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Effect of salinity on yield, yield attributing characters and quality of sesame (*Sesamum indicum* 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 salinity on yield, yield attributing characters and quality of sesame (*Sesamum indicum* L.) Varieties" during the summer, 2017. The pot experiment comprised of four levels of salinity *viz*., <2.0, 4.0, 6.0 and 8.0 dS $m^{-1}$and tested five different varieties *viz*., G Til 2, G Til 3, G Til 4, G J Til 5 and G Til 10 in FRCD. The results revealed that the yield, yield attributes and quality parameters were significantly influenced by the different tested varieties of sesame. The highest seed yield (4.05 g $plant^{-1}$) and stalk yield (6.20 g $plant^{-1}$) were observed with variety V_5 (G Til 10). The variety V_5 (G Til 10) also exhibited its superiority in achieving highest plant height (92.50 cm), branches per plant (4.23), capsule per plant (46.03), length of capsule (2.20 cm), wt. of dry capsules per plant (8.56 g) and quality parameters *viz.,* 1000 seeds weight and oil content in comparison to other tested varieties. Significant interaction of variety & saline water was obtained in respect of seed yield, stalk yield, plant height, dry capsule weight and seeds per capsule. Among the tested sesame varieties, variety G. Til 10 found tolerant upto EC 4.0 dSm^{-1} of irrigation water in summer sesame.

Keywords: sesame, salinity levels, varieties, growth, yield and yield attributes, quality parameters

Introduction
Sesame (*Sesamum indicum* L.) is an important oilseed crop in India next to groundnut and rapeseed – mustard. Sesame also known as Til, Gingelly, Simsim, Beniseed, Gergelim, *etc*. Sesame (*Sesamum indicum* L.) is one of the stress-tolerate crops that produces sorts of chemical components, unavailable in other edible oils that provide a resistance to oxidative rancidity and has made sesame well known as "Queen of oilseed crops" (Bouremia *et al*., 2011) [6].

Salinity effects are more noticeable in arid and semiarid regions, mainly due to the acceleration of salinity by a deficit of precipitation and high temperature coupled with a high evaporation demand (Azevedo *et al*., 2006) [3]. Salinity in coastal groundwater is a widespread problem in many parts of India and Gujarat. In the *Saurashtra* region, summer sesame is often irrigated with fresh water. Salt-tolerance sesame cultivars could be an option for its cultivation in salt affected areas. Therefore, screening of the most salt tolerant sesame cultivars would be of great value for agriculture by increasing sesame cultivation area. The reports reviewed here and elsewhere suggest that there is not enough information regarding the effect of salinity level on growth and quality of sesame cultivars. The present study was taken to investigate the influence of salinity levels on the yield, yield components and quality of sesame cultivars.

Materials and Methods
A pot experiment was conducted during summer-2017 at the Department of Agricultural Chemistry and Soil Science, College of Agriculture, Junagadh Agricultural University, Junagadh. The experimental soil was silty clay in texture and alkaline in reaction with $pH_{2.5}$ 8.0, $EC_{2.5}$ 0.58 dS m^{-1}, $CaCO_3$ 31.05% and CEC 36.2 cmol (p^+) kg^{-1}. The soil was low in available nitrogen (242 kg ha^{-1}), medium in available phosphorus (39.20 kg ha^{-1}), high in available potassium (298 kg ha^{-1}) and high in available sulphur (29.50 kg ha^{-1}). In case of micro nutrient status, soil was low in available iron (3.25 mg kg^{-1}), medium in available

manganese (5.20 mg kg^{-1}), low in available zinc (0.45 mg kg^{-1}) and high in available copper (1.25 mg kg^{-1}).The experiment consists of 20 treatments combinations comprising four levels of salinity water *viz.*< 2.0, 4.0, 6.0 and 8.0 dS m^{-1} and five levels of varieties *viz.* G Til 2, G Til 3, G Til 4, G J Til 5 and G Til 10 with CRD. The yield and yield attributing characters were recorded at harvested of crop. The quality parameters like crude protein content and oil content by nitrogen basis and NMR technique, respectively. All collected data of various parameters were statistically analysed using F' test (Panse and Sukhatme, 1985) [11].

