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## Identification of salinity tolerance in sorghum germplasm in National Plant Gene Bank of Iran

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( / / EC )

( )

(STI) (SSI)

SSI

STI

STI SSI STI

STI (r= / \*\*)

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/ / :

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(Tolerance index = TOL)

(YS)

(YP)

(Mean of Productivity = MP)

(Fischer and Maurer, 1978)

(Stress Susceptibility Index = SSI)

(Ramazani Moghadam and Parekar, 2002)

(Stress Tolerance Index = STI)

(Geometrical Mean Productivity = GMP)

(Velayati and Tavasol, 1991)

(Fernandez, 1992)

EC (Amacher, *et al.*, 1997)

EC

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(Amacher *et al.*, 1997)

(Holland *et al.*, 1999)

(Fernandez, 1992)

( )

(Elhagwa *et al.*, 2004)

(Farayedi, 2004)

(Rosielle and Hambelin, 1981)

(Abbasi, 2003)

(Naroui *et al.*, 2008)

Holland *et al.*, )

(Van Hoorn *et al.*, 1999)

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( )

(1999)

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(Boursier *et al.*, 2005)

NaCl

EC

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EC

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(Fouman and Majidi Hervan, 1992; Krishnamurthy

*et al.*, 2003)

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EC (

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ICRISAT

(Krishnamurthy *et al.*, 2003)

(Yazdi Samadi *et al.*, 2000)

$$SI = 1 - \left[ \frac{YS}{YP} \right] \quad SSI = \frac{1 - \left[ \frac{YS}{YP} \right]}{SI}$$

$$STI = \frac{(Yp)(Ys)}{YP^2}$$

YP YS

) ( ) (

( ) ( )

STI SSI

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%

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( )

%

b a

(IPGRI/ICRISAT, 1993)

(Fouman and Majidi Hervan, 1992)  
(Krishnamurthy *et al.*, 2003)

(SSI)

(STI)

( )

(NS)

(S)

Table 1. Statistical parameters of distribution and center tendency of agro-morphological traits in sorghum germplasm of National Plant Gene Bank in stressed (S) and non-stressed (NS) conditions

Traits*	Valid data		Missing data		Mean		Standard error of mean		Mode		Standard deviation		Minimum		Maximum	
	NS	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS	S
E (%)	142	142	1	1	87.7	52.64	1.4	1.79	100	30.18	16.73	0.33	7.5	0.33	100.00	100.00
NPP	142	119	1	23	18.2	3	0.4	0.2	17.5	3.13	4.78	1.00	2.5	1.00	32.00	17.00
PH (cm) ( )	142	117	1	25	138.6	60.33	2.12	2.3	137.5	35.2	25.22	4.00	73	4.00	186.50	128.00
PYF (g) ( )	142	142	1	0	3594	262.59	88.93	20.1	3000	338.79	1059.74	20.00	500	0.00	6775.00	2000.00
SPY (g) ( )	142	119	1	23	225.6	119.59	9.04	5.95	312.5	91.82	107.7	16.70	66.27	6.70	874.24	550.00
DF %	129	53	14	89	80.3	65.35	1.15	2.27	80	23.28	13.04	50.00	54	0.00	120.00	114.00
NLP	142	112	1	30	13.8	9.97	0.24	0.23	12	3.45	2.82	2.50	6	2.500	23.00	17.00
WB	142	118	1	24	4.9	4.41	0.12	0.14	5	2.16	1.43	1.00	2	1	8.00	9.00
NTP	142	122	1	20	4.1	2.77	0.13	0.09	3.5	1.4	1.55	1.00	1.5	1	13.50	10.00
SD(mm) ( )	141	99	2	43	19.2	16.92	0.89	0.44	16.975	6.19	10.6	2.45	6.615	2.45	125.58	34.52
PHR(cm) ( )	142	-	1	-	87.8	-	2.05	-	93	-	24.45	-	25	-	146.50	-
DM	120		23	-	102.5		0.84		105		9.16		82.5		123.00	-
PW(cm) ( )	126	60	17	82	8.3	4.64	0.27	0.2	6	2.18	2.99	2.00	3.5	2	18.50	13.00
PL (cm) ( )	126	60	17	82	19.4	12.79	0.73	0.55	8.5	6.05	8.18	5.00	5	5	42.50	35.00
GW(g) ( )	133		10		1.85		0.16	-	1.15	-	1.84		0.6	-	5.50	-
BYSP(g) ( )	141		2		510.9		26.64		162.5		316.36		25	-	1725.00	-
CC a and b a,b	142		0		42		0.68		40.5		8.16		0	-	60.25	-
FLA	142		1		184.9		10.52		71.9		125.35		0	-	695.25	-

