PERFORMANCE OF SOME GRAIN SORGHUM LINES AND THEIR HYBRIDS UNDER OPTIMUM AND LOW INPUT NITROGEN CONDITIONS

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Abstract: Twenty-eight crosses were developed from four cytoplasmic male sterile lines (CMS-lines) and seven restorer lines (R-lines) at Shandaweel Agric., Res., Station, Sohag, Egypt, in 2003 season. Two field trails were conducted separately for each N level (First trail with 50 kg N/fed., Second trail with 100 kg., N/fed.,) in each trail, twenty eight crosses and their parental lines with the check Shandaweel-6 (sh-6) were evaluated in 2004 and 2005 successive seasons in the same Station. Data were recorded on days to 50% flowering, plant height (cm.), number of green leaves after grain filling, 1000-grain weight (g.), grain yield/plant (g.) and Nitrogen Tolerance Index (NTI).

The combined analysis of variance for each of the two levels of nitrogen over the two studied seasons showed highly significant differences among nitrogen (N) effects and genotypes (G) effects and their interaction. The best parents for general combining ability(gca) effects and the best crosses for specific combining ability (sca) effects and heterosis under low and high N levels were identified. Equal importance of additive (gca) and non-additive (sca) variances were found in some studied traits. For grain yield the gca effect of the female line (ATX-ARG-1) was positive highly significant under both N levels. While, the female (ATX-2-2) had positive highly significant gca effect under high level of N. The male lines R-93001 and R-89028 had Positive significantly gca effects under low N level. But the male line (Zenzpar-821) had positive significantly gca effects under high N level. These lines can be used in breeding program for low and high N levels. Also, the crosses (ATX-ARG-1x Zenzpar-821), (ATX- ARG-1x R-93012), (ATX- ARG-1x R-93001), (ATX- ARG-1x ZSV-14) (ATX-2-2 x R-93012), (ATX-2-2x ZSV-14) , (ATX-2-1 x R-89028) (ATX-2-1 x R-89037) and (ATX-2-1 x Zenzpar-821) were the best crosses in grain yield/ plant under both N levels.

key words: grain sorghum lines, hybrids, nitrogen

Introduction

Sorghum [*Sorghum bicolor* (L.) Moench] is often grown under nitrogen or water-limited conditions, but there is insufficient information on genotypic variation for grain yield and its components under stress conditions (Kamoshita *et al.*, *2000*). Thomas and Rogers, 1990 found that longevity of a leaf is intimately related to its nitrogen status. They explained that, during senescence, amino acids cease to be formed, existing protein is degraded and not replaced, and the resultant amino acids are translocated out of the leaf. A considerable proportion of leaf protein is bound in pigment-protein complexes of the photosynthetic apparatus, resulting in the characteristic yellowing of the leaf as chlorophyll is released from this association and subsequently broken down. It is likely that the coordination and triggering of senescence in the whole plant is regulated by an increased demand for nitrogen elsewhere which is communicated to source leaves. Gardner *et al,* 1994 found that, thicker sorghum leaves resulted in more mesophyll per unit leaf area and could have contributed towards increased photosynthesis rate per unit leaf area. Nawar *et al.*, 1994, concluded that the non-stress condition permitted a greater degree of genetic variation, while stress condition limited the genetic variation. They explained that increasing nitrogen amounts led to increasing all variations of means squares. Also, many of studied crosses showed heterotic effects relative to three check varieties. The best performing 15% of the tested hybrids out yielded the check (1) by 33% to 40% ,check (2) by 25% to 37% and check (3) up 9%, there were three best restorer lines. Ragheb and Elnagar, 1997 found that sorghum genotypes had different response in yield and its components under different N levels. Maranville 1997, concluded that, the African genotypes, Malisor 8-7and S34, had greater N use efficiency than the U.S. line CK60 in Mali. Also, He indicated that the greatest N use efficiency was 100% in the NO_3^- form rather than a mixture of NO_3^- and NH_4^+ ions. Menkir and Ejeta, 2003, concluded that when indirect selection involved yield combinations from low and high fertility or rain-fed and irrigated conditions, at least five lines appeared among the 10 top-ranking lines of each contrasting environment. Thus, greater gain in performance over contrasting environments may be achieved by selecting for yield in more than one environment, rather than by selecting in any single environment. Moran and Rooney 2003, found a significant differences among hybrids for plant height, days to anthesis and grain yield under different N levels. Al-Nagar *et al.*, 2006, concluded that N levels and genotypes x N levels interactions were highly significant for all studied traits. Low N-stress caused a significant reduction in grain yield for parental lines and their F_1's about 17.9and 15.2%, respectively. They mentioned that some lines and hybrid showed maximum low –N tolerance. Both general (gca) and specific (sca) combining ability effects were highly significant for all studied traits under both control and low-N conditions. They identified the best parents for (gca) effects and the best crosses for (sca) and heterobeltiosis under low and high N levels. The present study examined the expression of specific adaptation of F_1 crosses to nitrogen stress conditions, studying the effects of N fertilizer application on grain yield, identifying sorghum genotypes which are superior in N use efficiency, quantify the effect of N on genetic response and decrease the quantity of N with using stressed N sorghum genotypes to increase the farmer's income and their health.

Materials and Methods

Four grain sorghum cytoplasmic male sterile lines (CMS-lines) were crossed with seven grain sorghum restorer lines (R-lines) at Shandaweel Agric., Res., Station, in 2003 season to develop twenty eight crosses. The origin of the four female lines is from The USA and the male lines are from India. Two field trails were conducted separately for each N level (First trail with 50 kg N /fed., Second trail with 100 kg.,/fed.,) in each trail were evaluated twenty-eight crosses and their parents (11 parental lines) with the check Shandaweel-6 (sh-6) in 2004 and 2005 successive seasons at the same Station. Sowing dates were on 15th and16 th of June in both studied seasons, respectively. The texture of the soils under study was loamy, pH was 7.9 and containing 0.018 % total nitrogen. Extractable P and K were 22 and 298 ppm,, respectively in 2004 season and 19; 309 ppm, respectively in 2005 season. Each trail of the two nitrogen doses was conducted with three replicates in randomized complete block design .The nitrogen doses were added in two times as recommended in each trail. Each genotype was represented by a single row plot 4.0 m., long 60 cm, apart and 20 cm, between hills. Thinning was done after 21 days from sowing date leaving two plants/ hill. The recommended cultural practices and plant protection operations for sorghum production were implemented. Data were recorded on days to 50% flowering, plant height (cm.), number of green leaves /plant at grain filling, 1000-grain weight (g.), grain yield / plant (g.) with grain moisture adjusted to 14 % moisture and Nitrogen Tolerance Index (NTI) for grain yield (Yield under 50 kg., N /fed., / Yield under 100kg.,N/fed X100). Grain Yield was taken from 1 m of one inner plot row and calculated as grain yield/plant to avoid bird damage. Data of each year and combined over the two years for each nitrogen levels (50 and 100 kg., N/fed.) were subjected to analysis of variance according to Gomez and Gomez 1984 after testing the homogeneity of the error according to Bartelett, 1937. The line x tester analysis for the data of studied traits was performed and the proportional contribution of lines, tester and their interactions to total variance were estimated as shown in Singh and Chaudhry, 1977. Heterosis was computed as the percentage deviation of the F_1 mean from the mean of its better parent and its significance was tested by the appropriate LSD test.

