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Effect of saline irrigation water on growth and yields of onion (*Allium cepa* L.) varieties

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Abstract
A pot experiment was conducted at Department of Agricultural Chemistry and Soil Science, College of Agriculture, Junagadh Agricultural University, Junagadh to assess the “Effect Of Saline Irrigation Water On Growth, Nutrients Composition And Yield Of Onion (*Allium Cepa* L.) Varieties” during the winter, season of 2017-18. The pot experiment comprised four levels of salinity *viz*., <2.0, 4.0, 6.0 and 8.0 dS m^{-1} and five different varieties *viz*., V_1- GJWO-3, V_2- GJRO-11, V_3-Talaj red, V_4- Pilli patti and V_5- PWF-131 in Factorial Completely Randomized Design with replicated three times. The experimental result revealed that the growth, yield and yield attribute, quality parameters, bio-chemical parameters, nutrient content and nutrient uptake were significantly influenced by the different varieties of onion. The highest plant height (49.33 cm), fresh straw yield (37.03 g), fresh weight of bulb (39.21 g), volume of bulb (25.67 cm^3), bulb yield (133.33 g/pot) and quality parameters *viz.*, neck thickness and TSS among different tested varieties of onion.

Keywords: Saline irrigation, onion *Allium Cepa* L.

Introduction
Onion (*Allium cepa* L.) is one of the most important commercial vegetable crop cultivated extensively in India and it belongs to family Alliaceae. Onion is considered to be the second most important vegetable crop grown in the world after tomato. It is most widely grown and popular vegetable crop among the alliums as well as cash crops. Approximately, 170 countries grow onion for its own domestic use and it is also involved in international trade. It is estimated that over 9.2 million acers of onion are harvested annually around the world (National Onion Association, 2011) [17]. Onion is a hardy bulbous plant. It’s an annual for bulb production and biennial for seed production. It is short duration crop.

According to Vavilov (1951) [22], the primary centre of origin lies in Central Asia. The Near East and Mediterranean is the secondary centre of origin. India is the second largest producer and third largest exporter of onion in the world. In India, onion is grown over an area of 12.03 lakh hectares with a production of 194.01 lakh tonnes (Anon., 2015) [3]. In Gujarat, Onion is cultivated on an area of about 53,200 ha. with a production of 1514.1 thousand tons and productivity of 14.2 t ha^{-1}. (Indian Horticulture Database, 2011) [11].

Onion water requirement varies depending on location and irrigation system (Al-Jamal *et al*., 2000) [1]. Olalla *et al.* (2004) [18] reported that the water requirements in Albacette (Spain) for optimum yield (75 t ha^{-1}) were 662 mm of water when using drip irrigation. The period most sensitive to lack of soil water is bulb growth (Kadayifci *et al*., 2005) [12]. Some studies give clear proof that the water requirements for onions are very high, restricting expansion to regions with limited water resources (Bandyopadhyay *et al*., 2003; Rajput and Patel, 2006; Kumar *et al*., 2007) [4, 19, 13]. The length of the period of germination might be an important determinant of the effective salt tolerance of onion, since the faster the radical emerges, the faster the seedlings will escape the high salinity of the upper soil layer (De Malach *et al*., 1989) [8]. Onion is more affected by salinity than other vegetables (Brewster, 1997). Onion is classified as being salt sensitive (Mangal *et al*., 1989) [15] and has 1–2 dS m^{-1} electrical conductivity (EC) threshold (Mass and Hofman, 1977) [16].

The extend of saline area in Gujarat is about 12.18 lakh ha. Soil salinity adversely affects plant growth and development. Worldwide, about one-third of irrigated arable land is already affected and that level is still rising (Lazof and Bernstein, 1999) [14] by salinity.

An excess of soluble salts in the soil leads to osmotic stress, which results in specific ion toxicity and ionic imbalances and the consequences of these can be plant demise (Rout and Shaw, 2001) [20]. Increasing crop salt tolerance is a highly attractive approach to overcoming the salinity threat. The need to explore and select salt-tolerant genotypes within a species in comparison to relatively salt-sensitive ones through conventional selection and breeding techniques.

