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Original article

Response of sugar beet multigerm genotypes to salinity stress

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Extended abstract

Introduction

Nowadays it is focused on sugar beet monogerm varieties because of mechanization improvement In Iran, but it couldn't be said that monogerm root and sugar yields are more than multigerm varieties. In some experiments, root yield of monogerm sugar beet varieties is more, equal or even less than multigerm ones. Although sugar and white sugar yields of monogerm sugar beet varieties are similar to multi germ in most experiments and sugar beet seed germ based on mono or multi doesn't affect on sugar purity percentage. Beet production areas such as clay texture lands are still dedicated to multigerm varieties. It is recommended to use multigerm varieties to alleviate undesirable environmental effects such as drought and salinity stress to have better plant germination and establishment. Improvement of salt tolerant multigerm varieties could be very important to decrease the effect of this stress on sugar beet. Therefore, screening of sugar beet multigerm germplasm under saline condition to develop multigerm varieties is necessary.

Material and Methods

In this study, 20 sugar beet multigerm genotypes were evaluated under normal and saline conditions (EC=20 dS/m) in factorial experiment based on completely randomized design with four replications. Firstly, two seed germination methods including fast germination test in Erlen and between paper tests, used in laboratory. Seed germination percentage and field emergence potential (FEP) were measured in this stage. Then, the genotypes were compared under normal and saline (EC=16 dS/m) conditions in four replications in greenhouse. Samples took two months after stress initiation at establishment stage (8-10 leaves). Fresh and dry matters, sodium (Na), Potassium (K), phosphorus (P), total soluble carbohydrates of leaves were measured in this stage .

Results

Salinity decreased seed germination in fast germination test in Erlen and between paper test significantly ($P<0.01$). Seed germination percentage decrease from 97 to 75 % in between paper test and from 17.4 to 0.15% in fast germination test also abnormal germs increased by 39%. Seed germination and abnormal germs were also different significantly among genotypes ($P< 0.01$). Effect of salinity, genotype, cross effect of salinity*genotype was significant ($p<0.01$) on plant density, shoot, root and

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total dry weights, P, total soluble carbohydrates in green house experiment. 7233, AMP2 and PB13-S2-151-HSF-91genotypes had the highest field emergence potential (FEP) with 0.176, 0.09 and 0.05, respectively. Salinity decreased total, shoot, and root dry weights, K and soluble carbohydrate by 20, 24, 6, 42 and 38 percent respectively and increased Na and P by 400 and 11 percent, respectively.

Conclusion

Finally, the genotypes PB 13S2-151-HSF 915, 7233, S1–930882, S1–931008, Poly8823, S1–930770, Gazale, S1–930910, 5RR-87-HS-28 and S1–930792 were selected as tolerant materials based on fast germination and between paper germination tests, yield and biochemical traits. Some of selected genotypes were evaluated and been selected under drought or saline stress studied in field experiments but result of field experiments could be achieved after 7 months while the result of this experiment was taken after two months. So, the similarity of result of this experiment with field tests showed that fast genotype screening in green house could be useful for accelerating breeding of salt tolerant varieties.

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***Keywords*:** Biochemical traits, Fast seed germination test, Greenhouse, Laboratory, Saline condition

Table 1. Characteristics of multigerm pollinators used in the experiment

No	Genotype	Background
1	**PB13-S2-151-HSF-915**	Drought tolerance
2	**5RR-87-HS-33**	Drought tolerance
3	**5RR-87-HS-28**	Drought tolerance
4	**AR-HS-735-91**	Early maturity
5	**SBSI-DR-I-HSF-14-P.35**	Drought tolerance
6	**8001 - bulk**	Salinity tolerance
7	**Motahar**	Rhizomania resistance
8	**AMP2**	Rhizomania resistance
9	**Poly8823**	Rhizomania resistance
10	**7233**	Salinity tolerance
11	**Gazale**	Salinity tolerance
12	**S1 - 930770**	Drought tolerance
13	**S1 - 930772**	Drought tolerance
14	**S1 - 930792**	Drought tolerance
15	**S1 - 930882**	Drought tolerance
16	**S1 - 930910**	Drought tolerance
17	**S1 - 930962**	Drought tolerance
18	**S1 - 931008**	Drought tolerance
19	**191**	Sensitive
20	**Shahrood-95**	Rhizomania resistance

