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Performance of Some Sorghum Genotypes under Salinity Conditions

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Abstract: *Tow field trials were carried out at Siwa station DRC, during two growing summer seasons (2012and 2013) to evaluate the variation and mean performance of seven selected genotypes of sorghum i.e. (ICSV93046,ICSR93034,S35, CSV745, JJ1041andCSV15) obtained from ICBA, and local variety hybrid 102, under salinity soil condition and water irrigation system(4500 ppm).Selection of the proper germoplasm, integrated soil and water management were essential, under standing diversity for salt tolerance among (sorghum bicolor L.Moench) genotypes is expected to facilitate their selection for use under Siwa Oasis conditions .Wide range of variability between sorghum genotypes , and high genotypic differences were detected . Hence, the genotypes tested had wide diversity and ranked differently among locations and seasons. The results showed that after 45 days of planting plant height, forage fresh weight/plant and forage dry weight/plant recorded its maximum value with JJ 1041 sorghum genotype, while the highest value of No .of tillers/plant were obtained from CSV15 sorghum genotype . The highest No. of leaves/plant was obtained from Hybrid 102 CV, with respect to yield and its components .The CSV15 genotype, recorded the highest value for each of flowering date 10%, No of leaves/plant, leaf area (cm^2) and biomass yield/plant(g), while, the highest value of plant height (cm) and 1000 seed weight (g) were obtained by ISCR 93034 genotype. In addition ICSV 745 genotype. had the highest value of No. of tillers / m^2, leaves dry weight / plant (g) and No of effective tillers/m^2 .Meanwhile , stem diameter (cm) , tillers fresh weight / plant (g) , leaves fresh weight / plant (g) and tiller dry weight / plant (g) reached to its highest value by using JJ1041genotype. Also, it has been noticed that ICSV 39046 Sorghum genotype, tended to obtained the maximum value of each of seed yield / plant (g) and harvest index, while flowering date (50%) reached to its highest value by using S35 genotype.*

Keywords: *performance, yield and its attributes, salinity, sorghum genotype*

I. Introduction

Soil salinity is an important constraint to crop production, affecting about 95 million hectares worldwide (Szaboles,1994 **).** Although some crops are moderately tolerant to saline conditions, many crops are adversely affected by even low levels of salt (Greenway and Munns, 1980).

Salinity and drought are the major problem due to limited water supply. Salinity tolerance in sorghum is a complex trait affected by a number of interacting plant and environmental factors which are related to the stage of growth. Due to their sedentary mode of life, plants involve many adaptive strategies in response to different abiotic stresses such as high salt, dehydration, cold and heat, which ultimately affect plant growth and productivity. Against these stresses, plants adapt themselves by different mechanisms including change in morphological and developmental pattern as well as physiological and biochemical responses (Gill et al., 2002and Sunseri .et al., (2002)

The salt-affected soils can be utilized by growing salt tolerant plants, whether halophytes or some crops. With this fact in mind, it is imperative to explore intra-specific (inter-cultivar) variation for salt tolerance of a crop by screening its available germplasm. For instance, a great magnitude of inter-cultivar variation for salt tolerance has been observed in different species However, identifying sorghum genotypes that are Although , crop variation and there genotypes significantly differed in their relative yield reduction and / or their threshold values by salinity, able to tolerate salt stress condition in the most transferable technology to the farmers .Sorghum (Sorghum bicolor (L.) Moench) are important coarse-grain cereals in the drier world. Sorghum is grown on 45million ha^{-1} annually and ranks fifth in global cereal cultivation and relatively more widespread where it is cultivated in 86 countries of the tropical, subtropical, and warm-temperate regions of the world (Szabolcs, 1994 and Rai et al., 1999).

Sorghum is C_4 species with high photosynthetic efficiency and dry matter production ability , a usually grown under stress conditions in arid and semi-arid environments. Also, the crop is used as useful forage crop, and its stover is used for fodder, fencing, thatching, and fuel purposes.

Soil salinity greatly hampers sorghum productivity, and severely regions of the affecting subsequent growth (Azhar and McNeilly, 1989 andTabatabaei et al., 2012. Selection on the basis of grain yield character alone is usually not very effective and efficient. However, selection based on its components and secondary characters could be more efficient and reliable. Knowledge of the association and inter relationship between yield and its

components and among the component characters themselves can improve the efficiency of selection in plant breeding **(**Azhar and McNeilly. (1988),Maramba and Ando 1995., Ezeaku and Mohammed , 2006).

