GENOTYPE X ENVIRONMENT INTERACTION FOR YIELD AND ITS COMPONENTS IN GRAIN SORGHUM (*Sorghum bicolor* L. Moench)

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ABSTRACT

The analysis of variance for phenotypic stability revealed that the variation due to genotype x environment was considerable for all the characters studied. The significance of G x E (linear) and pooled deviation for all the traits studied except days to 50 per cent flowering and days to maturity for pooled deviation suggested the importance of both linear and non-linear components in determining total genotype x environment interactions. Perusal of stability parameters revealed that four parents were found with average stability for grain yield. Nevertheless, it was noticed that the male parent SR 2872 exhibited significant bi value greater than one, showing below average stability which was suitable for favourable environments. Among hybrids, fourteen hybrids exhibited unit regression (bi) and least deviation from regression (S^2di) and therefore they were classified as stable. In general, the hybrids found stable for grain yield also showed stability for two or more component characters which indicated that the stability of various component traits might be responsible for the observed stability of various hybrids for grain yield per plot. The best five crosses viz., AKMS 14A x B 58586, 296A x CSV 20, 296A x Kekri local, 296A x SR 2879 and 1009A x SR 2872 were found to have average stability over environments for grain yield per plot with one or more stable yield contributing traits. In addition to these stable hybrids, hybrids AKMS 14A x SR 2879, ICSA 467A x SR 2872 and 1005A x B 58586 had specific adaptability for good environments, while only one hybrid, 296A x B 58586 showed specific adaptability to poor environments for grain yield per plot, these signifying their potential for commercial exploitation for genetic improvement in grain sorghum.

KEY WORDS: Genotype x environment interaction, regression coefficient, sorghum, stability

INTRODUCTION

Sorghum is an important cereal crop after wheat, maize, rice and barley and widely cultivated in semi-arid tropical areas of world, particularly rain fed conditions. It is a staple food for millions of people in these areas. It is widely cultivated under different environmental conditions and it is known to exhibit a high degree of genotype x environment (G x E) interactions. Evaluation of genotypes for consistency of performance in different environments is important in plant breeding programmes. The relative performance of genotypes often changes from one environment to another. The occurrence of large genotype x environment interaction poses a major problem of relating phenotypic performance to genetic constitution and makes it difficult to decide which genotypes should be selected. It is important to understand the nature of genotype x environment interaction to make testing and ultimately selection of more efficient genotypes. Breeding genotype with wider adaptability has been ultimate aim of plant breeders. A variety is desirable for commercial exploitation over a wide range of environment, if adaptability in real sense is due to genetic makeup. Although plant breeders have been unable to exploit them fully in breeding programme. This has been due to problems of measuring adaptability or other complexities of natural environments. Eberhart and Russell (1966) defined a stable genotype as one, which produced high mean yield and depicted regression co-efficient (bi) around unity and deviations from regression (S^2di) near zero. Present investigation aimed to study the interaction of 50 genotypes [five male sterile females lines, seven male parents, their resultant thirty five hybrids and three checks] of grain sorghum.

MATERIALS AND METHODS

The experimental material comprised of five male sterile female lines *viz*., 296A, AKMS 14A, ICSA 467A, 1005A and 1009A; seven male parents *viz*., B 58586, CSV 20, Kekri local, Pantchari, SR 2872, SR 2879 and Nizer goti, their resultant 35 hybrids generated by crossing them in line x tester mating fashion during *Kharif* 2014 and three checks. The materials were grown for evaluation in a randomized block design (RBD) with three replications in three diverse environments *viz*., Surat, Vyara and Waghai during *kharif* 2015. The observations were recorded on five randomly selected plants for each treatment in each replication for plant height (cm), panicle length (cm) and test weight (g). The observations for days to 50 % flowering, days to maturity and grain yield per plot (g) were recorded on the plot basis. Data were analyzed following model proposed by Eberhart and Russel (1966)