\*: E= Emergence, NPP= No. of plant/plot, PH= Plant height at flowering (cm), PYF= Plot yield at the first cut, SPY= Single plant yeild at first cut, DF= Days to 50% fowering , NLP= No. of leaf /plant, WB= Waxy bloomy, NTP= No. of tiller/plant, SD= Stem diameter, PHR = Plant height at regrowth , DM= Days to maturity, PW= Panicle width, PL= Panicle length (cm), GW= 100-grain weight, BYSP= Biological yield of single plant, CC a and b= Chlrophyll a, b content, FLA= Flag leaf area

.( (Abbasi, 2007)

STI

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04TN0076

04TN0074

04TN0085 ( )

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04TN0170

04TN0042

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KC90010

04TN0018

04TN0113

(

)

04TN0115

SSI

04TN0033

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04TN0024

(

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04TN0017

04TN00141

STI

IS2302

ICRISAT

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04TN0150

IS4242 ICRISAT

/

04TN0187

IS18758 ICRISAT

04TN0114

/

STI 04TN0009

SSI ( )

( )

04TN0018

SSI STI

( )

KC90016

SSI

(Narouei *et al.*, 2008)

SSI STI

SSI

STI SSI

STI

(Abbasi, 2007)

(STI)

(SSI)

(PH)

(Y)

Table 2. Tolerant and susceptible sorghum germplasm - using stress susceptibility (SSI) and stress tolerance (STI) indices based on the first cutting biological yield (Y)

Accession number	Susceptibility	STI		SSI		Origin		
		PH	Y	PH	Y	Country/Province	/ *City	
Semi-wild sorghum								
04TN0009	Tolerant	0.32	0.86	1.01	0.82	Sistan and Baluchestan		Saravan
04TN0038	Tolerant	0.17	0.55	1.01	0.70	Kerman		
04TN0050	Susceptible	0.27	0.24	1.01	1.36	Unknown		
04TN0033	Susceptible	0.08	0.15	1.07	1.54	USA		
Grass sorghum								
04TN0078	Tolerant	0.08	0.5	0.96	0.08	Yazd		Tabas
04TN0049	Tolerant	1.58	0.18	1.06	1.58	Unknown		
04TN0102	Tolerant	1.6	0.1	1.08	1.6	Mazandaran		Gobad Kavoods
04TN0004	Susceptible	0.69	0.48	0.9	0.69	Syria		
04TN0108	Susceptible	0.82	0.55	1.04	0.82	Bushehr		
Grain sorghum								
KC90002	Tolerant	0.38	0.61	2	0.78	Sistan and Baluchestan		Saravan
04TN0005	Tolerant	0.16	0.54	1.01	1.15	Syria		
04TN0191	Tolerant	0.2	0.26	1.03	0.78	Sudan		IS25017
04TN0181	Tolerant	0.02	0.17	1.06	1.41	Lebanon		IS18175
04TN0034	Tolerant	0.28	0.21	0.86	1.29	USA		
KC90006	Susceptible	0.1	0.41	6	0.85	Sistan and Baluchestan		Chabahar
KC90015	Susceptible	0.5	0.41	5	0.96	Markazi		Delijan