The present experiment was conducted to screen out various genotypes of sorghum for their response to salt stress during early growth and final stages, and to determine sorghum genotypes criteria for selection that could be effectively used to identify salt tolerant and adapted genotypes with high yield potential for large number of entries and selecting the suitable genotypes under salinity stress conditions of Siwa Oasis

II. Materials And Methods

This work was carried out during two successive summer seasons of 2012 and 2013 at Siwa experimental station, Desert Research Center. Seeds of six sorghum (Sorghum bicolor L. Moench) genotypes were obtained from (ICBA) as well as one Egyptian local cultivar Hybrid 102. The specific sorghum genotypes used in the research were accessions ICSV 93046, ICSR 93034, S 35, CSV 15, ICSV 745 and JJ 1041.

The seeds were sown on 16 May 2012 and 27 May 2013. Complete randomized block design with three replicates was applied. The plot area was of 8.0 x 3.5 m. two plant, per hill (40 cm. space). The other agricultural practices recommended for growing sorghum were followed. Plants were subjected to the proposed level of irrigation water (4500 ppm.) from sowing date. Data were recorded on plant height (cm.), No. of leaves/plant, No. of tillers/plant, forage fresh weight/plant (g.), and forage dry weight/plant (g), after 45days growth stage at maturity the average of ten graded plants were taken each of plot to calculate the seed yield of individual plants and their attributes i.e. Leaves dry weight / plant (g) ,tiller dry weight / plant (g) , No of effective tillers/ m^2, 1000 seeds weight (g) , biomass yield/plant ,seeds yield/ plant(g) and harvest index and for the two flowering date (10 and 50 %) and grain yield and its attributes.

Statistical analysis:-

The data were analyzed on individual plant mean basis the ordinary analysis of variance for randomized complete block design (R.C.B.D). Was performed, and upon obtaining significant differences the least significant differences (L.S.D.) test was applied for comparison of treatment means while phenotypic were calculated for all possible comparisons, according to snedecor and Cochran (1989). Correlation coefficient were analyzed following the procedures of Deway and Lu (1959).

III. Results And Discussion

Mean performance at early growth stage (45 days from plantin):

The mean performance of different sorghum genotypes after 45 days from planting date are presented in Table (1).There were significant differences between the studied genotypes after 45 days from planting. The tallest of plants were obtained from genotype (JJ 1041), recording a value of (51.93).The highest number of tillers/plant were obtained with genotype SV15 (1090). The highest value for number of leaves/plant was recorded with Hybrid 102 (6.50), while sorghum genotype JJ 1041 recorded the highest values for forage fresh weight / plant and forage dry weight / plant (41.83 and 16.28) respectively.,

Similar results were obtained by Maas et al. (1986), Azhar and McNeilly (1989), Kebebew and McNeilly (1996) and Jehan Bakht et al. (2000).

With respect to yield and its attributes**,** the results of the mean performance of the studied sorghum genotypes are presented in Table (2). Significant differences were detected among all genotypes for all traits recorded under salinity stress .The four genotypes CSV 15, JJ 1041, ICSV 745 and S 35 recorded the highest means for one or more of studied traits ;i.e. No. of effective tillers/m^2, 1000 grain weight and biomass yield/plant . This superiority in yielding ability was attributed to number of tillers/m^2, 1000 grain weight and biomass yield/plant as clearly shown in Table (2). The genotype of CSV15 was earlier in flowering date 10%, than S35, and recorded the highest values for No. of leaves/plant , leaf area, and biomass yield/plant, (16.65,515.18 and 212.58), respectively. Meanwhile, the genotype ICSR 93034 had the highest values of plant height and 1000 seeds weight/plant which reached 174cm and 32.5 g, respectively, while the highest values of seed yield/plant and harvest index (%) were obtained by genotype ICSV 39046 reaching 46.22 g and 40.06% respectively, Also, the highest values of tiller/m^2 , leaves dry weight/ plant and No of effective tillers /m2 were recorded for genotype ICSV 745, reaching 28.1,33.09 and 23.15, respectively . The genotype of JJ1041 recorded the highest values for stem diameter, tillers fresh weight/plant ,leaves fresh weight/plant and tillers dry weight/plant reaching 4.15cm,201.25g, 25,76.25g and 61.539, respectively). The genotype S35gave the high of flowering date at 50% 153days. It could be concluded from the above mentioned results that the sorghum genotypes under study showed a high tolerance to salinity under siwa conditions, they could be their fore or recommended of use in breeding programs to obtain lines characterized by the higher productivity of grain yield and/or forage yield via its component characters. These results in agreement with Azhar and McNeilly (1989), Rai et al. (1999), Desclaux et al. (2000), Sunseri et al. (2002), Kinfemichael and Melkamu (2008), Francois et al. (1984), and Kafi1 et al. (2013).