Results and Discussion

1-Analysis of variance:

Data in (Table 1) under 50 kg., N/fed., indicated that highly significant differences for all studied traits among Genotypes (G) parents (P), crosses (C), their partitions (females (F), males (M), and F x M) and parent vs. crosses, except for P x C the 1000-grain weight was insignificant and the interaction between F x M was significant for plant height. The interactions between G x Y ,C x Y, P x Y, C x P x Y, M x Y and F x M x Y were highly significant for all studied traits except for C x Y the days to 50% flowering was significant and for the interactions between (C x P x Y) had insignificant for plant height and No., of green leaves/plant. The interaction between F x Y was insignificant for all studied traits.

Most of the data under 100 kg., N/ fed., (Table 2) had the same trend except the interaction between (F x Y) was highly significant for days to 50% flowering, No., of green leaves/plant and grain yield /plant.

2-Mean performance of studied genotypes:

For days to 50 % flowering (Table 3) the combined data over two seasons under 50 kg., N/fed., showed that none of the parental lines (female and male) was earlier than the check Shandaweel-6 (Sh-6) although, nineteen crosses were earlier than the check. Under 100kgN/fed., none of the parental lines was significantly earlier than the check (sh-6), while twenty-one crosses were earlier than the check. Also, comparing the data of days to 50% flowering under 50 and 100kg.N/fed., it can be concluded that there were a delay in flowering under low N level (50 kg. N/fed.). May be adding N with optimum doses accelerate flowering. Combined data over all (N levels & seasons) for days to 50 % flowering had the same trend for the parental lines and fifteen crosses were earlier than the check (sh-6).

For plant height none of the parental lines and their crosses was taller than the check (sh-6) under both nitrogen levels (50 and 100 kg. N/fed.) over the two studied seasons and combined over all. The data showed that the plant height of the all genotypes (parental lines and crosses) were shorter under low nitrogen level (50 kg., N /fed.) comparing with the optimum condition (100 kg., N/fed.).

Table(1): Combined analysis of variance for five studied traits under 50 kg. N /fed., in the two studied seasons without check.

S.O.V	d.f	Days to 50% flowering	Plant height (cm.)	No. of green leaves	1000-grain weight (g.)	Grain yield /plant (g.)
Years (Y)	1	48.02*	1723.18**	6.17*	22.65*	15.84*
R /Y	4	2.56	38.57	0.7	1.26	1.4
Genotypes (G)	38	14.38**	1876.25**	4.41**	7.65**	915.66**
Crosses (C)	27	5.93**	253.0**	1.63**	6.52**	52.68**
Parents (P)	10	7.41**	602.5**	3.98**	11.22**	321.84**
C x P	1	312.26**	58441.7**	83.69**	2.51	30154.35**
G x Y	38	2.48**	69.67**	1.1**	3.37**	7.56**
C x Y	27	1.55*	83.16**	0.9**	2.64**	6.75**
C x P x Y	1	10.12**	41.05	0.23	22.89**	26.6**
P x Y	10	4.24**	36.14	1.74**	3.4**	7.84**
Female effects (F)	3	7.44**	428.17**	3.65**	6.89**	72.41**
F x Y	3	0.77	72.62	0.92	1.75	3.19
Male Effects (M)	6	8.0**	758.63**	2.05**	16.82**	21.86**
M x Y	6	1.87	122.82**	1.37**	2.43*	10.57**
F x M	18	5.0**	55.26*	1.16**	3.03**	59.66**
F x M x Y	18	1.57*	71.69**	0.74*	2.86**	6.06**
Error	152	0.93	30.34	0.41	0.96	2.59

*, ** Significant at 0.05 and 0.01 probability levels, respectively.

Table(2): Combined analysis of variance for five studied traits under 100 kg. N/fed, in the two studied seasons without check.

S.O.V	d.f	Days to 50% flowering	Plant height (cm.)	No. of green leaves	1000 Grain weight (g.)	Grain yield/plant (g.)
Years (Y)	1	13.4*	1168.93**	35.39**	6.47*	440.61**
R/Y	4	1.32	50.39	0.59	0.77	2.24
Genotypes (G)	38	15.17**	1915.31**	11.17**	11.52**	1292**
Crosses (C)	27	6.7**	303.24**	5.16**	10.56**	109.23**
Parents (P)	10	10.08**	768.56**	4.38**	12.54**	316.24**
C x P	1	295.0**	56908.45**	241.39**	27.04**	42984.27**
G x Y	38	3.9**	66.42**	2.75**	1.69**	15.09*
C x Y	27	3.25**	86.46**	3.18**	1.69**	16.68**
C x P x Y	1	10.97**	15.97	2.25	2.36*	22.94
P x Y	10	4.94**	17.35	1.64*	1.6**	10
Female effects (F)	3	3.66*	437.82**	12.69**	6.55**	380.06**
F x Y	3	9.07**	7.26	9.48**	0.17	46.04**
Male Effects (M)	6	13.47**	973.67**	6.54**	24.42**	96.13**
M x Y	6	2.65	328.04**	3.64**	3.96**	5.94
F x M	18	4.94**	57.34**	3.45**	6.61**	68.47**
F x M x Y	18	2.49*	19.13	1.97**	1.19**	15.37*
Error	152	1.24	27.6	0.8	0.53	8.67

*, ** Significant at 0.05 and 0.01 probability levels, respectively.

Table(3): Mean performance of days to 50% flowering, plant height and No. of green leaves under two nitrogen levels (50 and 100 kg N/ fed.) combined over the two studied seasons and combined overall (comb.).