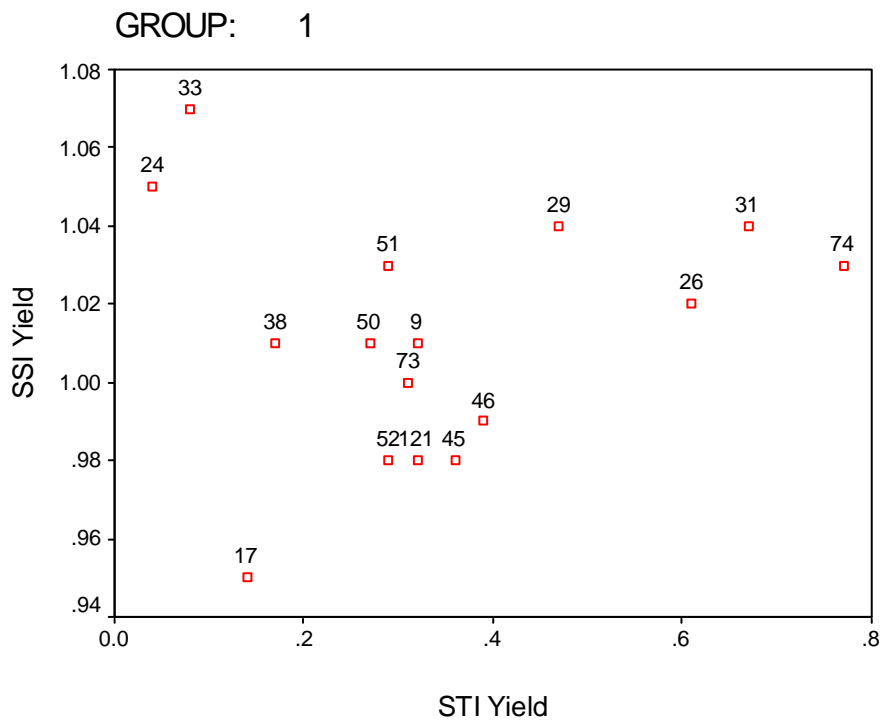
Table 2: Continued.

Accession number	Susceptibility	STI		SSI		Origin		
		PH	Y	PH	Y	Country/Province	/	*City
Forage and sugar sorghum								
04TN0042	Tolerant	2.91	0.86	1.00	0.85	Fars		Fasa
04TN0018	Tolerant	0.59	0.73	0.95	0.69	Yazd		Tabas
04TN0039	Tolerant	1.31	0.74	0.95	0.96	Sistan and Baluchestan		Iranshahr
04TN0113	Tolerant	1.65	0.45	0.99	1.15	Bushehr		Dashtestan
04TN0150	Tolerant	0.35	0.31	0.51	1.08	India		IS4242
04TN0187	Tolerant	0.31	0.15	0.69	1.18	Ethiopia		IS18758
04TN0071	Susceptible	0.43	0.28	1.07	1.49	Kerman		Kerman
04TN0083	Susceptible	1.1	0.53	0.94	0.75	Khorasan		Ferdos
04TN0070	Susceptible	0.59	0	1.04	1.79	Fars		Abadeh
04TN0167	Susceptible	0.33	0.06	0.73	1.02	Sudan		IS9639
Broom sorghum								
04TN0115	Tolerant	4.37	0.93	0.94	0.62	Yazd		Taft
04TN0101	Tolerant	1.13	0.91	0.96	0.63	Golestan		Gonbad Kavoods
04TN0114	Tolerant	0.41	0.43	0.76	0.76	Sorthern Khorasan		Birajnd
04TN0089	Tolerant	0.6	0.64	0.94	0.53	Ilam		Ilam
04TN0014	Susceptible	0.38	0.32	1.06	1.23	Qom		Qom
04TN0103	Susceptible	0.73	0.14	1.01	1.52	Kerman		Baft
04TN0112	Susceptible	0.44	0.12	0.99	1.44	Golestan		Gobad Kavoods