Table1. Mean performance of Sorghum genotypes for studied traits after 45 days of planting under Siwa conditions as an average of the two growing seasons.

No.	Genotypes	Plant height (cm)	No. of Tillers/plant	No. of leaves/plant	Forage fresh weight/plant(g)	Forage dry weight/plant(g)
	Sorghum					
1	ICSV 93046	44.57	1.00	5.67	16.47	5.12
2	ICSR 93034	38.90	1.33	5.83	18.17	3.67
3	S 35	35.00	1.00	5.67	11.30	2.88
4	CSV 15	34.20	1.90	4.83	11.67	2.36
5	ICSV 745	44.23	1.30	6.00	37.40	10.23
6	JJ 1041	51.93	1.86	6.33	41.83	16.28
7	Local CV. Hybrid 102	36.63	1.50	6.50	22.47	6.89
L.S.D.		5.05	0.67	1.07	2.35	5.31

Table2. Performance of Sorghum genotypes for some growth traits, yield and its attributes under Siwa conditions as an average of the two growing seasons.

No.	Genotypes	Flowering (10%)	Flowering (50%)	Plant Height(cm)	No. of Tillers/ M2	No. of leaves/plant	Leaf area (cm^2)	Stem diameter(cm)	Tillers Fresh Weight/ plant (g)
1	ICSV 93046	79	108	137.15	15.1	11	270.27	3.65	79.18
2	ICSR 93034	83	121.5	174	19.2	9.5	230.28	3.05	88.75
3	S 35	140	153	123	21.1	12.1	281.84	3.6	142.53
4	CSV 15	134.5	144	123.15	20.3	16.65	515.18	3.8	152.05
5	ICSV 745	100	114.5	159.4	28.1	15.1	401.02	3.4	97.57
6	JJ 1041	119.5	136	146.5	22.65	12.65	466.63	4.15	201.25
7	Local variety Hybrid 102	97	117.5	118.375	21.45	10.5	278.71	3.625	84.38
L.S.D.		10.27	12.03	13.23	1.97	1.19	34.03	0.34	11.97

Table 2 Continues

No.	Genotypes	Leaves Fresh Weight/plant (g)	Tillers Dry weight/plant (g)	Leaves Dry Weight/plant (g)	No. of Effective tillers/m^2	1000 seeds weight (g)	Biomass yield/plant (g)	seed yield/ plant (g)	Harvest index(%)
1	ICSV 93046	32.95	30.45	19.85	11.3	22.5	115.35	46.22	40.06
2	ICSR 93034	30.3	23.65	18.35	18.6	32.5	117.95	33.65	28.53
3	S 35	40.53	57.35	17.4	19.35	28.05	157.23	35.24	22.41
4	CSV 15	64.23	60.6	28.78	19.83	24.55	212.58	36.13	16.99
5	ICSV 745	65.3	37.14	33.09	23.15	24.8	181.17	30.77	16.98
6	JJ 1041	76.25	61.53	23.28	15.1	24.5	197.53	41.76	21.14
7	Local variety Hybrid 102	35.08	26.28	21.25	20.1	31.5	125.3	39.01	31.13
L.S.D.		4.39	4.06	2.22	1.75	2.54	15.19	3.54	2.56

