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Original article

Study of the effect of salinity stress on quantitative and qualitative characteristics of sugar beet genotypes

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Extend abstract

Introduction

Salt stress is one of the most important abiotic stresses, which decreases crop yields and limits the land use. Three hectares of agricultural land are being destroyed in each minute by salinity In Iran, salinity is one of the most important factors which limit the agriculture. Salt stress studies were very important in the most sugar beet planting regions of Iran based on sugar beet experts and farmers opinions producing sugar beet salt tolerant varieties, improving planting methods, irrigation and fertilizer use are the most Sugar Beet Seed Institute (SBSI) strategies for optimizing the production in saline lands.

Materials and methods

In order to investigate the effect of salinity stress on quantitative and qualitative characteristics of sugar beet genotypes in normal and salinity stress conditions an experiment was conducted in a completely randomized block design with three replications in Miandoab Agricultural and Natural Resources Research Station at 2016-17 Crop seasons. In this research, 16 sugar beet genotypes were tested under two normal conditions and saline conditions with salinity of 12.1 dS/m. In this research, root yield, sugar content, white sugar content, sugar yield, the amount of sodium, nitrogen, and potassium of root, white sugar yield percent of sugar extraction was measured. Data was analyzed by using SAS 9.2 software.

Results and discussion

The results showed that the effect of the environment on all studied traits wasn't significant. Differences between genotypes were significant for all traits except for white sugar content, also the interaction of genotype in environment on all traits except the white sugar content was significant. Results showed that the highest root yield, white sugar yield and sugar yield in

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normal and salinity conditions were allocated to genotypes 14 and 15. Based on the results of correlation analysis in both environmental conditions, white sugar yield had positively and significantly correlated with root yield, white sugar content and sugar yield. Based on the results of stepwise regression analysis, root yield, percent of sugar extraction and sugar yield in normal conditions with justified 93 percent of white sugar yield variation and in salt stress condition with justified 84 percent of the total white sugar yield variation were identified as the most effective traits on white sugar yield.

Conclusions

In the present study, there was no significant difference between two years in term of studied traits. It can be concluded that climate conditions in the two years studied did not have a significant difference in terms of effect on the studied traits. In the present study, there wasn't significant difference between normal and salinity stress conditions in terms of all traits and salinity Therefore, it can be said that sugar beet genotypes were resistant to salinity. In both environmental conditions, genotypes number 14 and 15 had the highest root yield, white sugar yield and sugar yield, Selection of these genotypes is recommended for future breeding programs. In both normal and salinity conditions root yield, percent of sugar extraction and sugar yield recommended as Criteria for selecting high-yielding genotypes.

***Keywords*:** Correlation, Percent of sugar extraction, Regression, White sugar yield

Table 1. Physicochemical properties of the experimental soil

	Value	
Soil Parameters	**Normal**	**Stress**
Depth (cm)	0-30	0-30
SP (%)	38	41
EC(ds/m)	2	5-6
pH	8	8
T.N.V (%)	8	8
O.C (%)	0.78	0.78
N (%)	0.13	0.12
P (ppm)	8.05	8.32
K (ppm)	255	265
Sand (%)	34	36
Silt (%)	42	41
Clay (%)	24	24
Texture	Silty loam	Silty loam

Table 2. Evaluated Sugar beet genotypes

1	8001-P.2
2	8001-P.3
3	8001-P.7
4	8001-P.8
5	MSC2*8001*P.7
6	MSC2*8001*P.10
7	MSC2*8001*P.11
8	(261*231)*8001P.1
9	(261*231)*8001P.3
10	8001 CHECK
11	7233*MSC2 HECK
12	191 CHECK
13	007
14	004
15	005
16	Isela

Table 3. Analysis of variance of traits related to quantitative and qualitative characteristics of sugar beet in normal and salinity stress at two years

S.O.V	DF	Root yield	Sugar content	NA	K	N%
Year (Y)	1	1.21^{ns}	1.59^{ns}	4.21^{ns}	4.74^{ns}	0.011^{ns}
Environment (E)	1	2753.66^{ns}	58.29^{ns}	34.82^{ns}	8.89^{ns}	0.44^{ns}
Y× E	1	2693.66**	0.98^{ns}	3.41^{ns}	0.69^{ns}	0.08^{ns}
E_a	8	9.26	0.50	1.01	0.15	0.02
Genotype (G)	15	758.79**	7.38**	19.37**	0.57^{ns}	2.03**
G× Y	15	92.29^{ns}	0.58^{ns}	1.21^{ns}	0.11^{ns}	0.52^{ns}
G× E	15	336.72**	13.78**	6.79**	1.87**	2.47*
G×Y×E	15	84.29^{ns}	1.12^{ns}	2.89^{ns}	0.38**	0.48^{ns}
E_b	120	155.02	1.28	2.47	0.52	0.60
CV(%)		*17.99*	*6.88*	*11.46*	*10.87*	*29.71*