\*: or Accession number of ICRISAT sorghum collection

ICRISAT

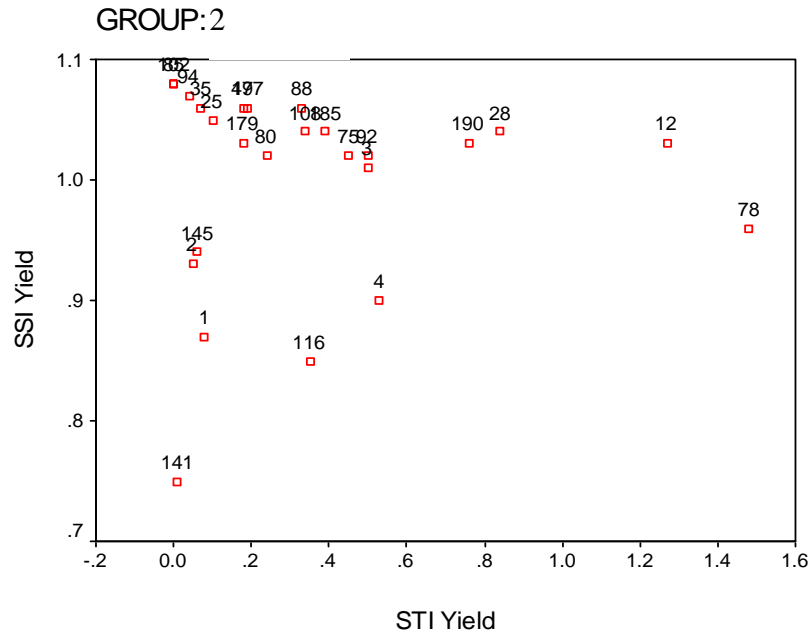
\*:



STI SSI  
 ( KC TN )

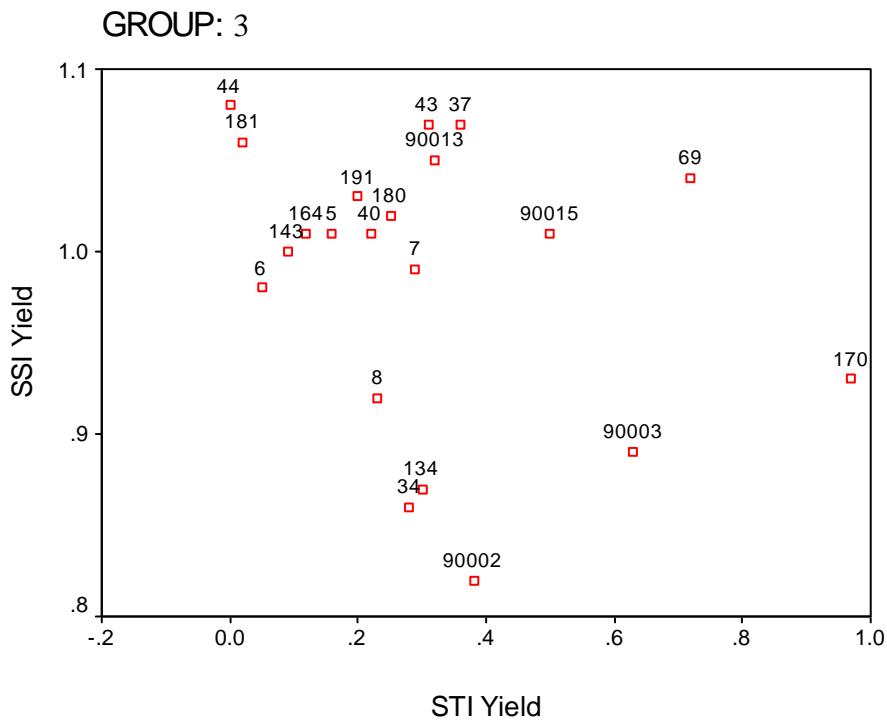
Fig. 1. Distribution of semi-wild sorghum accessions in biplot using SSI and STI for the first cutting yield (numbers in the plot indicate accession number in Gene Bank)

STI SSI  
 04TN0001 ( ) STI SSI  
 STI )  
 ( SSI  
 04TN0085 .( )  
 STI SSI  
 .( ) STI 04TN0031 04TN0074  
 SSI ( )  
 SSI  
 04TN0088 04TN0179 04TN0025 04TN0078  
 .( )  
 04TN0004



