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Short Communication

Heterosis in Sorghum (*Sorghum bicolor* (L.) Moench) Crosses under Water Stress Conditions

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Sorghum (*Sorghum bicolor* (L.) Moench) is second important food grain crop after rice in Andhra Pradesh. Sorghum, grown in Rayalaseema region of Andhra Pradesh, is highly valued for grain and fodder. Sorghum is planted in *maghi* season (September 15 to October 15) in Vertisols of scarce rainfall zone under stored soil moisture. Moisture stress and charcoal rot are primarily responsible for low yields of sorghum. The exploitation of hybrid vigor and incorporation of tolerance to moisture stress and charcoal rot have emerged as priority research areas. The magnitude and direction of heterosis would enable the breeder to identify promising F_1 crosses so that he can bestow his attention on few, possibly more productive ones, which would ultimately save time and resources. Isleib and Wynne (1983) opined that if heterosis is due to episatatic gene action, particularly additive by additive types of epistasis or to repulsion phase linkage of loci exhibiting partial or complete dominance, it should be possible through selection to fix alleles at the interacting and linked loci to preserve heterotic effect.

Eight F_1s viz., NTJ-4 x MJ-287, NTJ-4 x NJ-2557, NTJ-4 x RSLG-262, NTJ-1 x NJ-2414, NTJ-1 x NJ-2594, N-14 x NJ-2446, N-14 x NJ-2443, and NJ-2450 x NJ-2446 were evolved during rabi 2002-03 utilizing three promising varieties, viz., *Nandyal Tella Jonna 1* (NJT 1), *Nandyal Tella Jonna 4* (NTJ 4) and N-14 released form Regional Agricultural Research Station, Nandyal and promising pre-release culture NJ-2450 as females and diverse parental lines, viz., MJ-287, NJ-2557, RSLG-262, NJ-2414, NJ-2594, NJ-2446 and NJ-2443 as males. Eight F_1s and eleven parents were evaluated during *maghi* season of 2003-04 under receding soil moisture in three replications of a randomized block design with single row plots of 5 m length each. A spacing of 45 x 15 cm was adopted. Observations on length of the panicle (cm), weight of the panicle (g), 1000 grain weight (g) and grain yield/plant (g) were recorded on five randomly selected plants in each replication. Heterosis over mid parent and better parent of respective crosses was calculated as per cent deviation of F_1 mean form their respective parental average and better parent, respectively. The S.Ed. for testing significance of heterosis over mid parent was calculated as per the formula $\sqrt{3/2 \times Me/r}$ where as the S.Ed for testing significance of heterosis over better parent was calculated per formula $\sqrt{2 \times Me/r}$ (Me is the mean sum of squares from combined analysis of parents and F_1s).

Analysis of variance revealed highly significant differences among parents and hybrids indicating substantial variability among the material studied. The *per se* performance of parents and F_1 hybrids and heterosis over respective mid parent and better parent for four important attributes are presented in Table 1.

For length of panicle, heterosis over better parent ranged from -22.5% to 45.5% and that over mid parent ranged from -2.5% to 46.2%. All the F_1s exhibited significant heterosis both over better parent and mid parent for this trait except N-14 x NJ-2446, which expressed negative heterosis over both mid parent (-22.5%) and better parent (-2.5%). Regarding weight of panicle, heterosis ranged from -22.8% to 91.2% and -41.6 to 73.5% over mid parent and better parent, respectively. Only NTJ-4 NJ-2557 (73/5% and 912%) and NTJ-4 RSLG-262 (46.9% and 62.6%) exhibited significant heterosis over both mid parent and better parent, where as NTJ-4 x MJ-287 (23.5%) and N-14 x NJ-2446 recorded significant heterosis over mid parent. Heterosis ranged from -18.3% to 21.8% and from -27.7% to 20.7% over mid parent and better parent, respectively, for 1000-grain weight. NTJ-4 x NJ-2557 is the only F_1 to exhibit significant heterosis both over mid parent (21.8%) and better parent (20.7%) for this trait. Of the eight F_1s, five hybrids exhibited negative heterosis for this trait.

The extent of heterosis for grain yield per plant ranged from -44.2% to 71.3% and -47.7 to 65.0% both over mid parent and better parent, respectively. Only three crosses, viz., NTJ-4 x NJ-2557 (55.2% and 71.3%), NTJ-4 x RSLG-262 (65.0% and 68.2%), and N-14 x NTJ-2446 expressed significant and positive heterosis over both mid parent and better parent (18.4% and 43.4%, respectively).