Table 3. Continued

S.O.V	dF	White sugar content	Sugar yield	Percent of sugar extraction	White sugar yield
Year (Y)	1	1.16^{ns}	1.22^{ns}	2.15^{ns}	1.09^{ns}
Environment (E)	1	45.18^{ns}	101.91^{ns}	2.14^{ns}	130.65^{ns}
Y× E	1	1.05^{ns}	3.11^{ns}	2.18^{ns}	2.23^{ns}
E_a	8	0.61	1.02	1.01	0.85
Genotype (G)	15	1.11^{ns}	85.18**	180.12**	58.65**
G× Y	15	1.08^{ns}	4.89^{ns}	12.74^{ns}	1.51^{ns}
G× E	15	2.58^{ns}	33.28**	48.07**	15.33**
G×Y×E	15	2.18^{ns}	4.89^{ns}	15.56^{ns}	3.12^{ns}
E_b	120	2.18	5.30	15.50	3.95
CV(%)		10.80	14.58	6.18	15.33

^{ns}, * and ** no significant, significant in 5% and 1%

Table 4. Analysis of variance (Mean squares) of traits related to quantitative and qualitative characteristics of sugar beet in two conditions

		Root yield		Sugar content		Na		K	
S.O.V	**df**	**N**	**S**	**N**	**S**	**N**	**S**	**N**	**S**
Year (Y)	1	7.75^{ns}	17.7^{ns}	0.95^{ns}	0.33^{ns}	1.03^{ns}	0.38^{ns}	0.15^{ns}	0.64^{ns}
Ea	6	4.21	6.12	0.85	0.16	0.83	0.18	0.08	0.29
Genotype (G)	15	238.81*	604.63**	3.58**	18.58**	11.15**	14.99**	1.51**	0.93^{ns}
G× Y	15	98.21^{ns}	107.22^{ns}	1.15^{ns}	1.80^{ns}	0.85^{ns}	2.81^{ns}	0.35^{ns}	0.51^{ns}
Eb	60	118.37	167.31	1.03	1.65	1.19	3.57	0.42	0.63
Cv%	-	*22.19*	*18.62*	*5.68*	*6.68*	*26.75*	*22.86*	*10.06*	*11.32*

Table 4. Continued

		N		White sugar content		Sugar yield		Percent of sugar extraction		White sugar yield	
S.O.V	**df**	**N**	**S**	**N**	**S**	**N**	**S**	**N**	**S**	**N**	**S**
Year (Y)	1	0.11^{ns}	0.06^{ns}	0.11^{ns}	1.14^{ns}	0.46^{ns}	0.55^{ns}	3.29^{ns}	0.23^{ns}	0.53^{ns}	0.24^{ns}
Ea	6	0.05	0.04	0.08	1.10	0.09	0.43	2.12	0.24	0.14	0.19
Genotype (G)	15	2.61**	1.81**	1.81^{ns}	2.79^{ns}	7.05*	26.17**	41.63**	73.60*	5.25*	21.69**
G× Y	15	0.83^{ns}	0.20^{ns}	0.99^{ns}	0.88^{ns}	3.15^{ns}	5.41^{ns}	7.57^{ns}	1.82^{ns}	0.33^{ns}	5.01^{ns}
Eb	60	0.94	0.26	1.52	2.56	3.06	7.39	14.04	35.81	2.52	4.87
Cv %		*11.25*	*20.14*	*8.92*	*10.46*	*20.57*	*20.28*	*7.80*	*24.27*	*20.43*	*20.94*

ns, * and ** no significant, significant in 5% and 1%. N: Normal; S: Stress

Table 5. Mean comparison of the studied genotypes for quantitative and qualitative traits of sugar beet in two years