Table 2: Mean square of germination traits for sugar beet multigerm genotypes under salinity stress

S.O.V	df	Between paper germination test	Abnormal germs	Erlen fast germination test
Salinity	1	19250.15**	60.63**	653.10**
Genotype	19	1128.86**	3.49**	1.13**
Salinity*genotype	19	430.57**	3.62**	0.84**
Error	120	37.72	0.2	0.08
C.V.%		*7.13*	*54.97*	*11.24*

** and * significant at α=0.01 and 0.05, respectively

Table 3. Mean comparison of seed germination, abnormal germ and adjusted seed germination percentage of genotypes under saline level

Genotype	Seed germination[1] (%)	Abnormal germ (%)	Adjusted germination[2]
PB13-S2-151-HSF-915	80.04[cdef]	5.09 [bc]	0.81 [bcde]
5RR-87-HS-33	71.49[efg]	0.49 [c]	0.77 [cde]
5RR-87-HS-28	79.36[cdefg]	0.00 [c]	0.79 [cde]
AR-HS-735-91	83.53[bcde]	5.00 [bc]	0.84 [bcd]
SBSI-DR-I-HSF-14-P.35	74.83[defg]	4.62 [bc]	0.76 [de]
8001 - bulk	81.28[cde]	0.00 [c]	0.89 [abcd]
Motahar	89.30[abc]	1.46 [c]	0.91 [abc]
AMP2	95.09[ab]	0.00 [c]	0.95 [ab]
Poly8823	91.46[abc]	0.00 [c]	0.91 [abc]
7233	85.81[abcd]	0.00 [c]	0.86 [abcd]
Gazale	25.07[i]	0.00 [c]	0.33[g]
S1 - 930770	79.70[cdefg]	4.46 [bc]	0.80 [cde]
S1 - 930772	83.34[bcde]	4.50 [bc]	0.83 [bcd]
S1 - 930792	87.16[abcd]	1.02 [c]	0.87 [abcd]
S1 - 930882	68.34[fg]	8.03 [b]	0.68 [e]
S1 - 930910	75.94[defg]	3.00 [bc]	0.77 [cde]
S1 - 930962	52.72[h]	16.50 [a]	0.53 [f]
S1 - 931008	67.17[g]	5.00 [bc]	0.67 [e]
191	97.94[a]	0.00 [c]	0.99 [a]
Shahrood-95	33.90[i]	20.00 [a]	0.38 [g]

1. Seed germination without hollow seed.

2. Adjusted germination is calculated based on germination in salinity to normal condition. Means in each column followed by unsimilar letter (s) are significantly different at 5% probability level using Duncan's multiple range test

Table 4. Mean square of quantitative and qualitative traits of sugar beet genotypes under salinity in greenhouse

SOV	df	Plant no	Shoot dry weight	Root dry weight	Total dry weight
Salinity	1	42.03**	4.08**	0.03**	4.77**
Genotype	19	5.11**	0.44**	0.08**	0.82*
Salinity*genotype	19	5.76**	0.97**	0.15**	1.86**
Error	120	2.475	0.20	0.04	0.37
Cv%		*15.16*	*38.55*	*44.38*	*37.98*

Table 4. Continued

SOV	df	Growth score	SPAD	p	Soluble carbohydrate	K/Na
Salinity	1	45.16**	331.49**	0.014**	1309070.14**	955.65**
Genotype	19	1.34*	29.31*	0.005**	61783.69**	2.71**
Salinity*genotype	19	5.66**	16.94	0.006**	37718.35**	2.59**
Error	120	0.70	16.31	0.00	14680.84	0.36
Cv%		23.09	10.94	14.81	30.99	19.06

** and * significant at α=0.01 and 0.05, respectively

Table 5. Mean comparison of sugar beet leaf quantitative and qualitative characteristics under sliced salinity level in greenhouse during 2017 which were tested with Duncan multiple test at α=0.05