Result and Discussion

Yield parameters

The seed and stalk yield were significantly influenced by different varieties of sesame over different saline water (Table 1). Significantly higher value of seed (4.05g $plant^{-1}$) and stalk (6.20 g $plant^{-1}$) yield were registered with variety V_5 (G Til 10). The value of seed and stalk yield decreasing with increasing the level of saline irrigation water. Significantly higher seed (4.62 g $plant^{-1}$) and stalk (7.28 g $plant^{-1}$) yields were recorded under application of <2.0 dS m^1 (S_1) saline irrigation water. The interaction effect of salinity level and variety in relation to seed and stalk yield was also observed (Table 1.1). The highest seed (5.89 g $plant^{-1}$) and stalk (8.12 g $plant^{-1}$) yield were observed with variety V_5 (G Til 10) at S_1 (<2.0 dS m^{-1}). Decreased seed and stalk yield by increasing salinity of irrigation water may be due to more negative water potential of soil solution causing reduced water and nutrient uptake consequently lower leaf area development in turn reduced net assimilates. Similarly, Shani and Dudley (2001) [14] reported the yield loss to reduced photosynthesis, high energy and carbohydrate expenses in osmo-regulation and interference with cell function under saline conditions. Ghadiri *et al*. (2002) [8] also concerned that restricted water uptake by salinity due to the high osmatic potential in the soil and high concentration of specific ions that may cause physiological disorders in the plant tissues and reduce yields. These results are also in concordance with most similar previous studies of Babu and Thirumurugan (2001) [4], Ali *et al*. (2005) [2], Garg *et al*. (2005) [9] and Benzaidi *et al*. (2014) [5] in sesame.

Growth and yield attributes parameters

The varietal effect was found significant in respect of growth and yield attributing character *viz*., plant height, no. of branches per plant, number of capsule per plant, length of capsule, weight of dry capsules per plant, number of seed per capsule and higher values of those parameters noted with variety G Til 10 at different levels of saline water. The combined effect of variety and salinity produced significant effect on parameters like plant the tallest plant height (92.50 cm) was perceived in variety V_5 (G Til 10) at S_1 (< 2.0 dS m^{-1}), which was statistically at par to V_2(G Til 3) X S_1 (< 2.0 dS m^{-1}), V_4 (G J Til 5) X S_1 (< 2.0 dS m^{-1}) and V_5 (G Til 10) X S_2 (4.0 dS m^{-1})., Significantly higher value of number of branches per plant (4.23) was recorded with variety V_5 (G Til 10) at salinity level S_1 (2.0 dS m^{-1}). It was also remained at par with combination of V_2(G Til 3)X S_1 (<2.0 dS m^{-1}), Significantly maximum number of capsule per plant (46.03) were observed in variety V_5 (G Til 10) at S_1 (<2.0 dS m^{-1}), which was remained statistically at par with treatment combination of V_2 (G Til 3)X S_1 (<2.0 dS m^{-1}) and V_5 (G Til 10)X S_2 (4.0 dS m^{-1}), The interaction effect of different varieties and salinity levels with respect of weight of dry capsule per plant found significantly differed (Table 1.3) with variety V_5 (G Til 10) at S_1 (<2.0 dS m^{-1}), which remained statistically similar to that of all other varieties at salinity level S_1 (<2.0 dS m^{-1}). While, variety V_2 (G Til 3) exhibited its superiority in no. of seed per at salinity level < 2.0 dS m^{-1}. Gaballah *et al*. (2007) [7] also stated that number of capsules per plant of sesame cultivars were increased under moderate but reduced under high salt levels. Ali *et al.* (2005) [2] stated that the branches per plant, capsule per plant and seed per capsule was differentiated significantly due to tested varieties and imposed different saline irrigation water. Because of high salinity concentration which hampered the growth of branch on the individual plant and hindered photosynthetic activity of the plant as result the plant exposed to deficiency of important mineral and food to survive.

Table 1: Effect of varieties and salinity levels on yield and yield attributing characters at harvest of sesame

Treatments	Yield and yield attributing characters								
	Seed yield (g $plant^{-1}$)	Stalk yield (g $plant^{-1}$)	Plant height (cm)	No. of branches /plant	No. of capsules /plant	Length of capsule (cm)	Wt. of dry capsule (g)	No. of seed /capsule	Root biomass (cm^3)
Variety (V)									
V_1:G Til-2	2.63	5.62	55.91	2.15	28.32	1.81	5.03	36.05	2.63
V_2:G Til-3	3.58	6.15	63.63	2.61	31.03	2.03	5.15	42.63	2.72
V_3: G Til-4	2.59	5.40	54.99	1.93	27.63	1.62	4.59	33.39	2.63
V_4: G J Til-5	2.88	5.59	60.93	2.31	29.61	2.02	5.05	37.86	2.70
V_5: G Til-10	4.05	6.20	68.38	2.75	34.93	2.20	5.82	41.16	2.92
S.Em.±	0.08	0.14	0.96	0.06	0.81	0.04	0.14	0.55	0.08
C.D. (P=0.05)	0.22	0.41	2.73	0.18	2.32	0.12	0.41	1.58	NS
Salinity (S)									
S_1:< 2.0 dS m^{-1} (tap water)	4.62	7.28	87.73	3.54	40.21	2.46	8.49	52.18	3.19
S_2: 4.0 dS m^{-1}	3.41	6.16	67.70	2.93	34.00	2.20	6.51	44.71	3.00
S_3: 6.0 dS m^{-1}	2.84	5.33	53.71	1.57	26.10	1.79	3.34	32.16	2.35
S_4: 8.0 dS m^{-1}	1.71	4.40	33.93	1.36	20.90	1.31	2.17	23.83	2.33
S.Em.±	0.07	0.13	0.86	0.06	0.72	0.04	0.13	0.50	0.08
C.D. (P =0.05)	0.20	0.37	2.45	0.16	2.07	0.10	0.36	1.42	0.22
Vx S Interaction									
S.Em.±	0.15	0.29	1.91	0.12	1.62	0.08	0.28	1.11	0.17
C.D. (P =0.05)	0.44	0.83	5.47	0.36	4.63	NS	0.81	3.17	NS
C.V. %	8.47	8.66	5.45	9.16	9.26	7.31	9.60	5.02	10.71