Phenotypic correlation

Simple correlation coefficients are illustrated in Table (3) for sorghum genotypes after 45 days of planting. Results showed that plant height recorded highly significant ($P \leq 0.01$) positive phenotypic correlations with forage fresh and dry weight (0.825 and 0.874 respectively. The number of tillers/plant had significant ($P \leq 0.01$) positive phenotypic correlations with number of leaves/plant and forage dry weight /plant, Significant positive correlation coefficients were also found between forage fresh and dry weight/plant. Similar results obtained by Azhar and McNeilly (1988) and Ezeaku and Mohammed (2006) Data in , Table 4 represent the simple correlation coefficients for seed yield and its attributes , as flowering date (10%) correlated significantly and positively with each of, flowering date (50%), No. of leaves/ plant, leaf area, tillers fresh weight/plant (g), tillers dry weight/plant , biomass yield/plant and negatively with harvest index, flowering date (50%) correlated significantly and positively with each of, tillers fresh weight / plant , tillers dry weight/plant and biomass yield/plant. While, for No. of tillers/m^2, it correlated positively with each of, No. of leaves/plant, leaves fresh weight/plant, leaves dry weight/plant, No. of effective tillers/m2 and biomass yield/plant and negatively with both seed yield per plant and harvest index. For No. of leaves/ plant it correlated positively with each of, leaf area, leaves fresh weight/plant , tillers dry weight/plant , leaves dry weight/plant and biomass yield/plant, while it was negatively correlated with both 1000 seed weight and harvest index . For leaf area ,it correlated positively with each of stem diameter, tillers fresh weight/plant , leaves fresh, weight/plant, tillers dry

weight/plant, leaves dry weight/plant ,biomass yield / plant ,and negatively with both 1000 seed weight and harvest index . Tillers fresh weight/plant correlated positively with tillers dry weight/plant correlated positively and biomass yield/plant ,while leaves fresh weight/plant, tillers dry weight/plant, leaves dry weight/plant, and biomass yield/plan and negatively with harvest index .In addition, leaves dry weight/plant correlated positively with biomass yield/plant and negatively with harvest index, while No. of effective tillers/m^2 was significantly and negatively correlated with both seed yield/plant and harvest index . The same trend was found for relationship between biomass yield/plant and harvest index. Finally, seed yield / plant was highly significantly and positively correlated with harvest index. Similar findings were obtained by, Azhar and McNeilly. (1988) and Ezeaku and Mohammed (2006)

Table 3 .Phenotypic (Ph) correlation coefficients between characters in sorghum genotypes after 45 days of planting as an average of the two growing seasons.

Traits	Shoot length (cm.)	Root length (cm.)	Plant height (cm)	No. of Tillers/plant	No. of leaves/plant	Forage fresh weight/plant(g)
Root length (cm.)	0.283					
Plant height (cm.)	0.490	0.577				
No. of Tillers/plant	0.246	0.682	0.348			
No. of leaves/plant	0.447	0.325	0.490	0.832*		
Forage fresh weight/plant (g)	-0.332	0.472	0.825**	0.683	0.648	
Forage dry weight/plant (g)	-0.416	0.627	0.874**	0.749*	0.630	0.925**

In conclusion, taking the above results into consideration , sorghum genotypes could be categorized as sensitive, moderately tolerant and highly tolerant to salinity based on their relative abilities to maintain high germination level and well establishment under field conditions at early growth stage. Three genotypes of sorghum i.e. JJ1041, ICSV 745and S35 were found to be salt tolerant, while the two genotypes ICSV 93046 and ICSR 93034 were categorized as moderately tolerant, and the remaining genotypes were sensitive to salinity stress .Tolerant genotypes could be used in breeding programs as a source for genes of high yielding ability and confer adaptation genotypes under saline conditions .

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Table 4.Values of simple phenotypic correlation coefficients estimated between different pairs of sorghum traits estimated under Siwa conditions as an average of the average of the two growing seasons.