Genotype	Total dry weight (g/p)	Shoot dry weight (g/p)	Root dry weight (g/p)
PB13-S2-151-HSF-915	1.78 abcd	1.32 ab	0.46 abcde
5RR-87-HS-33	1.24 bcde	0.91 bcde	0.33 cdef
5RR-87-HS-28	1.35 bcde	0.96 bcde	0.39 bcdef
AR-HS-735-91	1.23 cde	0.89 bcde	0.35 cdef
SBSI-DR-I-HSF-14-P.35	1.22 cde	0.90 bcde	0.32 cdef
8001 - bulk	1.49 bcde	0.96 bcde	0.53 abc
Motahar	1.06 de	0.71 cde	0.35 cdef
AMP2	0.76 ef	0.54 def	0.23 def
Poly8823	1.46 bcde	1.03 bcd	0.43 abcdef
7233	2.38 a	1.71 a	0.67 ab
Gazale	1.75 abcd	1.14 bc	0.62 abc
S1 - 930770	1.96 abc	1.27 ab	0.69 a
S1 - 930772	1.32 bcde	0.93 bcde	0.39 bcdef
S1 - 930792	1.32 bcde	0.99 bcde	0.33 cdef
S1 - 930882	2.06 ab	1.38 ab	0.68 ab
S1 - 930910	1.79 abcd	1.27 ab	0.52 abcd
S1 - 930962	1.61 abcd	1.23 abc	0.38 bcdef
S1 - 931008	1.89 abc	1.31 ab	0.59 abc
191	0.69 ef	0.47 ef	0.22 ef
Shahrood-95	0.31 f	0.18 f	0.13 f
Sȳ	0.24	0.16	0.089

Table 5. Continued

Genotype	Growth score	P (%)	Soluble carbohydrate (mg/gdwt)	K/Na
PB13-S2-151-HSF-915	2.50 cde	0.17 ef	319.43 bcd	0.71 abcd
5RR-87-HS-33	2.50 cde	0.21 cdef	235.58 cd	0.75 abc
5RR-87-HS-28	2.50 cde	0.19 cdef	304.02 bcd	0.71 abcd
AR-HS-735-91	3.00 bcd	0.21 cdef	247.18 cd	0.87 a
SBSI-DR-I-HSF-14-P.35	3.25 bcd	0.22 bcde	246.26 cd	0.72 abcd
8001 - bulk	3.50 bc	0.19 cdef	312.41 bcd	0.53 de
Motahar	2.00 de	0.19 cdef	268.27 cd	0.57 cde
AMP2	2.00 de	0.23 bcde	222.05 d	0.45 e
Poly8823	3.00 bcd	0.17 f	305.77 bcd	0.53 de
7233	3.50 bc	0.18 def	342.60 abcd	0.70 abcd
Gazale	3.50 bc	0.21 cdef	444.02 a	0.82 ab
S1 - 930770	4.00 ab	0.22 bcdef	271.65 cd	0.78 ab
S1 - 930772	2.50 cde	0.23 bcd	233.55 cd	0.81 ab
S1 - 930792	2.50 cde	0.27 ab	276.99 cd	0.72 abcd
S1 - 930882	5.00 a	0.22 bcde	413.88 ab	0.81 ab
S1 - 930910	5.00 a	0.20 cdef	339.74 abcd	0.55 cde
S1 - 930962	4.00 ab	0.19 cdef	273.02 cd	0.63 bcde
S1 - 931008	4.00 ab	0.18 ef	339.50 abcd	0.75 abc
191	2.00 de	0.24 bc	257.73 cd	0.54 de
Shahrood-95	1.50 e	0.29 a	356.13 abc	0.76 abc
Sȳ	0.40	0.015	37.54	0.06

Means in each column followed by un-similar letter (s) are significantly different at 5% probability level using Duncan's multiple range test

Table 6. Suitable genotypes in this experiment and their comparisons with other trials

No	Genotype	Half sib family source	Description	reference
1	**PB13-S2-151-HSF-915**		Good FEP	
2	**7233**		Good FEP	Khayamim, 2010; Anagholi et al., 2018
3	**S1-930882**	SBSI-DRI-HSF-14 p.7	Good for root and sugar yields, and STI	Orazizadeh, 2010a, 2014; Abbasi 2012; Anagholi et al., 2018
4	**S1-931008**	RR-87-HS33		
5	**Poly8823**			
6	**S1-930770**	SBSI-DRI-HSF-6 p.8	Good for root and sugar yields, and STI	Orazizadeh, 2014; Anagholi et al., 2018
7	**Gazale**			Gaber et al., 2006; Anagholi et al., 2018
8	**S1-930910**	SBSI-Dri-HSF 14 p. 35	Good for root and sugar yields, and STI	Orazizadeh, 2010a, 2014; Abbasi, 2012; Anagholi et al., 2018; Khayamim, 2014