No.	Pedigree	Days to 50% flowering			Plant height (cm.)			No. of green leaves		
		50 N	100 N	Comb.	50 N	100 N	Comb.	50 N	100 N	Comb.
1	ATX-ARG1 x Zenzpar821	73.2	71.3	72.3	156.7	180.8	168.8	6.33	7.83	7.08
2	ATX-ARG1 x R-93012	72.5	70.0	71.3	160.0	179.7	169.8	6.50	8.17	7.33
3	ATX-ARG1 x R-93004	72.8	69.7	71.3	165.0	182.5	173.8	6.00	7.67	6.83
4	ATX-ARG1 x R-93001	75.0	71.5	73.3	161.7	192.5	177.1	5.83	7.83	6.83
5	ATX-ARG1 x ZSV-14	71.8	68.7	70.3	160.0	174.2	167.1	6.67	7.67	7.17
6	ATX-ARG1 x R-89028	72.5	69.5	71.0	157.5	181.7	169.6	6.33	7.67	7.00
7	ATX-ARG1 x R-89037	72.2	69.5	70.8	148.3	168.3	158.3	5.50	7.17	6.33
8	ATX-2-2 x Zenzpar821	74.8	71.8	73.3	169.2	189.2	179.2	7.17	8.33	7.75
9	ATX-2-2 x R-93012	73.0	71.7	72.3	164.2	187.5	175.8	6.33	8.67	7.50
10	ATX-2-2 x R-93004	73.7	71.3	72.5	160.8	182.5	171.7	6.83	9.50	8.17
11	ATX-2-2 x R-93001	71.7	69.2	70.4	167.5	187.5	177.5	7.00	9.50	8.25
12	ATX-2-2 x ZSV-14	71.8	69.7	70.8	166.7	184.2	175.4	7.00	9.83	8.42
13	ATX-2-2 x R-89028	72.7	69.5	71.1	160.0	182.5	171.3	6.33	8.50	7.42
14	ATX-2-2 x R-89037	74.3	71.2	72.8	150.0	170.8	160.4	7.17	7.83	7.50
15	ATX-2-1 x Zenzpar821	73.7	70.7	72.2	163.3	179.2	171.3	6.67	8.00	7.33
16	ATX-2-1 x R-93012	70.7	68.5	69.6	164.2	187.5	175.8	6.33	7.67	7.00
17	ATX-2-1 x R-93004	72.3	70.7	71.5	165.0	184.2	174.6	7.33	10.17	8.75
18	ATX-2-1 x R-93001	72.8	69.3	71.1	165.8	187.5	176.7	5.67	9.00	7.33
19	ATX-2-1 x ZSV-14	71.3	67.5	69.4	160.0	178.3	169.2	6.83	8.17	7.50
20	ATX-2-1 x R-89028	73.3	70.8	72.1	163.3	180.3	171.8	7.00	9.50	8.25
21	ATX-2-1 x R-89037	71.7	69.2	70.4	144.2	168.3	156.3	6.00	9.33	7.67
22	ATX-402 x Zenzpar821	73.3	71.3	72.3	155.8	172.5	164.2	7.33	9.33	8.33

** Significant at 0.05 and 0.01 probability levels, respectively based on the check.

Table(3): continue

No.	Pedigree	Days to 50% flowering			Plant height (cm.)			No. of green leaves		
		50 N	100 N	Comb.	50 N	100 N	Comb.	50 N	100 N	Comb.
23	ATX-402 x R-93012	72.7	69.5	71.1	157.5	178.0	167.8	6.00	8.33	7.17
24	ATX-402 x R-93004	73.0	70.5	71.8	161.7	179.2	170.4	7.17	10.83	9.00
25	ATX-402 x R-93001	73.0	70.5	71.8	155.8	183.3	169.6	7.00	8.83	7.92
26	ATX-402 x ZSV-14	73.2	69.2	71.2	153.3	177.5	165.4	6.83	8.50	7.67
27	ATX-402 x R-89028	73.7	70.7	72.2	157.5	178.3	167.9	6.83	7.67	7.25
28	ATX-402 x R-89037	73.3	71.3	72.3	145.0	160.8	152.9	6.00	7.33	6.67
29	BTX-ARG-1	73.3	71.8	72.6	122.5	149.2	135.8	3.83	5.17	4.50
30	BTX-2-2	75.0	73.2	74.1	113.3	134.2	123.8	5.33	5.83	5.58
31	BTX-2-1	76.0	73.3	74.7	111.7	128.3	120.0	4.00	5.33	4.67
32	BTX-402	74.8	74.3	74.6	106.7	125.0	115.8	5.83	6.67	6.25
33	Zenzpar-821	76.8	73.8	75.3	125.8	140.0	132.9	5.50	5.67	5.58
34	R-93012	76.8	73.8	75.3	130.0	153.3	141.7	4.83	5.33	5.08
35	R-93004	76.7	74.0	75.3	135.0	160.8	147.9	6.33	6.83	6.58
36	R-93001	75.7	73.0	74.3	132.5	150.8	141.7	6.33	7.83	7.08
37	ZSV-14	74.3	71.8	73.1	128.3	147.5	137.9	5.50	7.00	6.25
38	R-89028	75.3	73.7	74.5	137.5	157.5	147.5	5.00	6.67	5.83
39	R-89037	74.8	71.8	73.3	122.5	148.3	135.4	5.17	6.67	5.92
Shandaweel-6		74.8	72.0	73.4	161.7	184.2	172.9	6.17	9.17	7.67
$LSD_{0.05}$		1.56	1.83	1.70	8.49	8.54	8.52	1.34	1.13	1.24
$LSD_{0.01}$		2.05	2.40	2.23	11.14	11.20	11.17	1.76	1.48	1.63

** Significant at 0.05 and 0.01 probability levels, respectively based on the check.

For number of green leaves/plant, none of the parental lines and their crosses had significantly high number of green leaves/plant than the check under both N levels, over the two studied seasons and combined over all, except one cross (ATX-402 x R-93004) had highly significantly and significantly high number of green leaves/plant than the check under high N level and combined overall, respectively.

For 1000-grain weight/plant (Table 4) the combined data over two seasons under 50 kg. N/fed., none of the parental lines and their crosses had significantly heavy grain weight than the check (sh-6). Under 100 kg., N/fed., showed that two male lines (R-93004 & R-89037) and two crosses (ATX-402 x R-93004) and (ATX-402 x R-93001) had significantly heavy grain weight than the check (sh-6). Combined over all data showed that only one male line (R-93004) and one cross (ATX-402 x R-93004) had significantly heavy grain weight than the check (sh-6).

For grain yield /plant, the combined data over two seasons, under 50 kg. N/fed., showed that neither the female nor the male lines yielded significantly more than the check (sh-6) and nine crosses yielded significantly more than the check (sh-6). Under 100kgN/fed., the parental lines had the same trend, although, five crosses yielded significantly more than the check (sh-6). Combined data over all showed that none of the parental lines yielded more than the check and seven crosses yielded significantly more than the check (sh-6). Under low N level (50 kg., N/fed.) it is clear that the studied genotypes yielded less than the optimum condition (100 kg., N/fed.), but genotypes still have diversity under both N levels conditions.

Dealing with Nitrogen Tolerance Index (N T I) data, it is obvious that all the male lines, one female line (BTX-2-2) and twenty-two crosses had better NTI more than the check sh-6. These results in harmony with the results obtained byThomas and Rogers, 1990 found that longevity of a leaf is intimately related to its nitrogen status. They explained that, during senescence, amino acids cease to be formed, existing protein is degraded and not replaced, and the resultant amino acids are translocated out of the leaf. A considerable proportion of leaf protein is bound in pigment-protein complexes of the photosynthetic apparatus, resulting in the characteristic yellowing of the leaf as chlorophyll is released from this association and subsequently broken down. It is likely that the coordination and triggering of senescence in the whole plant is regulated by an increased demand for nitrogen elsewhere which is

Table(4): Mean performance of 1000-grain weight and grain yield/plant under two nitrogen levels combined over the two seasons and combined overall (comb.).