characters	1 Flowering date (10%)	2 Flowering date (50%)	3 Plant height (cm)	4 No. of Tillers/m^2	5 No. of leaves/ Plant	6 Leaf area cm^2	7 Stem diameter (cm)	8 Tillers Fresh Weight/plant (g)	9 Leaves Fresh Weight/plant (g)	10 Tillers Dry weight/plant (g)	11 Leaves Dry Weight/plant (g)	12 No. of Effective tillers/m^2	13 1000 seed weight (g)	14 Biomass yield/plant (g)	15 seed yield/ plant (g)	16 Harvest index
1		0.940**	-	0.291	0.588**	0.572*	0.513*	0.760**	0.496	0.944**	0.147	0.275	-0.178	0.740**	-0.236	.0.635**-
2			-0.401	0.101	0.362	0.386	0.37	0.746**	0.256	0.870**	-0.12	0.161	0.009	0.577*	-0.226	0.502
3				0.252	-0.206	-0.156	-0.543*	-0.176	-0.053	-0.446	0.116	-0.017	0.139	-0.146	-0.351	-0.065
4					0.501*	0.428	0.025	0.257	0.674**	0.222	0.685**	0.685**	-0.075	0.555*	.0.662**-	-0.764**
5						0.870**	0.366	0.432	0.971**	0.695**	0.839**	0.347	-0.598-	0.883**	-0.526	-0.809**
6							0.652**	0.710**	0.837**	0.699**	0.731**	0.133	-0.586**	0.955**	-0.075	-0.675**
7								0.751**	0.260	0.614**	0.138	-0.354	-0.582**	0.579*	0.568*	-0.044
8									0.368	0.818**	0.120	-0.121	-0.338	0.783**	0.079	-0.435
9										0.575**	0.923**	0.482	-0.510*	0.863**	-0.464	-0.873**
10											0.236	0.046	-0.461	0.820**	-0.084	-0.598**
11												0.475	-0.465	0.679**	-0.409	-0.720**
12													0.455	0.263	-0.863**	-0.704**
13														-0.498	-0.402	0.121
14															-0.262	-0.814**
15																0.767**

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الملخص العربى

تقييم بعض التراكيب الوراثية للسورجم تحت ظروف الملوحة

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اقيمت تجربتان حقليتان خلال الموسمين الصيفيين 2012و2013بمحطة بحوث سيوة – مركز بحوث الصحراء لدراسة استجابة بعض التراكيب الوراثيةالمستوردة من السورجم وهى((ICSV 93046,ICSR93034, S35, CSV745, JJ1041and CSV15 csv15))اضافة الى الصنف المحلى(هجين 102) تحت الظروف الملحية (4500جزء فى المليون) بواحة سيوة , وتم تقييم هذة التراكيب الوراثية من حيث النمو الخضرى (بعد 45 يوم من الزراعة) وكذلك المحصول ومساهماتة وكانت اهم النتائج كالتالى :

*- اشارت النتائج فى مرحلة النمو الخضرى (بعد 45 من الزراعة) الى تفوق التركيب الوراثى (JJ1041) على االتركيب الوراثية الاخرى تحت الدراسة فى صفات ارتفاع النبات والوزن الغض والجاف للعف/ نبات

*- وايضا اظهرت النتائج تفوق التركيب الوراثى (CSD15) بالمقارنة التراكيب الوراثية الاخرى للسورجم تحت الدراسة فى صفة عدد الاشطاء / نبات

*- كما دلت النتائج الى تفوق التركيب الوراثى المحلى (هجين 102) لصفة عدد الاوراق/ نبات عن بقية التراكيب الوراثية الاخرى للسورجم

*- واظهرت نتائج المحصول ومساهماتة الى تفوق التركيب الوراثى (CSV15) تفوقا واضحا على بقية التراكيب الوراثية الاخرى للسورجم فى الصفات الاتية وهى نسبة 10% من الازهار , عددالاورق / نبات , مساحة الاوراق/ نبات , المحصول البيولوجى للنبات . بينما نفس الاتجاة تحصل علية باستخدام التركيب الوراثى للسورجم (ISCR93034) لصفات ارتفا النبات , وزن الالف بذرة(جم)

و ايضا وصلت صفات عدد الاشطاء/ م2 ,وزن الاوراق الجاف/للنبات (حم) , وعدد الاشطاء الفعالة (النشطة) / م 2 الى اقصاها باستخدام التركيب الوراثى من السورجم (ICSV 745)

**- كذلك كان لاستخدام التركيب الوراثى (JJ1041) الى الحصول على اعلى القيم لكل من قطر الساق (سم) ووزن الاشطاء الغضة/ نبات , ووزن الاوراق الغضة/نبات , الوزن الجاف للاشطاء/نبات (جم) *- كما ادى استخدام التركيب الوراثى (ICSV93046) الى الحصول على اقصى القيم لكل من دليل الحصاد , ومحصول البذور/ نبات , ونسبة 50% من الازهار