RESULTS AND DISCUSSION

The analysis of variance for phenotypic stability (Table 1) revealed that mean squares due to genotypes as well as environments were highly significant for all the characters when tested against pooled deviation. The genotypes interacted significantly with environments for all the characters when tested against pooled error specifying that the genotypes interacted significantly to diverse environments. The mean squares due to environments (linear) were highly significant for all the characters when tested against pooled deviation. However, the same was significant for all the characters when tested against pooled error. This indicated that variation among environments was linear and it signifies unit change in environmental index for each unit change in the environmental conditions. The variances due to G x E were further partitioned in to components (i) G x E (linear) and (ii) G x E (non-linear) *i.e.* pooled deviation. The coincidence of genotypic performance with environmental values was observed for grain yield and panicle length, an evident from significant genotypes x environments (linear) mean squares when tested against pooled deviations. Although, G x E (linear) was found to be significant for all the characters when tested against pooled error indicating differential performance of genotypes under diverse environments but with considerably varying norms, *i.e.*, the linear sensitivity of different genotypes is variable. The mean squares due to pooled deviations were significant for all the characters except days to 50 per cent flowering and days to maturity, which suggested that performance of different genotypes fluctuated significantly from their respective linear path of response to environments.

On comparing relative magnitude of genotype x environment (linear) and pooled deviation from linearity (non-linear), it was found that the linear component was high for grain yield per plot, plant height and panicle length indicated that linear component contributed more towards the genotype x environment interactions. Both linear and non-linear components were almost equal for test weight, which indicated the importance of both linear and non-linear components in determining genotype x environment interactions for these attributes. These results are in general, concurring with those of Muppidathi *et al.* (1995); Narkhede *et al.* (1998), Muppidathi *et al.* (1999), Das and Prabhakar (2003), Khandelwal *et al.* (2005), Kale (2012), Rao *et al*. (2013), Shivani and Sreelakshmi (2014) and Vange *et al*. (2014).

The stability parameters *viz.*, mean performance ($\overline{X}$), regression coefficient (bi) and individual squared deviation from linear regression (S^2di) for parents as well as hybrids were estimated for six characters to assess the stability over the environments and are presented in Table 2A and 2B.

For Days to 50 per cent flowering, all the parents depicted non-significant deviation from regression coefficient indicating their stability for this trait. Female parent 1005A was found to be the most stable as it exhibited comparative less mean value (desirable for earliness), regression coefficient near unity and non-significant deviation from regression. On other hand, the male parent CSV 20 ($\overline{X}$ =77.22) exhibited adaptability in poor environment with significant regression coefficient (bi<1) and non-significant deviation from regression (S^2di). However, unfortunately, this recorded high mean value than parental mean. Hence, it cannot be recommended. Among 35 crosses, 3 crosses showed significant deviation from regression. Comparing the hybrids, it was observed that 20 hybrids along with two checks flowered earlier with average responsiveness (bi ≈ 1) and were stable across the environments. Among these hybrids, top five hybrids were 1005A x SR 2872, 1005A x B 58586, AKMS 14A x SR 2879, 1005A x CSV 20 and 1009A x Nizer goti. On the other hand, 14 hybrids were late in flowering, but were found to be stable as they depicted average responsiveness (bi ≈ 1) and non-significant S^2di.

All the parents were found stable as they had least deviation from regression for days to maturity. Among the stable parents, six parents showed low mean, out of them top three parents *viz*., SR 2872, 1005A and 1009A were observed with average responsive (bi ≈1) to all environmental conditions with earlier maturity. Parents AKMS 14A had low mean value, significant and greater than one regression coefficient and non-significant deviation from regression suggesting its below average stability for earliness. Parent ICSA 467A possessed low mean values and non-significant deviation from regression, their regression coefficient values were significant and less than unity suggesting their above average stability for earliness. Total twenty one hybrids along with two checks were found to be average stable owing to lower mean values and non-significant values of linear and non-linear components. Among these hybrids, top five hybrids were 296A x Nizer goti, 1009A x SR 2879, 1005A x SR 2879 and 1009A x Nizer goti and 296A x B 58586. Check (Bulky Y) also found stable for this trait with lower mean, regression coefficient near unity and non-significant deviation from regression. The cross combination, 1005A x Pant Chari proved to be an above average responder with high stability in poor environment (lower mean, *bi<1, S^2di around unity), while on other hand cross combination AKMS 14A x SR 2872 found stable in favourable environment.