No.	Pedigree	1000-grain weight (g)			Grain yield/plant (g)			
		50 kg N	100 kg N	Comb.	50 kg N	100 kg N	Comb.	N T I
1	ATX-ARG-1 x Zenzpar -821	21.7	27.1	24.4	72.5	93.9	83.2	77.2
2	ATX-ARG-1 x R-93012	21.9	25.2	23.6	73.7	94.1	83.9	78.3
3	ATX-ARG-1 x R-93004	24.6	28.5	26.6	71.9	90.3	81.1	79.6
4	ATX-ARG-1 x R-93001	22.7	26.4	24.6	76.3	93.4	84.9	81.7
5	ATX-ARG-1 x ZSV-14	23.7	28.3	26.0	75.3	91.2	83.3	82.5
6	ATX-ARG-1 x R-89028	23.4	27.7	25.5	67.5	89.0	78.3	75.8
7	ATX-ARG-1 x R-89037	22.6	29.2	25.9	69.1	90.8	79.9	76.1
8	ATX-2-2 x Zenzpar-821	22.5	27.1	24.8	72.4	90.4	81.4	80.1
9	ATX-2-2 x R-93012	22.4	26.7	24.5	72.6	93.8	83.2	77.4
10	ATX-2-2 x R-93004	24.2	28.0	26.1	69.0	89.1	79.0	77.4
11	ATX-2-2 x R-93001	23.6	28.3	26.0	70.3	92.6	81.5	76.0
12	ATX-2-2 x ZSV-14	23.4	27.6	25.5	75.2	87.0	81.1	86.4
13	ATX-2-2 x R-89028	24.3	27.4	25.9	69.6	89.6	79.6	77.7
14	ATX-2-2 x R-89037	22.9	28.5	25.7	67.6	91.0	79.3	74.3
15	ATX-2-1 x Zenzpar-821	22.2	27.3	24.7	68.1	88.0	78.0	77.5
16	ATX-2-1 x R-93012	23.3	26.2	24.7	67.4	86.2	76.8	78.2
17	ATX-2-1 x R-93004	25.3	28.8	27.1	69.9	82.9	76.4	84.2
18	ATX-2-1 x R-93001	24.7	29.1	26.9	69.4	90.7	80.1	76.5
19	ATX-2-1 x ZSV-14	22.7	26.8	24.8	68.9	88.0	78.5	78.2
20	ATX-2-1 x R-89028	23.5	26.4	25.0	72.8	97.6	85.2	74.6
21	ATX-2-1 x R-89037	23.1	27.5	25.3	75.4	94.7	85.1	79.7
22	ATX-402 x Zenzpar-821	21.9	27.5	24.7	75.1	83.5	79.3	90.1

*,** Significant at 0.05 and 0.01 probability levels, respectively based on the check.
NTI: Nitrogen tolerance index for grain yield.

Table(4): Mean performance of 1000-grain weight and grain yield/plant under two nitrogen levels combined over the two seasons and combined overall (comb.).

No.	Pedigree	1000-grain weight (g)			Grain yield/plant (g)			
		50 kg N	100 kg N	Comb.	50 kg N	100 kg N	Comb.	N T I
1	ATX-ARG-1 x Zenzpar -821	21.7	27.1	24.4	72.5	93.9	83.2	77.2
2	ATX-ARG-1 x R-93012	21.9	25.2	23.6	73.7	94.1	83.9	78.3
3	ATX-ARG-1 x R-93004	24.6	28.5	26.6	71.9	90.3	81.1	79.6
4	ATX-ARG-1 x R-93001	22.7	26.4	24.6	76.3	93.4	84.9	81.7
5	ATX-ARG-1 x ZSV-14	23.7	28.3	26.0	75.3	91.2	83.3	82.5
6	ATX-ARG-1 x R-89028	23.4	27.7	25.5	67.5	89.0	78.3	75.8
7	ATX-ARG-1 x R-89037	22.6	29.2	25.9	69.1	90.8	79.9	76.1
8	ATX-2-2 x Zenzpar-821	22.5	27.1	24.8	72.4	90.4	81.4	80.1
9	ATX-2-2 x R-93012	22.4	26.7	24.5	72.6	93.8	83.2	77.4
10	ATX-2-2 x R-93004	24.2	28.0	26.1	69.0	89.1	79.0	77.4
11	ATX-2-2 x R-93001	23.6	28.3	26.0	70.3	92.6	81.5	76.0
12	ATX-2-2 x ZSV-14	23.4	27.6	25.5	75.2	87.0	81.1	86.4
13	ATX-2-2 x R-89028	24.3	27.4	25.9	69.6	89.6	79.6	77.7
14	ATX-2-2 x R-89037	22.9	28.5	25.7	67.6	91.0	79.3	74.3
15	ATX-2-1 x Zenzpar-821	22.2	27.3	24.7	68.1	88.0	78.0	77.5
16	ATX-2-1 x R-93012	23.3	26.2	24.7	67.4	86.2	76.8	78.2
17	ATX-2-1 x R-93004	25.3	28.8	27.1	69.9	82.9	76.4	84.2
18	ATX-2-1 x R-93001	24.7	29.1	26.9	69.4	90.7	80.1	76.5
19	ATX-2-1 x ZSV-14	22.7	26.8	24.8	68.9	88.0	78.5	78.2
20	ATX-2-1 x R-89028	23.5	26.4	25.0	72.8	97.6	85.2	74.6
21	ATX-2-1 x R-89037	23.1	27.5	25.3	75.4	94.7	85.1	79.7
22	ATX-402 x Zenzpar-821	21.9	27.5	24.7	75.1	83.5	79.3	90.1

*,** Significant at 0.05 and 0.01 probability levels, respectively based on the check.
NTI: Nitrogen tolerance index for grain yield.

communicated to source leaves. Gardner *et al,* 1994 found that, thicker sorghum leaves resulted in more mesophyll per unit leaf area and could have contributed towards increased photosynthesis rate per unit leaf area. Maranville, 1997 found that the African genotypes, Malisor 8-7and S34, had greater N use efficiency than the U.S. line CK60 in Mali. Gardner *et al.* 1994 found that, thicker sorghum leaves resulted in more mesophyll per unit leaf area and could have contributed towards increased photosynthesis rate per unit leaf area. Nawar *et al.*, 1994, concluded that the non-stress condition permitted a greater degree of genetic variation, while stress condition limited the genetic variation. They explained that increasing nitrogen amounts led to increasing all variations of means squares. Also, many of studied crosses showed heterotic effects relative to three check varieties. The best performing 15% of the tested hybrids out yielded the check (1) by 33% to 40% ,check (2) by 25% to 37% and check (3) up 9%, there were three best restorer lines. Ragheb and Elnagar,1997 found that sorghum genotypes had different response in yield and its components under different N levels. Moran and Rooney 2003, found a significant differences among hybrids for plant height, days to anthesis and grain yield under different N levels. Al-Nagar *et al.*, 2006, concluded that N levels and genotypes x N levels interactions were highly significant for all studied traits. Low N- stress caused a significant reduction in grain yield for parental lines and their F_1's about 17.9 and 15.2%, respectively. They mentioned that some lines and hybrid showed maximum low–N tolerance.

3-Heterosis:

Estimated heterosis for twenty-eight F_{-1} crosses as percentage of better parent for each of the two N levels (50 and 100 kg., N/fed.) over the two studied seasons are presented in (Table 5) as follows:

Heterosis values for days to 50% flowering showed that fourteen and twenty F_{-1} crosses had negative and significantly heterosis under 50 and 100 kg., N/fed., respectively, indicating that, these crosses were earlier than early parent in each cross. Only one F_{-1} cross had positive significant heterosis under 50 kg., N/fed., indicating that this cross was late than the late parent.

On the other hand, heterosis values for plant height showed that all the F_{-1} crosses had positive and significantly heterosis for plant height under both N levels, indicating that these crosses were taller than the tall parent in each cross.

