed to greater cell elongation and turgidity owing to adequate moisture availability in the soil. Sharma *et al.* (1994) and Mishra *et al.* (1996) also reported higher growth parameter with irrigation scheduled at 1.5 IW/CPE ratio. The lowest growth parameters were recorded with irrigation scheduled at 0.95 IW/CPE ratio, it might be due to moisture stress in this treatment have adversely affected the cell division and cell enlargement because of reduction in the level of endogenous phyto hormones *viz.,* auxins (Davenport *et al.*, 1980 and Nandi *et al.*, 2002).

Significantly higher number of leaves (8.40), leaf area index (2.44), leaf area duration (101.26 days) and total dry matter production per plant (5.67 g) at harvest were recorded in 40 kg S ha^{-1} over 20 kg and no sulphur application but was at par with 60 kg S ha^{-1}. This is attributed to higher uptake of sulphur in leaf, bulb and total uptake in 40 kg S ha^{-1}. Jana and Kabir (1990) who reported that increase in number of leaves per plant with application of sulphur might be due to its role in the synthesis of chloroplast.

The bulb length (5.18 cm), bulb diameter (6.91 cm), bulb yield (189.26 q ha^{-1}) and B:C ratio(3.58) (Table 1) were recorded in 1.5 IW/CPE ratio over rest of irrigation schedules (0.9, 1.1 and 1.2 IW/CPE ratios). The significant increase in yield components and bulb yield is attributed to adequate moisture in the rhizosphere which did not show any visual stress on various physiological processes resulting in better uptake of nutrients and finally increased plant growth, yield and yield components.

Significantly higher bulb length (4.48 cm),(Table 1) bulb diameter (5.29 cm), weight of 20 bulbs (0.82 kg) and bulb yield (170.6 q ha^{-1}) were recorded in 40 kg S ha^{-1} over rest of sulphur levels (0, 20 kg S ha^{-1}) but was at par with 60 kg S ha^{-1}. This is attributed to higher number

Table 1 : Growth, yield components, yield, quality and B:C of onion as affected by irrigation schedules and sulphur levels

Treatments	Number of leaves per plant	Leaf area index	Leaf area duration (days)	Total dry matter per plant (g)	Bulb length (cm)	Bulb diameter (cm)	Bulb yield (q/ha)	TSS (%)	Pyruvic acid (µm/g)	B:C ratio			
Irrigation schedules										Sulphur levels			
										So	S1	S2	S3
I_1	7.21	2.16	90.89	4.40	3.43	3.62	121.00	11.09	2.12	1.5	1.64	2.06	1.67
I_2	7.63	2.26	94.03	4.59	4.02	4.16	138.56	11.27	2.15	1.83	2.0	2.42	2.11
I_3	7.66	2.32	96.64	4.99	4.33	5.03	157.53	11.32	2.21	2.04	2.40	2.82	2.54
I_4	8.61	2.54	108.25	5.93	5.18	6.91	189.26	11.36	2.23	2.64	2.80	3.58	3.42
S.E.±	0.26	0.05	3.20	0.14	0.01	0.16	4.24	0.27	0.07				
C.D. (P=0.05)	0.75	0.16	10.93	0.48	0.03	0.55	14.66	NS	NS	S.E.±		0.21	
Sulphur levels													
S_0	7.39	2.22	93.59	4.37	3.98	4.48	130.46	9.99	0.51	C.D. (P=0.05)		0.62	
S_1	7.48	2.30	96.43	4.52	4.10	4.72	143.36	10.65	2.07				
S_2	8.40	2.44	101.26	5.67	4.48	5.29	170.60	12.13	3.02				
S_3	7.84	2.36	98.58	5.37	4.40	5.23	161.94	12.26	3.10				
S.E.±	0.23	0.06	1.76	0.16	0.07	0.01	4.95	0.17	0.04				
C.D. (P=0.05)	0.68	0.16	5.18	0.48	0.20	0.03	14.45	0.51	0.11				
Interaction (I x S)													
S.E.±	0.46	0.16	4.41	0.31	0.15	0.23	9.57	0.41	0.09				
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS				

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

of leaves, leaf area index, leaf area duration and total dry matter production in 40 kg S ha^{-1}. These results confirm the earlier results of Kumar and Singh (1995).