	Root yield (Ton.ha^{-1})		Sugar content		Na(ppm)		K(ppm)	
Genotype	**Stress**	**Normal**	**Stress**	**Normal**	**Stress**	**Normal**	**Stress**	**Normal**
8001-P.2	54.21^{bc}	69.86^{bc}	16.93^{ab}	17.38^{df}	6.41^{ab}	5.50^{ab}	6.97^{a}	6.44^{bf}
8001-P.3	58.11^{bc}	73.66^{bc}	17.58^{ab}	14.65^{h}	6.78^{a}	4.50^{bc}	7.71^{a}	5.70^{cg}
8001-P.7	53.58^{bc}	76.66^{cf}	17.65^{a}	13.46^{h}	5.53^{ad}	3.95^{bc}	7.33^{a}	5.57^{fg}
8001-P.8	59.33^{ac}	74.33^{ad}	16.25^{ad}	14.25^{h}	5.25^{ad}	3.38^{ce}	7.85^{a}	5.18^{g}
MSC2*8001*P.7	44.10^{c}	56^{df}	16.73^{ad}	21.35^{a}	6.19^{ac}	6.83^{aa}	7.10^{a}	6.22^{bg}
MSC2*8001*P.10	53.66^{bc}	70.01^{ce}	16.3^{ad}	16.91^{fg}	1.47^{e}	0.97^{f}	6.71^{a}	7.62^{a}
MSC2*8001*P.11	54.20^{bc}	51.66^{ef}	16.6^{ad}	17.05^{fg}	1.39^{e}	0.89^{f}	6.87^{a}	7.19^{ab}
(261*231)*8001P.1	57.18^{bc}	55.11^{df}	14.62^{d}	18.55^{cf}	0.69^{e}	1.84e^{f}	6.87^{a}	6.86^{ad}
(261*231)*8001P.3	67.12^{ab}	62.66^{df}	16.65^{ad}	19.78^{ac}	2.34^{de}	1.21^{f}	6.80^{a}	7.16^{ac}
8001 CHECK	57.80^{bc}	46.33^{f}	17.07^{ad}	21.05^{ab}	3.51^{bc}	0.58^{f}	6.87^{a}	6.80^{ad}
7233*MSC2 HECK	53.66^{bc}	65.35^{de}	15.62^{cd}	18.93^{bf}	3.06^{ce}	1.73^{ef}	7.01^{a}	6.76^{ae}
191 CHECK	54.25^{bc}	68.18ce	15.38cd	18.93bf	7.92a	2.27df	6.76^{a}	7.12^{ac}
007	577.2^{bc}	73.3bd	15.63cf	18.93bf	5.13ad	1.56f	7.62a	5.62fg
004	67.11^{ab}	78.66ac	16.53ad	20.55ac	1.43e	5.45ab	5.82a	5.94dg
005	77.33^{a}	85.6a	15.73cd	19.16be	2.98ce	1.78ef	8.08a	6.10cg
Isela	77.10^{a}	82.66a	15.95bd	15.01gh	3.34be	1.69ef	6.57a	6.88ad

Table 5. Continued

	N(ppm)		White sugar content (Ton.ha^{-1})		Percent of sugar extraction		White sugar yield (Ton.ha^{-1})	
Genotype	**Stress**	**Normal**	**Stress**	**Normal**	**Stress**	**Normal**	**Stress**	**Normal**
8001-P.2	2.27^{ce}	2.13d^{g}	9.42^{bc}	11.83^{ab}	74.07^{ef}	74.11^{ce}	5.35^{ce}	7.78^{be}
8001-P.3	3.77^{ac}	1.43^{g}	8.51^{bc}	12.95^{ab}	74.73^{df}	70.43^{e}	6.34^{ae}	6.27^{ce}
8001-P.7	4.54^{a}	1.47^{fg}	7.21^{c}	13.53^{a}	76.20^{cf}	71.75^{de}	5.73^{be}	5.21^{e}
8001-P.8	3.42^{ad}	3.44^{be}	8.45^{bc}	12.08^{ab}	74.89^{df}	74.55^{ce}	5.93^{be}	6.83^{be}
MSC2*8001*P.7	2.64^{be}	2.64^{b}	9.42^{bc}	9.37^{bc}	70.54^{f}	78.76^{bd}	3.63^{e}	7.77^{be}
MSC2*8001*P.10	1.60^{e}	2.31^{be}	9.07^{bc}	11.41^{ab}	82.24^{ab}	80.06^{ac}	5.86^{be}	8.37^{be}
MSC2*8001*P.11	1.81^{de}	2.25^{cf}	9.24b^{c}	8.58^{c}	82.66^{ab}	81.28$_{ac}$	6.11^{ae}	5.86^{de}
(261*231)*8001P.1	2.83^{be}	2.89^{dg}	10.61ac	8.06c	78.73^{ae}	84.75^{ab}	5.40^{ce}	7.83^{be}
(261*231)*8001P.3	1.53^{e}	2.92^{bd}	13.28^{ab}	10.43^{bc}	82.30^{ac}	82.02^{ab}	7.90$_{ac}$	9.01^{bd}
8001 CHECK	1.29^{e}	2.50^{bd}	12.17^{ac}	7.91^{c}	83.93^{a}	81.81^{ab}	6.94^{ad}	6.53^{be}
7233*MSC2 HECK	2.65^{be}	4.69^{a}	10.16^{bc}	10.21^{bc}	79.23^{ae}	81.81a^{c}	5.28^{ce}	8.82^{be}
191 CHECK	4.23^{ab}	3.16^{be}	10.27^{bc}	10.49^{bc}	77.40^{be}	71.09^{e}	5.09^{de}	7.97^{be}
007	2.56^{ce}	2.37^{bc}	10.83^{ac}	11.46^{ab}	78.54^{ae}	79.45^{ac}	5.71^{be}	10.06^{b}
004	2.36^{ce}	2.29^{ce}	13.79^{ab}	13.00^{a}	75.38$_{df}$	86.15^{a}	7.04^{ad}	12.59^{a}
005	2.54^{ce}	2.36^{df}	14.82^{a}	13.46^{a}	77.35^{be}	82.45^{ab}	8.34^{ab}	12.37^{a}
Isela	2.78^{be}	1.80^{ce}	11.57^{ac}	13.18^{a}	80.56^{ad}	74.38^{ce}	8.81^{a}	8.93^{be}