For plant height, all the parents except Pant Chari exhibited non-significant deviation from regression. All female parents and two male parents (SR 2872 and SR 2879) were observed with stable low mean values (desirable for dwarfness) with unit regression and non-significant deviation from regression indicating stability for dwarfness. Among these parents, top three parents were 1009A, 1005A and AKMS 14A. Male parent SR 2879 possessed low mean values and non-significant deviation from regression, its regression coefficient values was greater than unity and significant suggesting their below average stability for plant height. Four male parents (B 58586, CSV 20, Kekri local and Nizer goti) recorded high mean value for plant height, regression coefficient near unity and least deviation from square deviation indicated its stability for tallness. Five hybrids and one check (Bulky Y) exhibited significant to highly significant deviation from regression. It was observed that check GJ 42 and 9 hybrids were dwarf with average responsiveness (bi ≈ 1) and were stable across the environments. Among these hybrids, top three hybrids were ICSA 467A x SR 2872, 1009A x SR 2879 and ICSA 467A x SR 2879. While the cross combinations AKMS 14A x Pant Chari, 1009A x B 58586, 1009A x CSV 20 and ICSA 467A x Pant Chari had significant to highly significant regression coefficient with less than unity and low mean value for this trait and least non-significant deviation from regression which revealed their above average stability for dwarfness.

With regards to panicle length, all the parents except SR 2872 exhibited non-significant deviation from regression. Five parents were recorded high values for panicle length, non-significant deviation from regression and around unity regression coefficients indicating their average stability for this trait. Among these parents, 1005A was on top. Parent AKMS 14A had high mean value, significant and greater than one regression coefficient and non-significant deviation from regression suggesting its below average stability for this trait. Out of 35 hybrids tested, 15 hybrids exhibited high mean, along with regression coefficient near unity and non-significant deviation from regression, thus classified as stable hybrids. Among the hybrids, two hybrids *viz*., 1009A x SR 2872 and 1009A x Kekri local had exhibited high mean, bi value significantly greater than unity and non-significant deviation from regression showing below average stability and were found suitable for favourable environments, whereas AKMS 14A x Pant Chari had showed high mean, bi value significantly lower than unity and non-significant deviation from regression suggested above average stability and was found suitable for poor environments. Three most stable hybrids for panicle length were 296A x SR 2872, AKMS 14A x SR 2872 and 296A x Nizer goti.

For grain yield per plot, significant to highly significant deviation from regression were exhibited by five hybrids and one parent, which revealed that larger contribution of non-linear component was important than linear components towards G x E interaction. Among females, 1009A and 1005A and from males, B 58586 and Nizer goti had higher mean than parents with bi not significantly deviated from unity and non-significant deviation from regression, hence they were considered stable for this trait. The female parent SR 2872 had exhibited high mean, significant bi value greater than unity and non-significant deviation from regression, thus showed below average stability which was suitable for rich environments. Out of 35 hybrids, 14 hybrids exhibited high mean, along with regression coefficient near unity and non-significant deviation from regression and therefore they were classified as stable hybrids. Among these hybrids, AKMS 14A x SR 2879, ICSA 467A x SR 2872 and 1005A x B 58586 had high mean, regression coefficient significant and greater than unity and non-significant deviation from regression suggested specific adaptability for favourable environments, while hybrid, 296A x B 58586 showed specific adaptability to poor environments for grain yield per plot. Five most stable hybrids for grain yield per plot were AKMS 14A x B 58586, 296A x CSV 20, 296A x Kekri local, 296A x SR 2879 and 1005A x SR 2872.

