EFFECT OF SALINE IRRIGATION WATER ON YIELD AND BIO-CHEMICAL PARAMETERS OF ONION (*Allium Cepa* L.) VARIETIES

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 *rabi* 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} as well as five varieties*viz*., GJWO-3, GJRO-11, Talaj red, Pilli patti and PWF-131 in Factorial Completely Randomized Design with replicated three times.The experimental result revealed that the fresh straw yield (37.03 g/pot), bulb yield (37.49 g/pot), RWC, proline (0.96 µmole/gf.wt), chlorophyll a (5.77 mg/gf.wt), chlorophyll-b (4.22 mg/gf.wt) and total chlorophyllwere significantly influenced due to different levels of salinity among different varieties of onion tested.

Keywords : Salinity, Yield parameters, Biochemical parameters, Onion crop

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). Onion is a hardy bulbous plant. It's an annual for bulb production and biennial for seed production. It is short duration crop.

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) 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). 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.

Salinity affects both vegetative and reproductive phases of plants. In the vegetative phase, it leads to the reduction in growth and in reproductive phase, the main issue will be related to the decline in the yield (Meena *et al*., 2012). Salinity stress produces adverse effect on quality of plant and resultant reduction in leaf area and number of leaves, simultaneously increased leaf thickness and chloroplast per unit leaf area due to lower photosynthesis, thus photosynthesis is measured in terms of chlorophyll. Therefore, biochemical traits like proline and chlorophyll and RWC are important criteria for screening of crop/variety for their tolerance against salinity stress.

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 dSm^{-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 biochemical parameters at 45 DAS and yield was recorded at harvested of crop.The bio-chemical parametersareproline, chlorophyll-a, chlorophyll-bandtotal chlorophyll respectively.

RESULT AND DISCUSSION

Yield parameter

Fresh straw yield and fresh bulb yield were significantly influenced by different level of salinity on different varieties of onion crop(Table 1).The highest value of fresh straw yield (23.53 g) and fresh bulb yield (25.05 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) and fresh bulb yield (37.49 g) (Table 2 and 3). 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). These results agree with those of Bernstein and Ayers (1953), Francois (1994), Singh and Pandita (1981) reported that Salinity decreased bulb weight.

Bio-chemical parameter

Bio-chemical parameters include RWC, proline, chlorophyll-a, chlorophyll-b andtotal chlorophyll at 45 DAT. Excluding proline all other parameters were found decreased in increasing salinity level. (Table.1).

Application of <2.0 dS m^{-1} (S_1) saline irrigation water, gave significantly higher value of RWC (73.83 %)(at 45 DAT)chlorophyll-a content (5.53 mg/gf.wt), chlorophyll b (3.92 mg/gf.wt), total chlorophyll (11.75 mg/gf.wt) and 8.0 dS m^{-1} gave lowest value of RWC(at 45 DAT) (61.59 %), chlorophyll-a (4.11 mg/gf.wt), chlorophyll b (2.65 mg/gf.wt), total chlorophyll (8.54 mg/gf.wt).In the case of proline content it increased with increasing level of salinity significantly.Higher proline content (0.75 µmole g^{-1} of fresh weight) was recorded under application of 8.0 dS m^{-1} (S_4) saline irrigation water and lower proline content (0.35 µmole/gf.wt) observed in <2.0 dS m^{-1} (S_1).

In case of varietysignificantly higher value of RWC (70.89 %) andtotal chlorophyll was recorded with variety V_4 (Pilli patti) which was statistically at par with V_1, chlorophyll a (4.93 mg/gf.wt), and lower value of RWC (63.66 %) (at 45 DAT), was of V_1 (GJWO-3). While in case of chlorophyll-a lower value (4.48 mg/gf.wt.) observed with V_3 (Talaja red). The highest chlorophyll-b (3.63 mg/gf.wt) was registered was ofV_4(Pilli patti) and was lowest chlorophyll-b (3.00 mg/gf.wtht) V_5 (PWF-131) and lowest total chlorophyll (9.16 mg/gf.wt) was recorded of V_3 (Talaja red).