In sorghum, length of panicle, 1000-grain weight and grain yield are the three important yield attributes that are useful in deciding the superiority of a F_1 hybrid. Breeding for yield in sorghum involves genetic improvement for its direct and indirect components. Plant height, panicle length and breadth, panicle weight, number of seeds per panicle and 100-seed weight are some important components. Ravinder Babu *et al.* (2003) reported both additive as well as dominance components of genotypic variances for yield and yield attributes in sorghum. Hence, the crosses exhibiting heterosis in F_1 generation are of immense value in sorghum breeding program as the probability of isolating a superior line with desirable combination of attributes is high in these crosses due to transgressive segregation in F_2 and subsequent generations. One such hybrid is NTJ-4 x NJ-2557, which showed significant heterosis for panicle length (9.7%), weight of panicle (73.5%), 1000- grain weight (20.7%) and grain yield per plant (55.2%) over better parent. This hybrid can be exploited in further generations, as the probability of it throwing superior segregants is very high. In addition to this, NTJ-4 x RSLG-262 and N-14 x NJ-2446 also expressed significant heterosis for panicle length and grain yield per plant, where as NTJ-4 x MJ-287 recorded significant heterosis for panicle length, weight of panicle and grain yield per plant. These crosses can be exploited further for isolating high yielding sorghum lines with desirable components of yield attributes. Jinks (1983) concluded that heterosis generally arises from

Table 1. Per se performance of parental lines and hybrids and heterosis over better parent (>BP) and mid parent (>MP) in sorghum

Cross (P_1 x P_2)	*Per se* performance			Heterosis (%)		*Per se* performance			Heterosis (%)	
	P_1	P_2	F_1	>BP	>MP	P_1	P_2	F_1	>BP	>MP
	Length of panicle (cm)					Weight of panicle (g plant^{-1})				
NTJ 4 X MJ 287	18.7	18.9	27.5	45.5**	46.2**	47.6	60.3	66.6	10.44	23.56**
NTJ 4 X NJ 2557	18.7	20.6	22.6	9.7**	15.3**	47.6	38.8	82.6	73.5**	91.2**
NTJ 4 X RSLG 262	18.7	17.2	23..0	22.9**	28.4**	47.6	59.0	86.7	46.9**	62.6**
NTJ 1 X NJ 2414	21.0	19.5	24.4	16.1**	20.7**	70.1	54.4	62.8	-10.4	0.96
NTJ 1 X NJ 2594	21.0	22.1	23.2	4.9**	7.9**	70.1	36.0	40.9	-41.6	-22.8
N 14 X NJ 2446	9.0	15.1	11.7	-22.5	-2.5	65.1	45.7	72.8	11.8	31.4**
N 14 X NJ 2443	9.0	8.9	10.1	12.2**	13.4**	65.1	66.0	67.9	2.8	3.6
NJ 2450 X NJ 2446	9.8	15.1	16.2	7.2**	30.6**	71.5	45.7	49.9	-30.2	-14.8
S.Ed		1.16		1.16	1.0		7.0		7.0	6.1
	Grain yield (g plant^{-1})					1000 grain weight (g)				
NTJ 4 X MJ 287	32.6	42.3	43.0	1.65	14.9**	31.8	30.3	28.0	-11.9	-9.6
NTJ 4 X NJ 2557	32.6	26.5	50.6	55.2**	71.3**	31.8	32.3	39.0	20.7**	21.8**
NTJ 4 X RSLG 262	32.6	34.0	56.1	65.0**	68.2**	31.8	32.0	32.3	0.9	1.25
NTJ 1 X NJ 2414	36.2	35.2	18.9	-47.7	-47.0	28.1	26.6	22.3	-20.6	-18.3
NTJ 1 X NJ 2594	36.2	26.7	17.5	-51.6	-44.2	28.1	24.0	20.3	-27.7	-21.9
N 14 X NJ 2446	36.8	24.1	43.6	18.4**	43.4**	32.1	26.0	27.0	-15.8	-6.8
N 14 X NJ 2443	36.8	45.0	45.0	0	10.0**	32.1	31.6	32.5	1.2	2.2
NJ 2450 X NJ 2446	41.7	24.1	28.3	-32.13	-1.2	31.0	26.0	26.1	-15.8	-8.42
S.Ed		5.6		5.6	4.9		1.3		1.3	1.1

* Significant at $P \leq 0.05$ and ** Significant at $P \leq 0.01$; P_1 - Parent 1, P_2 - Parent 2, BP - Better parent, MP - Mid parent.