Table 1.1 Interaction effects of varieties and salinity levels on yield (g plant^{-1}) of sesame

Treatment	Seed yield (g plant^{-1})					Stalk yield (g plant^{-1})				
	S_1:<2	S_2:4	S_3: 6	S_4: 8	Mean	S_1:<2	S_2:4	S_3: 6	S_4: 8	Mean
	EC dS m^{-1}					EC dS m^{-1}				
V_1:G Til-2	3.90	3.11	2.21	1.28	2.63	6.70	5.95	5.71	4.11	5.62
V_2:G Til-3	5.22	3.85	3.45	2.07	3.58	8.20	6.67	5.50	4.24	6.15
V_3: G Til-4	3.85	3.09	2.26	1.14	2.59	6.72	5.79	5.06	4.04	5.40
V_4: G J Til-5	4.21	3.33	2.54	1.43	2.88	6.68	5.77	5.06	4.85	5.59
V_5: G Til-10	5.89	3.95	3.75	2.61	4.05	8.12	6.61	5.30	4.77	6.20
Mean	4.62	3.41	2.84	1.71		7.28	6.16	5.33	4.40	
	S.Em. ±	0.15	C.D. (P =0.05)		0.44	S.Em. ±	0.29	C.D. (P =0.05)		0.83

Table 1.2: Interaction effect of varieties and salinity levels on plant height (cm) and number of branches/plant of sesame

Treatment	Plant height (cm)					Number of branches/plant				
	S_1:<2	S_2:4	S_3: 6	S_4: 8	Mean	S_1:<2	S_2:4	S_3: 6	S_4: 8	Mean
	EC dS m^{-1}					EC dS m^{-1}				
V_1:G Til-2	84.3	54.0	53.1	32.1	55.9	2.90	2.63	1.85	1.22	2.15
V_2:G Til-3	90.4	69.0	58.0	37.0	63.6	4.17	3.17	1.22	1.87	2.61
V_3: G Til-4	83.3	61.8	45.1	29.6	55.0	3.10	2.17	1.25	1.19	1.93
V_4: G J Til-5	88.0	65.6	55.7	34.2	60.9	3.30	3.10	1.38	1.48	2.31
V_5: G Til-10	92.5	88.0	56.5	36.5	68.4	4.23	3.57	2.16	1.03	2.75
Mean	87.7	67.7	53.7	33.9		3.54	2.93	1.57	1.36	
S.Em. ±	1.91					0.12				
C.D. (P =0.05)	5.47					0.36				

Table 1.3: Interaction effect of varieties and salinity levels on number of capsules/plant and weight of dry capsules (g) of sesame

Treatment	Number of capsules/plant					weight of dry capsules (g)				
	S_1:<2	S_2:4	S_3: 6	S_4: 8	Mean	S_1:<2	S_2:4	S_3: 6	S_4: 8	Mean
	EC dS m^{-1}					EC dS m^{-1}				
V_1:G Til-2	37.7	32.6	23.8	19.1	28.3	8.40	6.43	3.17	2.13	5.03
V_2:G Til-3	43.3	33.8	27.3	19.6	31.0	8.55	6.97	3.27	1.81	5.15
V_3: G Til-4	35.3	28.9	23.1	23.2	27.6	8.43	5.87	2.67	1.40	4.59
V_4: G J Til-5	38.6	32.3	25.4	22.1	29.6	8.50	6.40	2.87	2.43	5.05
V_5: G Til-10	46.0	42.3	30.9	20.5	34.9	8.56	6.90	4.73	3.07	5.82
Mean	40.2	34.0	26.1	20.9		8.49	6.51	3.34	2.17	
S.Em. ±	1.62					0.28				
C.D. (P =0.05)	4.63					0.81				