STI SSI  
 ( KC TN )

Fig. 1. Distribution of grass sorghum accessions in biplot -using SSI and STI for the first cutting yield (numbers in the plot indicate accession number in Gene Bank)



STI SSI  
 ( KC TN )

Fig. 1. Distribution of grainy sorghum accessions in biplot using SSI and STI for the first cutting yield (numbers in the plot indicate accession number in Gene Bank)

04TN0015

KC90002

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SSI

04TN0096 KC90010

04TN0170 KC90003

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04TN0048 04TN0060 04TN0137

04TN0134 04TN0034

STI SSI 04TN0079

04TN0043 04TN0044

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04TN0191 04TN0037 04TN0181

.( )

04TN0114 04TN0101

STI

04TN0150 04TN0042

SSI

STI

SSI

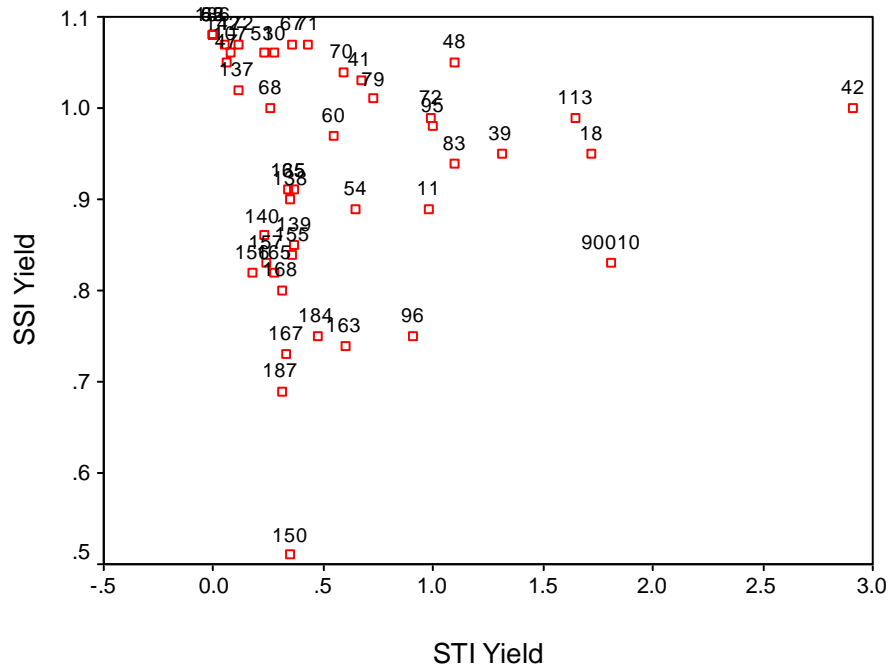
.( )

04TN0049 SSI

04TN0115 04TN0036

STI

GROUP: 4



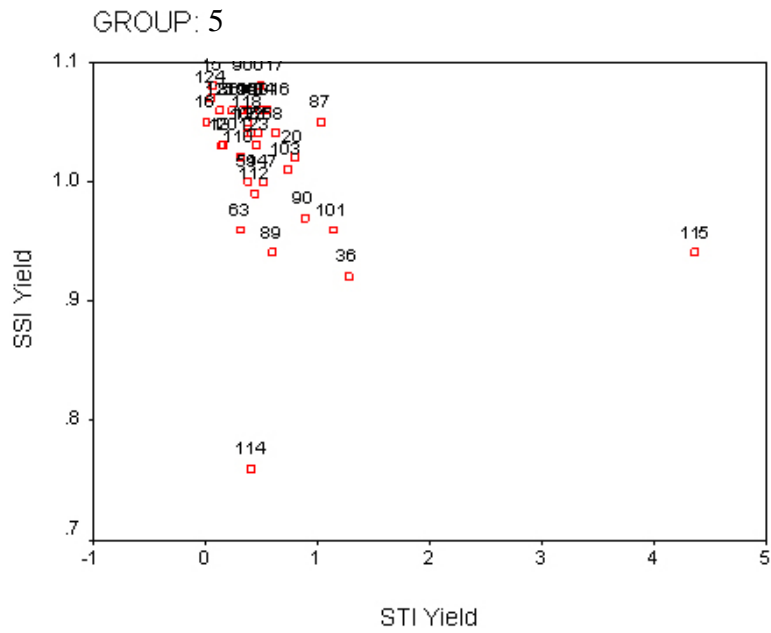
STI SSI

( KC TN )