Materials and Methods

The soil used for the experiment was silty clayey in texture and alkaline in reaction with pH 8.0, EC 0.58 dS m^{-1}, $CaCO_3$ 31.05% and CEC 36.2 cmol (p^+) kg^{-1}. The soil was medium in available nitrogen (242 kg ha^{-1}), medium in available phosphorus (34.20 kg ha^{-1}), high in available potassium (298 kg ha^{-1}) and high in available sulphur (23.50 mg kg^{-1}). Micro nutrient status was medium in available iron (6.25 mg kg^{-1}), low in available zinc (0.45 mg kg^{-1}), high in available manganese (15.20 mg kg^{-1}) and high in available copper (1.25 mg kg^{-1}). Experiment was laid out in Factorial Completely Randomization Design (FCRD) with three replications. The experiment consists of 20 treatments combinations comprising all possible combinations of four levels of salinity *viz*; S_1 - <2 dS m^{-1}, S_2 - 4 dS m^{-1}, S_3 – 6 dS m^{-1}, S_4 - 8 dS m^{-1} and five varieties *viz*; V_1- GJWO-3, V_2- GJRO-11, V_3-Talaj red, V_4- Pilli patti and V_5- PWF-131. The required quantity of N @ 20 kg ha^{-1} and P_2O_5 @ 40 kg ha^{-1} applied to all the pots as basal dose in the form of urea and DAP, respectively. A week after germination five plants per each pot were maintained under normal practices. When crop required irrigation, the pots were uniformly irrigated with saline water as per treatments throughout the growing season. The crop was grown to maturity and observations on plant height, fresh straw weight, bulb diameter, fresh weight of bulb, volume of bulb, bulb fresh and dry yield were recorded.

Result and Discussion

Effect on growth parameters

Growth parameters like on plant height and volume of bulb were significantly influenced by different level of salinity on different varieties of onion crop, while no. of leaves per plant and bulb diameter found non-significant. (Table-1). The value of plant height, fresh and dry weight of bulb, volume of bulb decrease with the increase in salinity level. highest plant height (44.73 cm), Bulb dry weight (3.57 g), Bulb fresh weight (33.77 g) and volume of bulb (22.55 cm^3) were recorded under application of <2 dS m^{-1} (S_1) salinity level. Higher value of plant height (34.57 cm), fresh (25.05 g) and dry (2.75 g) weight of bulb, volume of bulb (17.48 cm^3) were registered with the V_4 (Pilli patti). Interaction effect of salinity and varieties also observed. According to data highest plant height (49.33 cm), fresh (37.49 g) and dry (3.90 g) weight of bulb, volume of bulb (25.67 cm^3) in S_1 (<2 dS $m-^1$) x V_4 (Pilli patti). Plant height decreased with increased salinity levels. Bernstein and Hayward (1958) [7], Bernstein (1962) [5] and Allison (1964) [2] have evaluated that the plant height may be restricted or totally inhibited on saline soils due to the three reasons (a) osmotic effect on plant root, (b) the toxic effect of accumulated ions in the plant tissues, (c) the specific effect of the constituent ions or the combination of all these factors.

Table 1: Effect of salinity and varieties on growth, yield and yield attributed characters of onion at harvest

Treatments	Yield and yield attributed characters							
	Plant height (cm)	No. of leaves per plant	Fresh straw weight (g)	Dry straw weight (g)	Bulb Dry weight (g)	Fresh weight of bulb (g)	Bulb diameter (cm)	Volume of bulb (cm^3)
Salinity (S)								
S1:< 2.0 dSm^{-1} (tapwater)	44.73	5.30	34.40	4.09	3.57	33.77	4.90	22.55
S2: 4.0 dS m^{-1}	33.15	4.81	21.19	2.36	2.91	25.41	4.20	17.95
S3: 6.0 dS m^{-1}	28.53	4.29	17.02	1.78	1.85	15.11	3.38	11.63
S4: 8.0 dS m^{-1}	19.61	3.21	13.54	1.37	1.18	9.68	2.06	8.45
S.Em. ±	0.54	0.07	0.41	0.04	0.05	0.37	0.06	0.27
C.D. (P=0.05)	1.53	0.21	1.16	0.12	0.13	1.06	0.18	0.78
Variety (V)								
V1 - GJWO-3	34.27	4.53	23.49	2.64	2.66	24.37	3.71	17.11
V2 -GJRO-11	27.66	4.31	19.01	2.11	2.20	19.58	3.58	13.21
V3 -Talaja red	30.27	4.37	20.34	2.26	2.30	19.57	3.67	15.54
V4 -Pilli patti	34.57	4.63	23.53	2.69	2.75	25.05	3.79	17.48
V5 -PWF-131	30.78	4.17	21.33	2.30	1.98	16.38	3.44	12.38
S.Em. ±	0.60	0.08	0.45	0.05	0.05	0.41	0.07	0.30
C.D. (P=0.05)	1.71	0.23	1.30	0.14	0.15	1.18	0.20	0.87
S x V Interaction								
S.Em. ±	1.20	0.16	0.91	0.10	0.11	0.83	0.14	0.61
C.D. (P=0.05)	3.43	NS	2.60	0.28	0.30	2.37	NS	1.74
C.V.%	6.60	6.45	7.31	6.99	7.66	6.83	6.72	6.97

Table 2: Interaction effect of salinity and varieties on plant height (cm) of onion