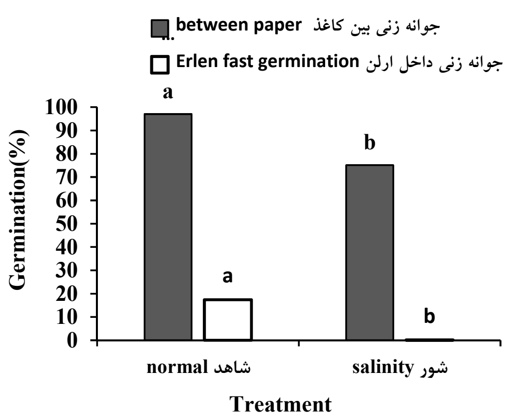

Fig. 1. Effect of salinity on sugar beet multigerm genotypes germination in two separate germination tests including between paper (ISTA, 1985) and in the Erlen fast germination (McGrath et al., 2008) tests

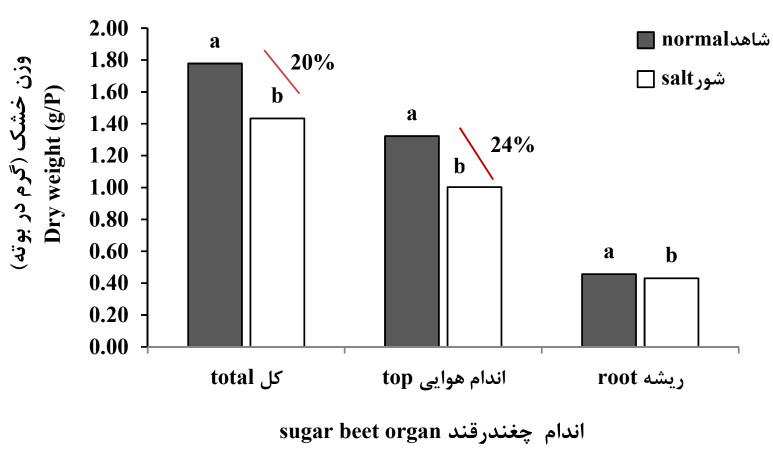

Fig. 2. Total, top and root dry weights of sugar beet in normal and saline conditions (EC= 16 dS/m)

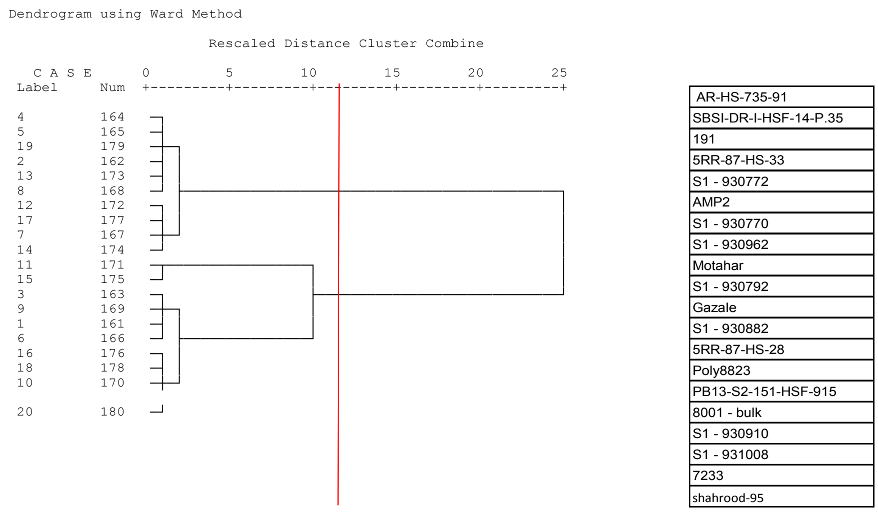

Fig. 3 .Cluster analysis using Ward's method for classifying genotypes based on dry weight, growth score, soluble carbohydrates and leaf K/Na in greenhouse during 2017