All the parents expect AKMS 14A, 1009A and Kekri local depicted non-significant deviation from regression for test weight. Four parents were recorded high values for test weight, non-significant deviation from regression and around unity regression coefficients indicating their average stability for this trait. ICSA 467A was most stable for test weight. Parent 1005A had high mean value, significant and greater than one regression coefficient and non-significant deviation from regression suggested its below average stability for the trait. Out of 35 hybrids, 15 hybrids exhibited high mean, along with regression coefficient near unity and non-significant deviation from regression and proved as stable hybrids. Among them the first five stable hybrids were AKMS 14A x Nizer goti, 1005A x SR 2879, 1009A x SR 2872, AKMS 14A x SR 2879 and 296A x Nizer goti. Hybrid 296A x SR 2872 was found with below average stability as it had recorded high mean value, with significant regression coefficients greater than one whereas two hybrid 1005A x Nizer goti and 1009A x Nizer goti were found suitable for poor management condition, as exhibited above average stability. This hybrid had high mean value with significant regression coefficient less than one.

When stability parameters as suggested by Eberhart and Russell (1966) were studied for different genotypes (5 females, 7 males, 35 hybrids and 3 checks), it was revealed that none of the parents or hybrids exhibited average stability for all the characters. Among the hybrids, 14 crosses exhibited stable performance for grain yield per plot. The best five average stable crosses for grain yield per plot were AKMS 14A x B 58586, 296A x CSV 20, 296A x Kekri local, 296A x SR 2879 and 1009A x SR 2872. The genotype may express different phenotypes in different environments, each of which being better adapted for the particular situation. Similar results reported by Muppidathi *et al*. (1999), Prabhakar and Patil (2002), Nagare (2010), Kale (2012), Rao *et al*. (2013), Shivani and Sreelakhmi (2014) and Vange *et al.* (2014). Parents 1005A, 1009A, B 58586 and Nizer goti were found stable for grain yield per plot and most of the traits. Stability of parents for various traits has been reported by Prabhakar and Patil (2002). However, it was noticed that the male parent SR 2872 exhibited bi value significantly greater than one, showed below average stability and suitability for rich environments for grain yield per plot. The result earlier observed by Kale (2012). The heterozygous entries (hybrids) were in general, slightly more stable than the homozygous ones (parents), but the wide ranges found within both the parents and hybrids for stability parameters indicating that it should be possible to select stable entries at both levels of genetic structure. These results corroborated with the findings of Haussmann *et al*. (2000) and Kale (2012).

CONCLUSION

From the stability analysis, it could be seen that the best five stable hybrids for grain yield per plot were AKMS 14A x B 58586, 296A x CSV 20, 296A x Kekri local, 296A x SR 2879 and 1009A x SR 2872. In general, the hybrids found stable for grain yield also showed stability for two or more component characters, which indicated that the stability of various component traits might be responsible for the observed stability of various hybrids for grain yield per plot.

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Table 1: Analysis of variance for G x E interaction and stability parameters for different characters in grain sorghum

Source of Variation	d.f.	Days to 50% Flowering	Days to Maturity	Plant Height (cm)	Panicle Length (cm)	Grain Yield Per Plot (g)	Test Weight (g)
Genotypes	49	88.331 **••	80.950 **••	8073.321 **••	38.138 **••	102373.100 **••	0.294 **••
Environments	2	178.770 **••	156.182 **••	5470.573 **••	49.739 **••	60639.640 **••	0.124 **••
Genotypes x Environments	98	5.888 **••	7.084 **••	387.992 **••	4.391 **••	3539.468 **••	0.011 **••
Environment (Linear)	1	357.540 **••	312.365 **••	10941.150 **••	99.477 **••	121279.300 **••	0.247 **••
Genotypes x Environments (Linear)	49	8.419 **••	9.980 **••	588.180 **••	6.513 **••	5237.222 **••	0.016 **••
Pooled deviation	50	3.290	4.100	184.047 **	2.223 **	1804.880 *	0.006 *
Pooled error	294	3.107	4.788	117.329	1.420	1213.951	0.004