Heterosis values for number of green leaves/plant showed that eleven and seventeen F_{-1} crosses had positive significantly heterosis for number of green leaves/plant under

Table(5): Estimated heterosis as a percentage of the better parent for five traits of twenty-eight F_1 crosses under two nitrogen levels combined over the two studied seasons.

No.	crosses	Days to 50% flowering		Plant height (cm)		Number of green leaves		1000- grains weight (g.)		Grain yield /plant (g.)	
		50 N	100 N	50 N	100 N	50 N	100 N	50 N	100 N	50 N	100 N
1	ATX-ARG-1xZenzpar-821	-0.23	-0.70	24.50**	21.23**	15.15	38.24**	-13.99**	-6.83**	59.44**	68.26**
2	ATX-ARG-1xR-93012	-1.14	-2.55	23.08**	17.17**	34.48**	53.13**	-13.33*	-13.14**	55.11**	55.50**
3	ATX-ARG-1xR-93004	-0.68	-3.02*	22.22**	13.47**	-5.26	12.20	-2.44	-8.36*	49.82**	51.91**
4	ATX-ARG-1xR-93001	2.27*	-0.46	22.01**	27.62**	-7.89	0.00	-10.03**	-9.12**	44.32**	38.33**
5	ATX-ARG-1xZSV-14	-2.05	-4.41**	24.68**	16.76**	21.21*	9.52	-6.20*	-2.70	46.36**	39.93**
6	ATX-ARG-1xR-89028	-1.14	-3.25*	14.55**	15.34**	26.67*	15.00	-7.33*	-4.82*	26.96**	32.48**
7	ATX-ARG-1xR-89037	-1.59	-3.25*	21.09**	12.85**	6.45	7.50	-10.36**	-3.95*	30.09**	35.55**
8	ATX-2-2 x Zenzpar-821	-0.22	-1.82	34.44**	35.12**	30.30**	42.86**	-1.25	-2.46	59.27**	61.97**
9	ATX-2-2 x R-93012	-2.67*	-2.05	26.28**	22.28**	18.75	48.57**	-2.19	-4.92*	52.67**	55.06**
10	ATX-2-2 x R-93004	-1.78	-2.51	19.14**	13.47**	7.89	39.02**	-1.76	-10.13**	43.64**	49.79**
11	ATX-2-2 x R-93001	-4.44**	-5.25**	26.42**	24.31**	10.53	21.28*	4.51	0.71	33.03**	37.10**
12	ATX-2-2 x ZSV-14	-3.36**	-3.02*	29.87**	24.86**	27.27**	40.48**	3.47	-4.56*	46.15**	33.49**
13	ATX-2-2 x R-89028	-3.10**	-5.02**	16.36**	15.87**	18.75	27.50*	7.68*	-4.08*	30.96**	33.30**
14	ATX-2-2 x R-89037	-0.67	-0.93	22.45**	15.17**	34.38**	17.50	1.33	-6.36**	27.28**	35.78**
15	ATX-2-1 x Zenzpar-821	-3.07**	-3.64**	29.80**	27.98**	21.21*	41.18**	-10.14**	0.31	49.92**	57.59**
16	ATX-2-1 x R-93012	-7.02**	-6.59**	26.28**	22.28**	31.03**	43.75**	-5.74	-6.76**	41.83**	42.46**
17	ATX-2-1 x R-93004	-4.82**	-3.64**	22.22**	14.51**	15.79	48.78**	2.64	-7.45**	45.53**	39.48**
18	ATX-2-1 x R-93001	-3.74**	-5.02**	25.16**	24.31**	-10.53	14.89	0.14	3.38	31.33**	34.33**
19	ATX-2-1 x ZSV-14	-4.04**	-6.03**	24.68**	20.90**	24.24*	16.67	-7.84*	-7.27**	33.92**	35.04**

*,** Significant at 0.05 and 0.01 probability levels, respectively.

Table(5): continue.

No.	crosses	Days to 50% flowering		Plant height (cm)		Number of green leaves		1000- grains weight (g.)		Grain yield /plant (g.)	
		50 N	100 N	50 N	100 N	50 N	100 N	50 N	100 N	50 N	100 N
20	ATX-2-1 x R-89028	-2.65*	-3.40**	18.79**	14.50**	40.00**	42.50**	-4.59	-7.76**	36.99**	45.29**
21	ATX-2-1 x R-89037	-4.23**	-3.71**	17.69**	13.48**	16.13	40.00**	-6.42*	-9.43**	42.05**	41.32**
22	ATX-402 x Zenzpar-821	-2.00	-3.39**	23.84**	23.21**	25.71**	40.00**	-3.66	-2.07	65.35**	43.88**
23	ATX-402 x R-93012	-2.90**	-5.87**	21.15**	16.09**	2.86	25.00*	-0.73	-3.85	39.31**	32.88**
24	ATX-402 x R-93004	-2.45*	-4.73**	19.75**	11.40**	13.16	58.54**	-1.76	1.39	41.54**	37.50**
25	ATX-402 x R-93001	-2.45*	-3.42**	17.61**	21.55**	10.53	12.77	10.76**	8.83**	28.76**	30.75**
26	ATX-402 x ZSV-14	-1.57	-3.71**	19.48**	20.34**	17.14	21.43*	-4.55	-7.04**	32.31**	32.00**
27	ATX-402 x R-89028	-1.56	-4.07**	14.55**	13.23**	17.14	15.00	-2.51	-7.06**	32.98**	36.40**
28	ATX-402 x R-89037	-2.00	-0.70	18.37**	8.43**	2.86	10.00	3.66	-8.28**	28.33**	23.67**

*,** Significant at 0.05 and 0.01 probability levels, respectively.

50 and 100 kg., N/fed., respectively, indicating that these crosses stay green more than the better greenness parent at each cross.

Heterosis values for 1000-grain weight showed that nine and nineteen F_1 crosses had negative and significantly heterosis for 1000-grain weight, under 50 and 100 kg., N/fed., respectively. While, two and one crosses had positive significantly heterosis for 1000-grain weight under 50 and 100 kg., N/fed., respectively. Positive heterosis for1000-grain weight, indicating that these crosses had bigger seed size and heavier seed weight more than better parent in each cross. This trait also, shares in grain yield production in some genotypes. Also, negative heterosis may be indicated that the seed number was high because there is a negative correlation between seed size and seed number.

Heterosis values for grain yield/plant showed that all the F_1 crosses had positive and significantly heterosis for grain yield/plant under both 50 and 100 kg., N/fed., indicating that these crosses were yielded more than the better parent in each cross.

From the above data it can be concluded that all crosses had high grain yield compare with their better parents and the yield most correlated with the plant height and some with No. of green leaves /plant. These results in agreement with those obtained by Nawar *et al.*, 1994, concluded that the non-stress condition permitted a greater degree of genetic variation, while stress condition limited the genetic variation. They explained that increasing nitrogen amounts led to increasing all variations of means squares. Also, many of studied crosses showed heterotic effects relative to three check varieties. The best performing 15% of the tested hybrids out yielded the check (1) by 33% to 40%, check (2) by 25% to 37% and check (3) up 9%, there were three best restorer lines. Menkir and Ejeta, 2003, reported that heterosis was manifested in different grain sorghum crosses for many studied traits under different N levels conditions. Al-Nagar *et al.*, 2006, They mentioned that some lines and hybrid showed maximum low –N tolerance. They identified the best parents for (gca) effects and the best crosses for (sca) and heterobeltiosis under low and high N levels.