The combined effect of salinity and variety was non-found significant on RWC and total chlorophyll content of onion. The water content of plants leaves under optimum conditions is significantly greater than those of plants under high salinity conditions. The water intake of plants is limited based on salt concentration in soil solution. Under these conditions plants try to overcome water stress by increasing the concentrations of their intracellular osmotic compounds. The relative water content decreases under salinity stress conditions (Katerji *et al.* 2003 andKaya *et al.* 2003). Inhibition of growth and a decrease in water content induced by water stress has been universally observed even in tolerant plants (Bartels and Salamini, 2001; Mittler *et al*., 2001). Water status is a major factor affecting plant growth and development. A decrease of the leaf relative water content under saline conditions has been observed frequently (Qin *et al*., 2010 and Aroca *et al.,* 2012). The result is agreed with Yeo and Flowers (2006) result. chlorophyll a and b contents and total chlorophyll decreased with increasing NaCl supply.

The interaction effect of salinity and varieties levels was found significant on the proline content (Table 4). The highest proline content (0.96 µmole/gf.wt) was observed in variety V_4 (Pilli patti) at salinity S_4 (8.0 dS m^{-1}) The lowest proline content was observed in V_3 (Talaja red) under S_1 (<2.0 dS m^{-1}). In response to drought and salinity stress, many plant species accumulate high levels of proline, which is throught to function in stress adaptation (Adams and Frank, 1980). Also increase in proline content in response to salinity has been reported by (Goudarzi and Pakniyat 2008, El-Baz *et al.* 2003, and Sidari *et al*. 2008).

The interaction effect of salinity and variety levels was found significant in respect to chlorophyll-a content of onion leaves (Table5). The highest chlorophyll-a (5.77 mg g^{-1} of fresh weight) was observed in combination of V_4 (Pilli patti) and S_1 (<2.0 dS m^{-1}) which was statistically at par to those combination of V_1(GJWO-3) x S_1 (< 2.0 dS m^{-1}), V_2 (GJRO-11) x S_1 (< 2.0 dS m^{-1}) and V_3 (Talaja red) x S_3 (< 2.0 dS m^{-1}) .The lowest chlorophyll-a (3.73 mg/gf.wt) was observed in V_3(Talaja red) under 8.0 dS m^{-1} (S_4).

The data on interaction effect of salinity and varieties levels on chlorophyll-b content was presented in Table6.Highest chlorophyll-b content was found in combination of V_4 x S_1 (< 2.0 dS m^{-1}) and lowest chlorophyll-b content was found in V_5 (PWF-131) x S_4.

The reduction of the chlorophyll content from the leaves under salt-stress conditions due to destruction of the pigments chlorophyll and the instability of protein complex of pigments (Zhang& Davies, 1991). Due to the interference of the salt ions with novo protein synthesis (chlorophyll structural components) rather the decomposition of chlorophyll (Meloni *et al*., 2003).

Table 1 - Effect of salinity and varieties on yield and bio-chemical parametersof onion at harvest