***** = Tested against pooled error at 1% level*** **** = Tested against pooled error at 5% level***

•• *= Tested against pooled deviation at 1% level* **• *= Tested against pooled deviation at 5% level***

Table 2A: Stability parameters for days to 50 % flowering, days to maturity and plant height in grain sorghum

Sr. No.	Parents / Hybrids	Days to 50 % Flowering			Days to Maturity			Plant Height (cm)		
		Mean	b_i	S^2d_i	Mean	b_i	S^2d_i	Mean	b_i	S^2d_i
1	296A x B 58586	71.44	0.59	-2.85	107.11	0.78	-4.74	327.20	1.47	-99.17
2	296A x CSV 20	72.56	0.45	-1.77	108.44	0.49	0.47	311.51	0.98	62.09
3	296A x Kekri local	84.22	1.71	-2.56	119.44	1.70	-3.75	335.76	-0.58	-77.84
4	296A x Pant Chari	78.00	-0.82	9.01*	116.89	-2.64	14.46*	290.05	-0.81	794.10 **
5	296A x SR 2872	82.89	1.11	-2.85	117.78	1.23	-4.39	247.51	-0.92	734.44 **
6	296A x SR 2879	74.44	0.29	-2.71	109.67	0.20	-4.37	267.56	4.87	209.34
7	296A x Niger goti	73.44	1.00	1.81	108.89	1.13	-1.63	299.27	1.36	-90.36
8	AKMS 14A x B 58586	60.89	-0.87	3.19	96.22	-1.03	-1.50	266.93	0.87	-4.24
9	AKMS 14A x CSV 20	62.11	1.47	-2.93	100.67	0.14	3.08	275.38	1.69	-39.59
10	AKMS 14A x Kekri local	73.00	-0.88	0.11	108.11	-0.98	-0.53	255.89	-0.35	-78.16
11	AKMS 14A x Pant Chari	77.67	2.63	3.31	113.22	2.59	-0.74	172.27	-0.24 **	-117.67
12	AKMS 14A x SR 2872	72.56	2.45	12.89*	107.67	2.48*	7.37	263.73	1.05	-39.23
13	AKMS 14A x SR 2879	65.11	1.03	-3.06	101.00	1.34	-4.52	271.22	1.21	-117.03
14	AKMS 14A x Niger goti	68.33	0.60	-3.00	103.44	0.58	-4.61	266.24	1.41	-93.39
15	ICSA 467A x B 58586	64.00	0.13	2.36	99.78	0.05	-0.29	162.96	-0.40	-87.54
16	ICSA 467A x CSV 20	69.44	2.10	-3.04	105.33	1.79	-4.68	161.84	-0.49	-113.57
17	ICSA 467A x Kekri local	83.00	1.84	-2.98	118.00	1.97	-4.77	329.76	2.80	-10.68
18	ICSA 467A x Pant Chari	71.33	-0.57	17.48*	106.44	-2.17	30.76**	173.40	-1.75 *	-108.86
19	ICSA 467A x SR 2872	74.00	0.49	-2.80	108.89	0.61	-3.27	225.06	0.89	-104.25
20	ICSA 467A x SR 2879	70.00	-1.15	-1.65	105.11	-1.26	-3.74	240.93	1.36	-111.38
21	ICSA 467A x Niger goti	74.33	2.66	7.12	109.56	2.68	3.91	253.78	3.39	-57.04
22	1005A x B 58586	68.78	0.98	-2.28	103.22	1.41	-4.24	304.02	1.71	-66.75
23	1005A x CSV 20	67.78	1.09	-2.10	103.56	0.76	-3.89	281.71	3.09	448.93 *
24	1005A x Kekri local	85.22	1.05	-1.54	120.67	0.85	-4.59	313.62	0.27	-95.38
25	1005A x Pant Chari	71.22	-0.16	-0.06	106.33	-0.23*	-0.89	316.38	-1.77	-51.98
26	1005A x SR 2872	72.11	1.01	-2.89	108.44	2.30	-0.12	249.46	-0.85	861.75 **
27	1005A x SR 2879	68.78	0.76	-2.66	107.67	0.83	4.92	282.09	2.83	-4.74