Table 1.4: Interaction effect of varieties and salinity levels on number of seed/capsule of sesame

Treatment	S_1:<2	S_2:4	S_3: 6	S_4: 8	Mean
	EC dS m^{-1}				
V_1:G Til-2	50.47	41.80	30.47	21.47	36.05
V_2:G Til-3	54.84	51.67	35.00	29.00	42.63
V_3: G Til-4	48.90	36.23	30.10	18.33	33.39
V_4: G J Til-5	52.18	44.32	31.33	23.60	37.86
V_5: G Til-10	54.50	49.52	33.90	26.73	41.16
Mean	52.18	44.71	32.16	23.83	
S.Em. ±	1.11		C.D. (P =0.05)	3.17	

Quality parameters

The quality parameters are mostly associated with genetic character of genotype, however these are affected management practices. In this study, test weight and oil content were influenced significantly either by variety and saline water, while protein was remaining unaffected (Table 2). Significantly highest test weight (3.33 g) was recorded in V_5 (G Til 10), which remained statistically at par with V_2 (G Til 3) and V_4 (G J Til 5) and lowest test weight (2.75 g) observed in V_3 (G Til 4). It also considerably affected by increasing salinity levels. Significantly higher value of test weight (3.61 g) observed in (S_1) 2.0 dS m^{-1} which remained statistically similar with (S_2) 4.0 dS m^{-1}. Test weight is an important predictor of value addition. With some minor changes in plant environment through nutrient, irrigation, cultural operation etc. obtained the significant variation in test weight of tested varieties of sesame (Ali, 2004; Sarwar & Haq, 2006 and Pathan *et al.*, 2007) [1, 13, 10].

Protein content of seed did not influence significantly by different varieties of sesame but protein content was observed high with variety V_5 (G Til 10) as compared to other varieties of sesame. However, decreased in protein content (21.84 to 20.39) was observed with increasing salinity level from <2.0 to 8.0 dS m^{-1}. The decline in protein content at higher salinity levels may be due to the fact that the higher salt load over plant root zone reported to reduce the root area which lowers down the uptake of nitrogen by plants which ultimately leads to lower crude protein content in plant biomass as it is essential for protein synthesis.

Oil content in seeds was significantly affected by the varieties and highest value (46.33%) recorded in V_5 (G Til 10), which remained statistically at par with V_2 (G Til 3), V_1 (G Til 2) and V_4 (G J Til 5) and it lowest content (44.43%) was

observed in V_3 (G Til 4). Significantly higher value of oil content (46.50%) observed in (S_1) 2.0 dS m^{-1} and was remained statistically at par with (S_2) 4.0 dS m^{-1}. The interaction effect of variety and salinity was resulted non-significant with regarding to oil content.

Table 2: Effect of varieties and salinity levels on quality parameter of sesame

Treatments	Quality parameters		
	Test weight-1000 seed (g)	Protein content (%)	Oil content (%)
Variety (V)			
V_1:G Til-2	2.79	20.09	45.21
V_2:G Til-3	3.27	20.66	45.89
V_3: G Til-4	2.75	21.54	44.43
V_4: G J Til-5	3.20	20.90	45.69
V_5: G Til-10	3.33	21.80	46.33
S.Em. ±	0.08	0.55	0.45
C.D. (P =0.05)	0.24	NS	1.28
Salinity (S)			
S_1:< 2.0 dS m^{-1}	3.61	21.84	46.50
S_2: 4.0 dS m^{-1}	3.48	20.94	45.46
S_3: 6.0 dS m^{-1}	2.64	20.83	45.35
S_4: 8.0 dS m^{-1}	2.55	20.39	44.72
S.Em. ±	0.08	0.50	0.40
C.D. (P =0.05)	0.22	NS	1.14
Vx S Interaction			
S.Em. ±	0.17	1.11	0.89
C.D. (P =0.05)	NS	NS	NS
C.V. %	9.58	9.13	3.40

Conclusion

On the basis of results, the sesame variety G TIL 10 showed significantly higher values of yield (seed and stalk), yield attributing characters (plant height, branches per plant, capsules per plant, length of capsule, weight of dry capsule and seed per capsule), quality parameters (test weight and oil content). The sesame variety G TIL 10 is found better up to EC 4 dS m^{-1} irrigation water. Overall, relative tolerance sequence order of sesame varieties was found in order of: G Til 10 > G Til 3 > G J Til 5> G Til 2> G Til 4 against salinity in silty clay soil.

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