Treatment	Yield parameters		Bio-chemical parameters (at 45 DAT)				
	Fresh straw weight (g)	Fresh weight of bulb (g)	RWC (%)	Proline (µmole/gf.wt)	Chlorophyll a (mg/gf.wt)	Chlorophyll b (mg/gf.wt)	Total chlorophyll (mg/gf.wt)
Salinity (S)							
S_1:< 2.0 dS/m^{-1}(tap water)	34.4	33.77	73.83	0.35	5.53	3.92	11.75
S_2: 4.0 dS m^{-1}	21.19	25.41	69.06	0.50	4.75	3.60	10.21
S_3: 6.0 dS m^{-1}	17.02	15.11	64.01	0.59	4.39	3.06	8.93
S_4: 8.0 dS m^{-1}	13.54	9.68	61.59	0.75	4.11	2.65	8.54
S.Em. ±	0.41	0.37	1.26	0.01	0.05	0.07	0.16
C.D. (P=0.05)	1.16	1.06	3.59	0.03	0.16	0.20	0.46
Variety (V)							
V_1 - GJWO-3	23.49	24.37	69.85	0.59	4.92	3.54	10.41
V_2 -GJRO-11	19.01	19.58	65.85	0.48	4.63	3.26	9.88
V_3 -Talaja red	20.34	19.57	65.37	0.5	4.48	3.11	9.16
V_4 -Pilli patti	23.53	25.05	70.89	0.63	4.93	3.63	10.55
V_5 -PWF-131	21.33	16.38	63.66	0.53	4.52	3.00	9.28
S.Em. ±	0.45	0.41	1.40	0.01	0.06	0.08	0.18
C.D. (P=0.05)	1.30	1.18	4.02	0.03	0.17	0.23	0.51
S x V Interaction							
S.Em. ±	0.91	0.83	2.81	0.02	0.12	0.16	0.36
C.D. (P=0.05)	2.60	2.37	NS	0.07	0.35	0.45	NS
C.V.%	7.31	6.83	7.25	7.23	4.47	8.27	6.32

Table 2 - 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	34.40	21.19	17.02	13.54	
S.Em. ±	**0.91**		**C.D. (P=0.05)**	**2.60**	

Table 3 - 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 4-Interaction effect of salinity and varieties on proline (µmole/gf.wt) content in leaves of onion at 45 DAT

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	0.37	0.49	0.59	0.90	0.59
V_2 -GJRO-11	0.34	0.46	0.58	0.55	0.48
V_3 -Talaja red	0.32	0.46	0.58	0.65	0.50
V_4 -Pilli patti	0.37	0.55	0.66	0.96	0.63
V_5 -PWF-131	0.34	0.52	0.55	0.69	0.53
Mean	0.35	0.50	0.59	0.75	
S.Em. ±	**0.02**		**C.D. (P=0.05)**	**0.07**	

Table 5- Interaction effect of salinity and varieties on chlorophyll-a (mg/gf.wt) content in leaves of onion at 45 DAT

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	5.59	5.15	4.57	4.35	4.92
V_2 -GJRO-11	5.60	4.39	4.30	4.22	4.63
V_3 -Talaja red	5.57	4.54	4.09	3.73	4.48
V_4 -Pilli patti	5.77	5.00	4.64	4.30	4.93
V_5 -PWF-131	5.10	4.67	4.38	3.93	4.52

Mean	5.53	4.75	4.39	4.11	
S.Em. ±	**0.12**		**C.D. (P=0.05)**	**0.35**	

Table 6- Interaction effect of salinity and varieties on chlorophyll-b (mg/gf.wt) content in leaves of onion at 45 DAT

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	4.06	3.47	3.43	3.21	3.54
V_2 -GJRO-11	3.76	3.49	3.15	2.63	3.26
V_3 -Talaja red	3.77	3.40	2.98	2.30	3.11
V_4 -Pilli patti	4.22	4.01	3.40	2.89	3.63
V_5 -PWF-131	3.82	3.61	2.37	2.21	3.00
Mean	3.92	3.60	3.06	2.65	
S.Em. ±	**0.16**		**C.D. (P=0.05)**	**0.45**	

CONCLUSION

Different level of saline irrigation water significantly influenced the bulb and straw weight of onion. The maximum bulb and straw weight were observed under S_1(<2.0 dS m^{-1}) with the value of 37.49 g $plant^{-1}$ and37.03 g $plant^{-1}$ respectively. The proline content increased with increasing salinity. Significantly higher proline content (0.75 µmole g^{-1} of fresh weight) was recorded under application of 8.0 dS m^{-1} (S_4) saline irrigation water. The different salinity levels produce significant effect on biochemical parameters like RWC, chlorophyll a, chlorophyll b and total chlorophyll content. These parameters were highest at salinity level S_1 (< 2.0 dS m^{-1}).

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