Table 2A: Contd....

Sr. No.	Parents / Hybrids	Days to 50 % Flowering			Days to Maturity			Plant Height (cm)		
		Mean	b_i	S^2d_i	Mean	b_i	S^2d_i	Mean	b_i	S^2d_i
28	1005A x Niger goti	73.11	0.54	-2.85	108.78	0.73	-4.29	289.13	1.61	-59.88
29	1009A x B 58586	78.22	0.94	-2.67	113.89	1.31	-3.51	202.24	-0.99*	-114.51
30	1009A x CSV 20	81.67	3.15	-1.90	116.67	3.36*	-3.08	186.53	-1.26**	-117.69
31	1009A x Kekri local	81.56	2.67	4.66	116.78	2.80	-0.46	290.69	-0.47	-113.07
32	1009A x Pant Chari	75.44	0.95	-1.44	110.44	1.00	-2.98	247.98	5.05	1005.40**
33	1009A x SR 2872	77.11	2.73	4.14	112.11	2.89	3.51	258.13	2.59	-44.32
34	1009A x SR 2879	70.67	0.90	-2.92	106.00	0.85	-4.59	240.80	1.16	-111.51
35	1009A x Niger goti	69.22	1.16	6.53	105.22	1.20	5.33	208.84	-0.91	-102.23
36	296A	74.78	0.54	-2.85	110.56	0.54	-4.76	149.40	-0.14	-115.38
37	AKMS 14A	70.67	2.66	-2.74	106.67	2.34*	-4.32	150.16	1.30	-78.12
38	ICSA 467A	67.89	-0.65	-1.11	106.33	-0.69*	9.80	163.76	-0.99	335.03
39	1005A	72.44	1.14	0.59	107.44	1.20	-0.81	205.78	1.21	-117.77
40	1009A	70.44	1.44	0.13	105.44	1.52	-1.21	191.53	1.10	-114.91
41	B 58586	73.22	3.38	-0.93	108.89	3.25	-2.99	283.53	2.76	-56.78
42	CSV 20	77.22	0.67*	-3.06	112.33	0.67	-4.72	240.82	1.45	-24.82
43	Kekri local	76.67	0.63	-3.02	112.22	0.46	-2.49	305.51	1.52	-45.01
44	Pant Chari	80.22	1.57	-2.89	115.22	1.69	-4.70	281.33	3.36*	439.49*
45	SR 2872	68.11	0.57	3.81	105.11	1.09	7.01	217.67	1.98	-77.05
46	SR 2879	74.78	2.07	0.95	109.78	2.20	-0.16	220.89	3.17	5.11
47	Niger goti	74.89	1.32	-2.65	109.89	1.41	-4.24	278.64	2.68	23.83
48	GJ 42 (standard check)	74.22	-0.10	3.60	109.22	1.04	-4.78	229.59	1.31	-117.51
49	Rampur local (R. Check)	69.22	0.72	-2.27	104.78	0.43	-4.77	275.53	0.60	-100.04
50	Bulky (S. Check)	70.67	-0.03	6.48	105.78	1.08	-4.67	162.73	-1.17	1475.21**
	S.E.	1.28	0.67		1.39	0.93		9.60	0.90	
	Population mean	73.18			108.82			248.53		
	Parental mean	73.44			109.16			224.09		
	Hybrids mean	73.25			108.90			259.14		