Interaction effects between irrigation schedules and sulphur levels were not significant with respect to plant growth, yield and yield components.

Quality of onion *viz.*, pyruvic acid and TSS content in onion bulbs were not significantly influenced by irrigation schedules.Results revealed that significantly higher pyruvic acid (3.10 m mole/g) and TSS (12.26 per cent), content in onion bulbs (Table 1) were observed in 60 kg S ha^{-1} over 20 kg S ha^{-1} and no sulphur application but was at par with 40 kg S ha^{-1}. This is attributed to sulphur application which enrich the bulbs with sulphur which is responsible for increase in synthesis of volatile sulphur compounds and production of more pungency in onion. Stress *et al.* (1978) reported that higher dry matter content in bulb is conductive to higher pungency.

2). 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. 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 1.3 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 closely followed by 1.3 (26.17 kg ha^{-1} mm), 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.) Highest water use efficiency in 1.5 IW/CPE ratio can be attributed to relatively more yield increase rather than increase in

Table 2 : Seasonal consumptive use of water (mm), water use efficiency (kg ha^{-1} mm) and soil moisture extraction pattern (%) of onion as influenced by irrigation schedules and sulphur levels

Treatments	Sulphur levels										Soil moisture extraction pattern (%)						
Irrigation schedules	Seasonal consumptive use of water (mm)					Water use efficiency (kg ha^{-1} mm)					Soil layers (cm)						
	S_0	S_1	S_2	S_3	Mean	S_0	S_1	S_2	S_3	Mean	0-15 cm	15-30 cm	30-45 cm		0-15 cm	15-30 cm	30-45 cm
I_1	517	534	576	536	541	20.66	21.66	23.90	23.08	22.33	41.1	32.5	26.3	S_0	42.0	32.0	25.8
I_2	545	562	573	588	567	22.30	23.59	27.06	24.66	24.40	41.5	32.4	26.0	S_1	42.2	32.1	25.6
I_3	585	590	614	615	601	22.71	25.96	28.72	27.27	26.17	42.4	32.2	25.4	S_2	42.5	31.8	25.6
I_4	624	630	661	635	637	25.77	27.31	32.25	33.27	29.65	42.9	32.0	25.0	S_3	41.7	32.1	26.0
Mean	568	579	606	594	-	22.86	24.80	27.98	27.07	-	41.9	32.2	25.7		42.1	32.0	25.8

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

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 (Table 2) 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 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 5 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 is attributed to less availability of soil moisture for evapotranspiration in surface soil owing to least number of irrigations applied to this treatment (Table

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 are 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 (41.9 per cent) soil moisture from the (Table 2) surface layer (0-15 cm) irrespective of the irrigation schedules followed by 15-30 cm (32.2 per cent) and the least (25.7 per cent) was from 30-45 cm layer. Among the irrigation schedules, 1.5 IW/

CPE ratio extracted relatively (Table 2) more soil moisture (42.9 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 (26.3 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 cm layer was attributed to higher concentration of roots in surface layers (Rana and Sharma, 1994) due to frequent irrigations (1.5 IW/CPE ratio). Under relatively drier soil moisture regimes (0.9 IW/CPE ratio) higher root density was observed in deeper soil layers

Thus scheduling of irrigation at 1.5 IW/CPE ratio and 40 kg S ha^{-1} application was found better for maximum growth, bulb yield, quality of onion bulbs and higher seasonal consumptive use of water, water use efficiency and soil moisture extraction pattern in typical red loamy soils of Northern Transitional Tract of Karnataka.

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