4-Combining ability

4-1- General combining ability:

General combining ability (gca) effects of the parental lines for five studied traits combined for each N levels (50 and 100 kg N/fed.) over the two studied season are presented in (Table 6).

Days to 50% flowering the gca effects data showed that one of the female and one of the male lines had

Table(6): Estimates of general combining ability (gca) effects for five traits of four female and seven male lines for each N level combined over the two studied seasons.

No.	Lines	Days to 50% flowering		Plant height (cm.)		Number of green leaves		1000 grains weight (g.)		Grain yield / plant (g.)	
		50 N	100 N	50 N	100 N	50 N	100 N	50 N	100 N	50 N	100 N
	Female										
1	ATX-ARG-1	0.00	-0.18	-0.83	-0.01	-0.40**	-0.82**	-0.15	-0.24	1.64**	2.58**
2	ATX-2-2	0.29	0.43	3.33*	3.49**	0.26	0.35	0.12	-0.06	0.26	1.27*
3	ATX-2-1	-0.60**	-0.07	1.55	0.80	-0.02	0.30	0.44*	-0.28	-0.40	0.49
4	ATX-402	0.31	-0.18	-4.05**	-4.29**	0.17	0.16	-0.49*	0.57**	-1.50**	-4.34**
	Males										
1	Zenzpar-821	0.56	0.90**	0.46	1.96	-0.15	0.30	-0.46*	-1.03**	-0.31	1.35**
2	R-93012	0.48	-0.65*	3.21*	2.17	-0.32	-0.28	-1.41**	-0.56*	-0.65	-0.69
3	R-93004	0.64	0.10	2.13	3.84*	1.01**	0.26	1.48**	1.46**	-3.21**	-1.02*
4	R-93001	-0.19	0.27	7.75**	3.42*	0.26	-0.20	0.90**	0.70*	2.01*	0.36
5	ZSV-14	-1 52**	-0.82**	-1.42	0.71	0.01	0.26	-0.34	-0.33	-1.15	1.15*
6	R-89028	0.18	0.18	0.75	0.30	-0.20	0.05	-0.71**	0.05	2.74**	-0.52
7	R-89037	-0.15	0.02	-12.88**	-12.41**	-0.61*	-0.40*	0.54**	-0.29	0.59	-0.63

*,** Significant at 0.05 and 0.01 probability levels, respectively.

negative significant gca effects for days to 50% flowering under 50 kg., N/fed.,, and two male lines had the same trend under 100 kg., N/fed. ,indicating that these lines had desirable gene action for earliness . Only one male line (Zenzpar-821) had positive significantly gca effects under 100 kg., N/fed., indicating that this line had desirable gene action for lateness. While, line ZSV-14 had negative significantly gca effects, indicating that this line had desirable gene action for earliness.

For plant height the gca effects data showed that the female line ATX-2-2 and the male line R-93001 had positive significantly gca effects under both N levels, indicating that these lines had desirable gene action for tallness. While, the female line ATX-402 and the male line R-89037 had negative significantly gca effects in both N levels, indicating that these lines had desirable gene action for dwarfness. Also, the male line R-93012 had positive significantly gca effects under low N level, although, the male line R-93004 had positive significantly gca effects under high N level.

For number of green leaves /plant the gca effects data showed that the female line ATX-ARG-1 and the male line R-89037 had negative significantly gca effects in both N levels, indicating that this line had desirable gene action for leaf senescence. The male line R-93004 had positive significantly gca effects under 50 kg., N/fed., indicating that this line had desirable gene action for stay-green materials and need more stability to act in this direction.

For 1000-grain weight the gca effects data showed that under 50 kg., N /fed., one of the female and three of the male lines had positive significantly gca effects for 1000-grain weight. Also, under 100 kg., N/fed., one of the female and two of the male lines had the same trend. Indicating that these lines have desirable gene action for heavy grain weight and bigger seed size. Under 50 kg., N/fed., one female and three male lines had negative significantly gca effects and two male lines under 100 kg., N/fed had the same trend , indicating that these lines did not have desirable gene action for heavy grain weight and may be this due to increase in the seed number in the panicle of sorghum.

For grain yield /plant the gca effects data showed that one female line (ATX-ARG-1) had positive significantly gca effects for grain/plant in both N levels. This female line had desirable gene action for inheritance high yield. While, the female line (ATX-402)and the male line (R-93004) had negative significantly gca effects for grain/plant in both N levels. Also, the female line (ATX-2-2) and the male lines (Zenzpar-821) and (ZSV-14) had positive significantly gca effects under high N level moreover, two male lines (R-93001) and (R-89028) had positive significantly gca effects under low N level. It can be concluded that the inheritance of yield in some genetic materials depend on additive gene action (gca).

4-2 Specific combining ability:

Combined data of each N levels (50 and 100 kg., N/fed.,) over the two studied seasons in (Table 7) showed that specific combining ability effects (sca) for days to 50% flowering, under 50 kg., N/fed., two crosses had positive significantly sca effects and one cross had negative significantly sca effects. Under 100 kg., N/fed., one cross had negative significantly sca effects. The negative sca effects, indicating that crosses had favorable gene action for earliness.

For plant height none of the crosses had positive or negative significantly sca effects under both N levels.

For No. of green leaves/plant one and two crosses had positive significantly sca effects under 50 and 100 kg., N/fed., respectively. Only one cross had negative significantly sca effects under 100kg., N/fed. Positive sca effects indicating that crosses had favorable gene action for staying green.

For 1000-grain weight one and five crosses had negative significantly sca effects under 50 and 100 kg., N/fed., respectively. Four crosses had positive significantly sca effects under 100 kg., N/fed. Positive sca effects indicating that crosses had favorable gene action for heavy grain weight and bigger seed size.

For grain yield/plant seven and four crosses had negative significantly sca effects under 50 and 100 kg., N/fed., respectively. While, seven and four crosses had positive significantly sca effects under 50 and 100 kg., N/fed., respectively. Positive sca effects indicating that crosses had favorable gene action for inheritance high yield.

Data in (Table 8) indicated that the contribution of male (M) from the total variance was higher than the contribution of females for all studied traits under both N levels except for grain yield/plant the contribution of the females was higher than it for males under both N levels. Also, the contribution of males x females was higher than the contribution of both males and females from the total variance for days to 50% flowering, No. of green leaves/plant and grain yield/plant under both N levels. Where the contribution of males from the total variance was higher than the contribution of both females and (M x F) for plant height and 1000-grain weight under both N levels. The contributions were greater under low N level than under high N levels except for plant height the

Table(7): Estimates of specific combining ability (sca) effects of five traits for twenty-eight F_1 crosses for two nitrogen levels combined over the two studied seasons.