** = significant at 5% level, ** = significant at 1% level, R. Check= Resistant Check, S. Check=Susceptible Check*

Table 2B: Stability parameters for panicle length, grain yield per plot and test weight in grain sorghum

Sr. No.	Parents / Hybrids	Panicle Length (cm)			Grain Yield Per Plot (g)			Test Weight (g)		
		Mean	b_i	S^2d_i	Mean	b_i	S^2d_i	Mean	b_i	S^2d_i
1	296A x B 58586	33.73	1.95	6.13*	642.08	0.46*	-1227.57	2.34	1.91	0.00
2	296A x CSV 20	25.42	-0.99	3.58	626.17	1.11	-388.66	2.77	3.14	0.00
3	296A x Kekri local	24.44	1.41	-0.72	713.82	1.34	-1226.40	2.24	4.38	0.01
4	296A x Pant Chari	28.36	-1.64	-0.25	589.00	2.24	720.08	2.30	-1.44	0.00
5	296A x SR 2872	26.53	0.91	0.45	625.64	0.28	-731.69	2.56	2.00*	0.00
6	296A x SR 2879	27.71	0.06	-0.87	853.99	1.49	-976.89	2.78	3.20	0.00
7	296A x Niger goti	28.42	0.67	-1.40	308.16	0.67	7922.14**	2.68	1.26	0.00
8	AKMS 14A x B 58586	25.98	0.28	3.28	714.30	1.08	-987.79	2.61	1.48	0.00
9	AKMS 14A x CSV 20	26.02	-0.23	-0.07	597.08	0.31	-281.95	2.47	-4.49	0.02 *
10	AKMS 14A x Kekri local	23.69	0.71	-0.45	618.55	2.03	4125.70*	2.26	-2.78	0.00
11	AKMS 14A x Pant Chari	27.76	-4.11**	-1.44	447.21	1.28	-289.21	2.33	2.92	0.01
12	AKMS 14A x SR 2872	33.42	0.86	-0.36	705.67	0.35	-1173.39	2.36	0.49	0.01
13	AKMS 14A x SR 2879	25.71	-1.81	0.98	778.96	1.92*	-267.49	2.86	1.21	0.00
14	AKMS 14A x Niger goti	26.56	-0.05	8.87**	790.46	1.53	-1070.91	2.90	0.92	0.00
15	ICSA 467A x B 58586	25.24	-0.94	0.09	355.50	1.33	-629.61	2.44	3.02	0.00
16	ICSA 467A x CSV 20	22.71	-1.79	3.38	552.43	-0.11	1085.79	2.18	0.38	0.01
17	ICSA 467A x Kekri local	21.16	0.68	1.02	507.71	3.04	-1014.59	2.43	3.23	0.00
18	ICSA 467A x Pant Chari	21.53	-0.57	-1.13	433.45	0.40	634.26	2.16	1.53	0.00
19	ICSA 467A x SR 2872	23.07	0.67*	-1.45	667.08	1.63*	478.19	2.60	1.89	0.00
20	ICSA 467A x SR 2879	24.18	0.49	0.34	817.26	1.41	8291.09**	1.95	2.03	0.00
21	ICSA 467A x Niger goti	24.33	0.16	-0.91	525.74	1.12	-452.36	2.50	2.44	0.00
22	1005A x B 58586	26.84	4.38	-1.39	650.89	3.81*	-452.05	2.03	1.54	0.00
23	1005A x CSV 20	23.13	1.37	-1.44	556.47	-0.20	815.88	2.30	1.92	0.00
24	1005A x Kekri local	21.64	0.53	-1.37	662.36	1.33	3752.14*	2.25	0.98	0.00
25	1005A x Pant Chari	24.24	0.94	-1.45	886.73	-0.46	-1161.68	2.46	0.02	0.00
26	1005A x SR 2872	26.24	2.81	-1.43	1055.60	1.52	-1096.00	2.16	1.09	0.00
27	1005A x SR 2879	22.22	2.24	-1.42	744.49	-6.63	7113.83**	2.52	0.85	0.00

Table 2B: Contd…..