Fig. 1. Distribution of forage-sorghum accessions in biplot using SSI and STI for the first cutting yield (numbers in the plot indicate accession number in Gene Bank)

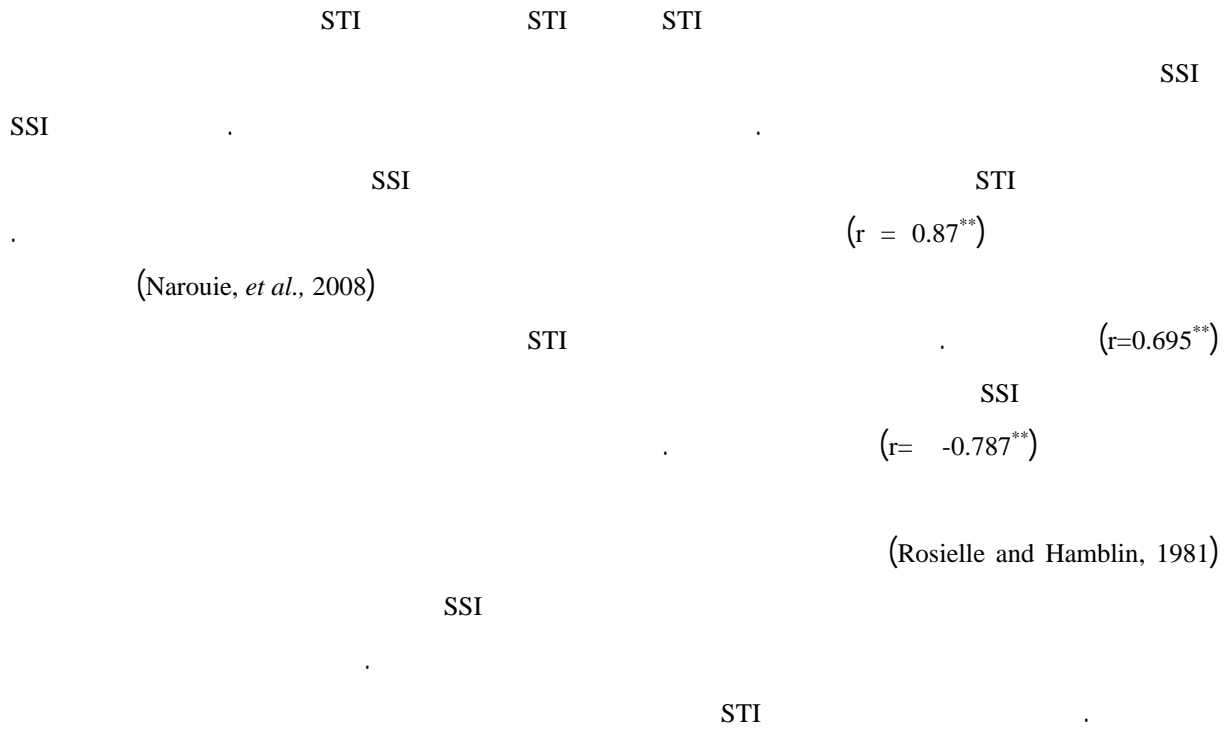
( )

04TN0124 04TN0014



STI SSI  
 ( KC TN )

Fig. 1. Distribution of broom sorghum accessions in biplot using SSI and STI for the first cutting yield (numbers in the plot indicate accession number in Gene Bank)



(STI) (SSI)