No.	crosses	Days to 50% flowering		Plant height (cm.)		Number of green leaves		1000-grains weight (g.)		Grain yield /plant (g.)	
		50 N	100 N	50 N	100 N	50 N	100 N	50 N	100 N	50 N	100 N
1	ATX-ARG-1xZenzpar-821	-0.58	-0.12	-3.75	0.42	-0.14	0.27	-0.20	0.05	-1.22	2.40
2	ATX-ARG-1xR-93012	0.29	0:48	-0.63	-3.49	0.61	0.77	-0.51	-0.83*	2.10*	2.87
3	ATX-ARG-1xR-93004	-0.13	-1.02	2.71	0.42	-0.43	-1.06*	0.22	-0.45	0.61	1.72
4	ATX-ARG-1xR-93001	1.88**	0.98	-0.21	4.80	-0.14	-0.14	-0.94	-1.96**	3.63**	-0.42
5	ATX-ARG-1xZSV-14	-0.21	0.48	0.83	-4.37	0.24	-0.06	1.06	1.14**	1.79	0.56
6	ATX-ARG-1xR-89028	-0.54	-0.40	-1.25	0.96	0.11	0.15	0.40	0.89*	-4.30**	-5.53**
7	ATX-ARG-1xR-89037	-0.71	-0.40	2.29	1.26	-0.26	0.07	-0.03	1.17**	-2.62**	-1.61
8	ATX-2-2 x Zenzpar-821	0.80	-1.06	4.58	5.26	0.03	-0.39	0.20	-0.06	0.09	0.23
9	ATX-2-2 x R-93012	0.51	0.86	-0.63	0.84	-0.22	0.11	-0.39	0.49	2.32*	3.95*
10	ATX-2-2 x R-93004	0.42	0.19	-5.63	-3.07	-0.26	-0.39	-0.61	-1.18**	-0.97	1.80
11	ATX-2-2 x R-93001	-1.74**	-1.14	1.46	-3.70	0.36	0.36	-0.41	-0.22	-0.96	0.08
12	ATX-2-2 x ZSV-14	-0.49	0.86	3.33	2.13	-0.10	0.94	0.38	0.26	3.06**	-2.31
13	ATX-2-2 x R-89028	-0.66	-0.68	-2.92	-1.70	-0.55	-0.18	0.95	0.47	-0.80	-3.64*
14	ATX-2-2 x R-89037	1.17*	0.98	-0.21	0.29	0.74*	-0.43	-0.14	0.25	-2.74**	-0.12
15	ATX-2-1 x Zenzpar-821	0.51	0.94	0.54	-2.05	-0.18	-0.68	-0.34	0.31	-3.49**	-1.46
16	ATX-2-1 x R-93012	-0.95	-0.48	1.16	3.53	0.07	-0.85	0.27	0.19	-2.17*	-2.92
17	ATX-2-1 x R-93004	-0.03	1.02	0.33	1.28	0.52	0.32	0.32	-0.13	0:59	-3.58*
18	ATX-2-1 x R-93001	0.30	-0.14	1.58	-1.01	-0.68	-0.10	0.46	0.75	-1.21	-1.03
19	ATX-2-1 x ZSV-14	-0.11	-1.64*	-1.55	-1.01	0.02	-0.68	-0.48	-0.31	-2.56**	-0.54

*,** Significant at 0.05 and 0.01 probability levels, respectively.

Table(7): continue.

No.	crosses	Days to 50% flowering		Plant height (cm.)		Number of green leaves		1000-grains weight (g.)		Grain yield /plant (g.)	
		50 N	100 N	50 N	100 N	50 N	100 N	50 N	100 N	50 N	100 N
20	ATX-2-1 x R-89028	0.89	0.48	2.20	-1.18	0.40	0.86	-0.06	-0.36	3.07**	5.17**
21	ATX-2-1 x R-89037	-0.61	-0.18	-4.26	0.46	-0.14	1.11*	-0.17	-0.46	5.77**	4.37**
22	ATX-402 x Zenzpar-821	-0.73	0.23	-1.37	-3.60	0.29	0.80	0.34	-0.30	4.62**	-1.16
23	ATX-402 x R-93012	0.15	-0.86	0.09	-0.88	-0.46	-0.04	0.63	0.15	-2.26*	-3.90*
24	ATX-402 x R-93004	-0.27	-0.19	2.59	1.37	0.17	1.13*	0.08	1.77**	-0.22	0.06
25	ATX-402 x R-93001	-0.43	0.31	-2.83	-0.08	0.46	-0.12	0.89	1.43**	-1.46	1.36
26	ATX-402 x ZSV-14	0.82	0.31	-2.62	3.25	-0.17	-0.20	-0.97	-1.09**	-2.29*	2.29
27	ATX-402 x R-89028	0.32	0.60	1.96	1.92	0.04	-0.83	-1.30*	-1.01**	2.04	4.01*
28	ATX-402 x R-89037	0.15	-0.40	2.17	-1.96	-0.33	-0.74	0.33	-0.96*	-0.42	-2.65

*,** Significant at 0.05 and 0.01 probability levels, respectively.

contribution of male under high N levels was higher than under low N level. Moreover, for days to 50% flowering, under both N levels variance due to M x F or M and F contributed approximately 50 % to the total variance, indicating equal important of gca and sca variance for this traits. The contribution of the variance due to males x females interaction (sca variance) to total variation was greater than that due to males or females (gca variance) for grain yield under low N levels, while, the contribution of the variance due to males (gca variance) was greater than that of the variance due to males x females interaction (sca variance) for plant height under both N levels. That indicated the important of both additive (gca) and non-additive (sca) in the inheritance of the traits.

Table(8): Proportional contribution of female, male and their interaction to total variance for five traits under both N levels and combined over the two studied seasons.

Traits	Nitrogen levels					
	50 kg., N/ fed.,			100 kg., N/fed.,		
	Female (F)	Male (M)	F x M	Female (F)	Male (M)	F x M
Days to 50 % flowering	13.94	29.98	56.21	6.07	44.68	49.15
Plant height (cm.)	18.80	66.63	14.56	16.04	71.35	12.61
No. of green leaves/ plant	24.88	27.95	47.44	27.33	28.17	44.57
1000-grain weight (g.)	11.74	57.33	30.98	6.89	51.39	41.73
Grain yield /plant (g.)	15.27	9.22	75.50	38.66	19.56	41.79

The obtained data were similar to those obtained by Al-Nagar *et al.*, 2006, they mentioned that some lines and hybrid showed maximum low –N tolerance. Both general (gca) and specific (sca) combining ability effects were highly significant for all studied traits under both control and low-N conditions. They identified the best parents for (gca) effects and the best crosses for (sca) and heterobeltiosis under low and high N levels. Also, they mentioned to the importance of the contribution of males and females (gca or additive) and the contribution of M x F (sca or non-additive) in the inheritance of studied traits.

Generally, it can be concluded that the contrast between parent and crosses (ANOVA Tables 2& 3) was highly significant for all studied traits under low and optimum N levels except 1000-grain weight under low N level, suggesting significant non-additive gene effects (heterosis).

For grain yield the gca effect of the female line (ATX-ARG-1) was positive highly significant under both N levels. While, the female (ATX-2-2) positive highly significant gca effect under high level of N. The male lines R-93001 and R-89028 had Positive significantly gca effects under low N level. But the male line (Zenzpar-821) had positive significantly gca effects under high N level.