Means that have a common letter, have not significantly different together based on LSD test at 5%

Table 6. The correlation between traits, low numbers related to normal and high numbers related to salinity conditions at two years

	Treats	1	2	3	4	5	6	7	8	9
1	**Root yield**	1	-0.44^{ns}	0.20^{ns}	-0.35^{ns}	-0.15^{ns}	-0.39^{ns}	0.84**	-0.31^{ns}	0.75**
2	**Suger percent**	-0.18^{ns}	1	-0.24^{ns}	0.40^{ns}	0.54*	0.95**	0.34**	-0.17^{ns}	0.20^{ns}
3	**Na**	-0.28^{ns}	0.20^{ns}	1	-0.39^{ns}	0.36^{ns}	-0.29^{ns}	0.21^{ns}	-0.84**	-0.36^{ns}
4	**K**	0.28^{ns}	-0.15^{ns}	0.21^{ns}	1	0.45^{ns}	0.33^{ns}	-0.41^{ns}	0.25^{ns}	-0.17^{ns}
5	**N**	-0.13^{ns}	0.27^{ns}	0.43^{ns}	0.43^{ns}	1	0.18^{ns}	0.38^{ns}	-0.12^{ns}	0.19^{ns}
6	**Net Suger percent**	-0.03^{ns}	0.74**	-0.44**	-0.37**	0.23^{ns}	1	0.31*	0.84**	0.49**
7	**Suger yield**	0.95**	0.26^{ns}	-0.15^{ns}	0.25^{ns}	0.03^{ns}	0.17^{ns}	1	0.20^{ns}	0.96**
8	**S.E.C**	0.26^{ns}	-0.17^{ns}	-0.86**	-0.48^{ns}	-0.49^{ns}	0.78**	0.26^{ns}	1	0.59*
9	**W.Suger yield**	0.94**	0.48**	-0.28^{ns}	0.22^{ns}	-0.22^{ns}	0.45^{ns}	0.93**	0.05^{ns}	1

Ns, *, ** significant and insignificant at 1 and 5% levels respectively

Table 7. Results of stepwise regression analysis of the studied traits with white sugar yield as dependent variable under normal condition

Variables	1	2	3
Contrast	-0.07	-6.43	-14.71
Root yield	0.14	0.13	0.13
Percent of sugar extraction		0.08	0.10
Sugar content			0.39
R^2	0.84	0.89	0.93

Table 8. Path analysis of traits affecting white sugar yield under normal condition

		Indirect effect		
Variables	**Direct effect**	**Root yield**	**Percent of sugar extraction**	**Sugar content**
Root yield	0.91**	1	0.072	-0.043
Percent of sugar extraction	0.28**	0.23	1	-0.040
Sugar content	0.24**	-0.16	-0.047	1

Table 9. Results of stepwise regression analysis of the studied traits with white sugar yield as dependent variable under salt stress condition

Variables	1	2	3
Contrast	-19.95	-22.84	-24.40
Percent of sugar extraction	0.28	0.16	0.16
Root yield		0.14	0.16
Sugar content			0.52
R^2	0.69	0.85	0.88

Table 10. Path analysis of traits affecting white sugar yield under Salt stress condition

		Indirect effect		
Variables	**Direct effect**	**Percent of sugar extraction**	**Root yield**	**Sugar content**
Percent of sugar extraction	0.40**	1	0.27	-0.10
Root yield	0.89**	0.12	1	-0.27
Sugar content	0.62**	-0.06	-0.39	1