Interaction	S_1:< 2.0 dS m^{-1} (tap water)	S_2: 4.0 dS m^{-1}	S_3: 6.0 dS m^{-1}	S_4: 8.0 dS m^{-1}	Mean
V1 - GJWO-3	48.00	37.67	32.67	18.73	34.27
V2 -GJRO-11	41.33	26.33	24.00	18.97	27.66
V3 -Talaja red	44.00	32.33	27.00	17.73	30.27
V4 -Pilli patti	49.33	34.67	29.33	24.93	34.57
V5 -PWF-131	41.00	34.77	29.67	17.67	30.78
Mean	44.73	33.15	28.53	19.61	
S.Em.±	1.20		C.D. at 5%	3.43	

Table 3: Interaction effect of salinity and varieties on fresh weight of straw of onion

Interaction	S_1:< 2.0 dS m^{-1} (tap water)	S_2: 4.0 dS m^{-1}	S_3: 6.0 dS m^{-1}	S_4: 8.0 dS m^{-1}	Mean
V_1 - GJWO-3	36.33	22.60	19.73	15.28	23.49
V_2 -GJRO-11	33.13	16.57	14.17	12.17	19.01
V_3 -Talaja red	33.60	20.27	15.07	12.43	20.34
V_4 -Pilli patti	37.03	23.07	19.00	15.00	23.53
V_5 -PWF-131	31.90	23.47	17.13	12.80	21.33
Mean				13.54	
S.Em. ±	0.91		C.D. (P=0.05)	2.60	

Table 4: Interaction effect of salinity and varieties on dry straw weight of onion

Interaction	S_1:< 2.0 dS m^{-1} (tap water)	S_2: 4.0 dS m^{-1}	S_3: 6.0 dS m^{-1}	S_4: 8.0 dS m^{-1}	Mean
V_1 - GJWO-3	4.30	2.51	2.14	1.59	2.64
V_2 -GJRO-11	3.92	1.86	1.48	1.19	2.11
V_3 -Talaja red	4.02	2.26	1.54	1.25	2.26
V_4 -Pilli patti	4.46	2.60	2.14	1.55	2.69
V_5 -PWF-131	3.73	2.59	1.61	1.26	2.30
Mean	4.09	2.36	1.78	1.37	
S.Em. ±	0.10		C.D. (P=0.05)	0.28	

Table 5: Interaction effect of salinity and varieties on fresh weight of bulb

Interaction	S_1:< 2.0 dS m^{-1} (tap water)	S_2: 4.0 dS m^{-1}	S_3: 6.0 dS m^{-1}	S_4: 8.0 dS m^{-1}	Mean
V_1 - GJWO-3	37.21	31.66	17.50	11.06	24.37
V_2 -GJRO-11	32.01	23.89	14.99	7.45	19.58
V_3 -Talaja red	31.96	22.63	13.88	9.79	29.57
V_4 -Pilli patti	37.49	30.32	16.14	12.25	25.05
V_5 -PWF-131	30.17	16.54	10.99	7.83	16.38
Mean	33.77	25.41	15.11	9.68	
S.Em. ±	0.83		C.D. (P=0.05)	2.37	

Table 6: Interaction effect of salinity and varieties on bulb dry yield of onion

Interaction	S_1:< 2.0 dS m^{-1} (tap water)	S_2: 4.0 dS m^{-1}	S_3: 6.0 dS m^{-1}	S_4: 8.0 dS m^{-1}	Mean
V_1 - GJWO-3	3.81	3.39	2.09	1.34	2.66
V_2 -GJRO-11	3.35	2.78	1.78	0.90	2.20
V_3 -Talaja red	3.53	2.71	1.70	1.26	2.30
V_4 -Pilli patti	3.90	3.44	2.21	1.43	2.75
V_5 -PWF-131	3.26	2.24	1.46	0.97	1.98
Mean	3.57	2.91	1.85	1.18	
S.Em. ±	0.11		C.D. (P=0.05)	0.30	

Effect on Yield of onion

Fresh straw yield, dry straw yield, fresh bulb yield and dry bulb yield were significantly influenced by different level of salinity on different varieties of onion crop. The highest value of fresh straw yield (34.40 g), dry straw yield(4.09 g), fresh bulb yield (33.77 g) and dry bulb yield (3.57 g) were noted with the application of salinity level S_1 <2 dS m^{-1}. Highest Fresh straw yield (23.53 g), dry straw yield (2.69 g), fresh bulb yield (25.05 g) and dry bulb yield (2.75 g) noted with the variety (V_4) Pilli patti. Interaction effect of salinity and varieties gives highest value in the interaction of S_1 (<2 dS m-^{1}) x V_4 (Pilli patti). Fresh straw yield (37.07 g), dry straw yield (4.46 g), fresh bulb yield (37.49 g) and dry bulb yield (3.90 g). This tolerance to salinity may be due to selectivity in ion uptake and capacity to adjust to the osmotic pressure of the substrate without the danger of accumulating excess salts as suggested by Hayward and Wadleigh (1949) [10]. These results agree with those of Bernstein and Ayers (1953) [6], Francois (1994) [9], Singh and Pandita (1981) [21] reported that Salinity decreased bulb weight.

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