The sca effect for grain yield of the crosses (ATX- ARG-1x R-93012), (ATX- ARG-1x R-93001) (ATX-2-2 x R-93012) (ATX-2-2x ZSV-14), (ATX-2-1 x R-89028) (ATX-2-1 x R-89037) and (ATX-402 xZenzepar-821) were positive significantly under low N levels. While, (ATX-2-2 x R-93012) , (ATX-2-1 x R-89028) and (ATX-2-1 x R-89037) had positive significantly sca effects for grain yield /plant under both N levels but, cross (ATX-402 x R- 89028) had positive significantly sca effects under high N level only.

The crosses (ATX- ARG-1x Zenzpar-821), (ATX- ARG-1x R-93012), (ATX- ARG-1x R-93001), (ATX- ARG-1x ZSV-14) (ATX-2-2 x R-93012), (ATX-2-2x ZSV-14) , (ATX-2-1 x R-89028) (ATX-2-1 x R-89037) and (ATX-2-1 x Zenzpar-821) were the best crosses in grain yield/ plant under both N levels.

Recommendations

1- Breeders should engage the yield potential with yield index under stresses conditions when selecting under different stress environments.

2- For grain yield the gca effect of the female line (ATX-ARG-1) was positive highly significant under both N levels. While, the female (ATX-2-2) positive highly significant gca effect under high level of N. The male lines R-93001 and R-89028 had Positive significantly gca effects under low N level. But the male line (Zenzpar-821) had positive significantly gca effects under high N level. These lines can be used in breeding program for low and high N levels.

3- Also, the crosses (ATX- ARG-1x Zenzpar-821), (ATX- ARG-1x R-93012), (ATX- ARG-1x R-93001), (ATX- ARG-1x ZSV-14) (ATX-2-2 x R-93012), (ATX-2-2x ZSV-14) , (ATX-2-1 x R-89028) (ATX-2-1 x R-89037) and (ATX-2-1 x Zenzpar-821) were the best crosses in grain yield/ plant under both N levels.

References

Al-Nagar, A. M., D.A. El-kadi and Zeinab S.H. Abo-Zaid, 2006. Quantitative genetic parameters of grain sorghum traits contributing to low-N tolerance. Egypt. J. Plant breed.,10 :79-102.

Bartelett, M. S., 1937. Properties of sufficiency and statistical test. Proc. Roy. Soc., London, Series A., 160:268-282.

Gardner J.C., Maranville J.W. and Paparozzi E.T.1994. Nitrogen use efficiency among diverse sorghum cultivars. Crop Science; 34:728-733.

Gomez, K.A. and A.A. Gomez. 1984. Statistical Procedures for Agricultural Research. John Wiley and Sons. New York. 2nd ed.

Kamoshita A. , R. C. Muchow, M. Cooper and S. Fukai 2000. Genotypic variation for grain yield and grain nitrogen concentration among sorghum hybrids under different levels of nitrogen fertilizer and water supply. Crop Science; 40:1295-1307.

Maranville, J. W. 1997. Nutrient use efficiency in sorghum and pearl millet. INTSORMAL Annual Report,64-69.

Menkir, A. and Ejeta, G., 2003. Selection for grain yield in sorghum under moisture and nutrient stress environments. African Crop Science Journal; 11, 55-64.

Moran J.L. and W.L. Rooney,2003. Effect of cytoplasm on the agronomic performance of grain sorghum hybrids. Crop Sci. 43:777-781.

Nawar A. A., A.A. Abul-Nass, Sh. A., El-Shamarka and A.E. El-Shahawy, 1994. Analysis of combining ability in sorghum under different nitrogen levels. Menofiya J. Agric., Res., 19; 989-1005.

Ragheb H.M.A., and G. Elnagar,1997. Response of grain sorghum to nitrogen fertilization and irrigation intervals. Assiut Journal Sciences; 28 : 147-157.

Singh, R.K. and B.D. Chaudhry. 1977. *Biometrical Methods in quantitative genetic analysis. 178-185. Kalyani: pub. New Delhi.*

Thomas H. and Rogers L.J.1990. Turning over an old leaf. University of Wales Rev. Sci. Technol.; 6:29-38.

سلوك بعض سلالات ذرة الحبوب الرفيعة وهجنها تحت المستويات المثلي والمنخفضة من النتروجين

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أنتجت ثمانية وعشرون هجينا وذلك بالتهجين بين أربعة سلالات عقيمة عقم ذكري سيتوبلازمي وسبعة سلالات معيدة للخصوبة بمزرعة بحوث جزيرة شندويل بسوهاج– مصر في موسم٢٠٠٣. بعد ذلك أقيمت تجربتان حقليتان منفصلتان لتقييم هذه الهجن تحت مستويين من النيتروجين هما ٥٠و١٠٠كجم نيتروجين للفدان وفي كل تجربة تم تقييم الثمانية والعشرون هجينا وآباؤها (أحد عشر أبا) بالإضافة لهجين المقارنة شندويل-٦ تحت كل مستوي من النتروجين بمحطة البحوث السالفة الذكر في موسمي ٢٠٠٤–٢٠٠٥م. تم أخذ البيانات لخمس صفات هي:عدد الأيام حتي ٥٠% تزهير وارتفاع النبات بالسنتيمتر وعدد الأوراق الخضراء للنبات عند امتلاء الحبة ووزن الألف حبة بالجرام ووزن محصول الحبوب للنبات الواحد بالجرام ومعامل تحمل نقص النيتروجين.

أوضحت النتائج لتحليل التباين المشترك أن هناك اختلافات معنوية بين التراكيب الوراثية و أن تأثير النتروجين كان عالي المعنوية وكذلك التفاعل بينهما في موسمي الدراسة. وقد تم تحديد الهجن والسلالات التي لها القدره علي إعطاء محصول عالي تحت مستويات منخفضة من التسميد الأزوتي. أما بالنسبة للقدرة العامة علي الائتلاف لصفة المحصول وجد أن السلالة الأميه (ATX-ARG-1)لها قدرة معنوية موجبة عاليه لصفة المحصول تحت المستويين المنخفض والعالي من النيتروجين. في حين أن السلالة الأميه (ATX-2-2) لها قدرة معنوية موجبة عاليه لصفة المحصول تحت المستوي العالي من النيتروجين.السلالات الأبوية R-93001و R-89028 لها قدرة معنوية موجبة عاليه لصفة المحصول تحت المستوي المنخفض من النيتروجين. السلالة الأبويةZenzpar-821 لها قدرة معنوية موجبة عاليه لصفة المحصول تحت المستوي العالي من النيتروجين. وهذه السلالات يمكن استخدامها في برامج التربية لتربية تراكيب وراثية جديده تصلح للزراعة تحت المستويات المنخفضة والعالية من النيتروجين.أيضا الهجن التاليه يمكن زراعتها تحت المستويات المنخفضة والمثلي من النيتروجين:

(ATX-ARG-1x Zenzpar-821), (ATX- ARG-1x R-93012), (ATX- ARG-1x R-93001), (ATX- ARG-1x ZSV-14) (ATX-2-2 x R-93012) , (ATX-2-2x ZSV-14), (ATX-2-1 x R-89028) (ATX-2-1 x R-89037) .و (ATX-2-1 x Zenzpar-821).