Table 3. Correlation coefficients between stress susceptibility (SSI) and stress tolerance (STI) indices with biological yield in the stressed and non-stress conditions

Traits		STI		SSI		PYS		
		PYNS	PHNS	PH	Y		PH	Y
PHS		0.042 <sup>ns</sup>	0.258 <sup>**</sup>	0.787 <sup>**</sup>	0.267 <sup>**</sup>	-0.732 <sup>**</sup>	0.063 <sup>ns</sup>	0.543 <sup>**</sup>
PYS		0.082 <sup>ns</sup>	0.054 <sup>ns</sup>	0.359 <sup>**</sup>	0.695 <sup>**</sup>	-0.380 <sup>**</sup>	-0.209 <sup>**</sup>	
SSIY	SSI	0.068 <sup>ns</sup>	0.141 <sup>*</sup>	0.076 <sup>ns</sup>	-0.064 <sup>ns</sup>	0.035 <sup>ns</sup>		
SSIPH	SSI	0.063 <sup>ns</sup>	-0.106 <sup>ns</sup>	-0.575 <sup>**</sup>	-0.232 <sup>**</sup>			
STIY	STI	0.472 <sup>**</sup>	0.168 <sup>**</sup>	0.240 <sup>**</sup>				
STIPH	STI	0.039 <sup>ns</sup>	0.372 <sup>**</sup>					
PHNS		0.264 <sup>**</sup>						

\* and \*\*: Significant at the 5% and 1% probability levels, respectively

ns: Non-significant

+: PYS = Plant yield in stressed condition, SSIY = SSI using yield, SSIPH = SSI using plant height, STIY = STI using yield, STIPH = STI using plant height, PHNS= Plant height in non-stress condition, PYNS = Plant yield in non-stress condition, PHS = Plant height in stressed condition.

STI

(Abbasi, 2003)

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(Abbasi, 2003)

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(Hemati and Abbasi, 2000)

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## **Identification of salinity tolerance in sorghum germplasm in National Plant Gene Bank of Iran**

**Abbasi<sup>1</sup>, M. R. and A. R. Nakhfroush<sup>2</sup>**

### **ABSTRACT**

**Abbasi, M. R. and A. R. Nakhfroush.** Identification of salinity tolerance in sorghum germplasm in National Plant Gene Bank of Iran. **Iranian Journal of Crop Sciences.** 10(2): 191-207.

In order to screen sorghum germplasm in National Plant Gene Bank of Iran for salinity tolerance, 142 sorghum accessions from five different types were planted in two different field growing conditions. Electronic conductivity (EC) of irrigation water was 2.12 and 14.8 ds/m in non-stress and salinity stress conditions, respectively. Experimental design was Balanced Group Blocks with two replications. The grouping in each block was based on sorghum types (wild, grass, grain, forage, and broom sorghums). This experimental design allowed us to compare sorghum types in order to differentiate and identify the most tolerant and susceptible germplasm. Stress susceptibility index (SSI) and stress tolerant index (STI) based on single plant biological yield and plant height traits were used in the analysis. Based on these indices the tolerant accessions were identified within and between sorghum types. The distribution of tolerant and susceptible accessions in each type was determined by using biplot for SSI and STI. These analyses facilitated the identification of the tolerant germplasm in both local or introduced accessions. These germplasm can be used in sorghum breeding programs for tolerance to salinity. Passport data showed that there was no correlation between the tolerance to salinity and the origin of germplasm. However, the correlation coefficients of STI, SSI, yield and plant height showed a high relationship between STI and the first cutting yield ( $r = 0.695^{**}$ ), implying that STI is the most suitable index for screening sorghum germplasm for tolerance to salinity stress.

**Key words:** Sorghum, Salinity stress, Accession, Tolerance and Susceptibility.

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1. Faculty member, Seed and Plant Improvement Institute, Karaj, Iran, (Corresponding author)

E-mail address: [rezaabbasi@yahoo.com](mailto:rezaabbasi@yahoo.com)

2. Faculty member, Agriculture and Natural Resources Research Center of Khorasan Razavi.