Sr. No.	Parents / Hybrids	Panicle Length (cm)			Grain Yield Per Plot (g)			Test Weight (g)		
		Mean	b_i	S^2d_i	Mean	b_i	S^2d_i	Mean	b_i	S^2d_i
28	1005A x Niger goti	22.84	2.13	11.09 **	543.77	3.49*	-1046.72	2.75	-1.55*	0.00
29	1009A x B 58586	20.29	1.37	-1.35	315.46	2.35	-467.99	2.45	2.35	0.00
30	1009A x CSV 20	20.15	2.00	-1.19	284.16	0.88	-927.05	2.40	1.19	0.00
31	1009A x Kekri local	25.40	3.21*	-1.17	392.35	1.00	-545.25	2.37	0.66	0.00
32	1009A x Pant Chari	19.83	4.86	2.82	403.80	1.72	1151.00	2.83	2.43	0.00
33	1009A x SR 2872	25.84	5.02*	1.21	1014.64	1.54	-1077.00	2.65	1.18	0.01
34	1009A x SR 2879	24.00	1.60	-1.33	350.52	0.65	783.25	2.63	1.84	0.00
35	1009A x Niger goti	24.49	-0.47	-0.39	457.56	-0.30	-1143.40	2.59	-3.11*	0.00
36	296A	21.58	2.14	-1.45	441.17	1.09	-626.25	1.95	-0.51	0.00
37	AKMS 14A	22.78	4.94*	-0.14	481.48	3.21	198.38	1.89	2.53	0.02*
38	ICSA 467A	23.64	2.27	-1.45	579.23	1.97	16255.20**	2.27	0.48	0.01
39	1005A	26.22	1.24	-1.43	503.27	0.38	-1121.73	2.12	2.78*	0.00
40	1009A	22.04	1.32	3.60	533.86	1.04	-411.85	2.38	0.26	0.01*
41	B 58586	24.96	3.77	-0.11	694.18	0.40	-1112.04	1.54	1.24	0.00
42	CSV 20	20.98	-0.14	-1.09	415.16	2.11	-1119.16	2.26	1.59	0.00
43	Kekri local	14.71	1.97	-1.16	405.51	-0.04	-1035.54	2.00	1.55	0.02*
44	Pant Chari	21.11	-0.28	3.52	381.69	-0.06	-528.78	1.86	-0.33	0.00
45	SR 2872	20.93	-1.25	4.89*	596.44	1.97*	756.54	2.06	-1.47	0.00
46	SR 2879	14.62	1.04	0.76	390.07	0.36	-834.64	1.56	1.04	0.00
47	Niger goti	20.96	1.54	-1.39	518.12	0.04	-857.17	2.45	2.00	0.01
48	GJ 42 (standard check)	20.07	2.01	-0.53	732.52	0.65	-1136.46	2.45	0.78	0.00
49	Rampur local (R. Check)	23.49	0.12	5.67*	357.41	0.73	3281.67	2.25	0.93	0.00
50	Bulky (S. Check)	20.80	0.62	8.74**	233.67	0.61	-1101.48	1.79	-2.90	0.00
	S.E.	1.05	1.05		30.00	0.90		0.05	1.13	
	Population mean	23.84			569.06			2.34		
	Parental mean	21.21			495.01			2.03		
	Hybrids mean	24.94			605.40			2.46		

**** = significant at 5% level, ** = significant at 1% level, R. Check= Resistant Check, S. Check=Susceptible Check***

[MS received : May 27, 2017] ***[MS accepted : June 04, 2017]***