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Evaluation of crosses involving *rabi* landraces of sorghum for productivity traits

Sorghum is an important food staple for the rural poor in the Semi-Arid tropics. It is being grown in India in both *kharif* (rainy) and *rabi* (post rainy) seasons. The Rabi sorghum crop accounts for 45% of the total area under cultivation and 32% of the total production. Although rabi sorghum is highly valued because of its good grain quality, but its yields are lower (750 kg/ha) compared to *kharif* yields (1100 kg/ha) (Anonymous, 2006). With its cultivation under residual moisture conditions during post rainy season, incidence of charcoal rot and terminal drought are limiting its productivity. Unlike in *kharif* sorghum and other major cereals, crop improvement efforts have not had much impact on the productivity of rabi sorghum in India. Most of the rabi sorghum varieties are only of *durra* type where as *kharif* cultivars that are being grown are belonging to *caudatum* and *kafir* races (Reddy *et al.*, 2003). Genetic improvement of rabi sorghum is therefore hindered by lack of phenotypic variability among breeding lines. On the other hand rabi landraces form an important source of genetic variation. In general, *rabi* adapted sorghums are characterized by tolerance to shoot fly, stalk rot and terminal stress and large lustrous grain with semi-corneous endosperm (Reddy *et al.*, 2006). Hence, breeding for landrace based hybrids form an alternative strategy for rabi sorghum improvement. In the present study, an effort was made to study heterosis in crosses involving *rabi* landraces, varieties and A lines (*milo and maldandi* cytoplasms).

A total of ten crosses were made from thirteen parents involving nine landraces, two varieties (M 35-1 and DSV 5) and two A/B lines (104A on *milo* and M31-2A on *maldandi* cytoplasms). The landraces include four varieties with roti making quality (Gidda Maldandi, Korwar GRS-1 type, Chitapur local and Hattarakihal local), one *Kadabina Jola* type with grain property of flour stickiness used to prepare steamed product *kadabu* (Atharga Kempu Jola) and four pop-sorghum genotypes (Kagi Moti Jola, Pop sorghum 228, Pop sorghum 48 and Pop sorghum 43). The crosses were made during *rabi* 2006-07. The F1s and parents including checks were grown in Randomized Block Design (RBD) in two replications at Regional Agricultural Research Station, Bijapur during *Rabi* 2007-08. Each entry was represented by two rows of 4 m length with spacing of 60 cm between rows and 15 cm spacing between the plants. Observations were recorded on five random competitive plants from each plot for six quantitative characters *viz.*, plant height (cm), panicle weight (g), panicle length (cm), panicle breadth (cm), grain yield per plant (g) and 1000 seed weight (g). Heterosis was estimated for each character over midparent, better parent and check variety M 35-1 (Singh and Singh, 1994).

The evaluation of parents for yield parameters revealed that the genotype Hattarakihal local recorded significantly high grain weight (55.6 g) and panicle weight (74.7 g). The special purpose genotypes (Atharga Kempu Jola, Pop sorghum 43, Pop sorghum 48 and Pop sorghum 228) showed per plant grain weight (31.1-42.3 g), panicle weight (46.9-60.4 g), panicle length (16.2-19.7 cm) and panicle breadth (14.4-15 cm) at par with M 35-1 (34.4 g, 50.7 g, 17.8 cm and 15.0 cm, respectively). But these genotypes showed lower 1000 seed weight (22.0-28.0 g) than other lines. The parents Gidda Maldandi and 104B showed significantly lower plant height (117.2 cm and 129.1 cm, respectively) than M 35-1 (199 cm) and rest of the genotypes. The genotypes Korwar GRS-1 type (21.4 cm), Kagi Moti Jola (21.5 cm) and 104B (22.8 cm) showed significantly longer panicle length compared to rest of the genotypes studied. Significantly high test weight (g/1000 seeds) was recorded by DSV 5 (44.0 g). The other genotypes which recorded high test weight were Hattaraki hal local (38.0 g), Gidda Maldandi (38.0 g), M 35-1 (36.0 g) and 104B (35.0 g).

The heterotic values of 10 crosses were analyzed for yield and related components. None of the crosses was heterotic for all the traits simultaneously (Table 1). The crosses involving varieties and pop sorghum genotypes showed either significant negative or non-significant heterosis for 1000 seed weight. However, the crosses 104A x Pop sorghum 48 and 104A x Pop sorghum 43 showed significant positive heterosis for 1000 seed weight over mid parent (30.5% and 38.4%, respectively) and 17.5% over better parent in cross 104A x Pop sorghum 43. Where as the cross Korwar GRS-1 type x Kagi Moti Jola showed positive but non-significant heterosis over mid parent (18.6%) and better parent (4.9%).

The cross Atharga Kempu Jola x M 35-1 showed high and significant positive heterosis for panicle weight (79.8% and 73.2% over midparent and better parent/check variety, respectively) and grain yield (109.7% and 99.5% over midparent and better parent/check variety, respectively) indicating the scope of isolating transgressive segregants for grain yield from this cross. Similar reports of heterosis for grain yield were reported by Hovny *et al.* (2001) and for panicle weight by Ganesh *et al.* (1996) and Biradar *et al.* (2004). Recently, the variety Atharga Kempu Jola was identified for its suitability to flaking [Sajjanar *et al.* (2009a), Sajjanar *et al.* (2009b) and Sajjanar *et al.* (2010)]. Isolation of high yielding genotypes from this cross while retaining flaking property will be useful for promoting sorghum food industry.

In the cross M 35-1 x Gidda Maldandi, significant negative heterosis was observed for plant height over better parent (-13.9%) and midparent (-19.9%). However, the cross Gidda Maldandi x Korwar GRS-1 showed significant positive midparent heterosis for plant height (20.7%) indicating dominance of height in Korwar GRS-1 type. In this cross significant positive heterosis over M 35-1 was also observed for grain yield (57.1%). Based on genetic diversity analysis of *rabi* landraces for yield traits, it was observed that the cluster involving Korwar GRS-1 showed high cluster distance with rest of the 11 clusters (Sajjanar *et al.*, 2009 unpublished). This confirms the report by Ramanujam *et al.* (1974) that genetically diverse parents are likely to produce high heterotic effects which can be exploited for the desired crop improvement programme.

Among the *maldandi* based A line crosses, M31-2A x Chitapur local showed significant positive midparent heterosis for grain yield (114.9%). Likewise significant positive heterosis for test weight over midparent (32.2%), better parent (27.6%) and check variety (18.9%) was also observed in this cross, thus,

Table 1. Heterosis (%) in different landrace based hybrids of *rabi* sorghum for yield and yield components

Sl. No.	Crosses	Plant height			Panicle weight			Panicle length			Panicle breadth			Grain weight			1000 seed weight		
		MP%	BP%	CC%	MP%	BP%	CC%	MP%	BP%	CC%	MP%	BP%	CC%	MP%	BP%	CC%	MP%	BP%	CC%
1	M 35-1 x Gidda Maldandi	8.4	-13.9*	-13.9**	-1.2	-14.1	16.0	-9.2	-11.7	-11.7	-3.1	-4.4	-4.4	-4.9	-18.9	14.9	-19.9*	-22.3*	-17.3*
2	Gidda Maldandi x Korwar GRS-1	20.7**	-9.0	5.4	13.0	4.8	41.4	-7.9	-17.9**	-0.9	0.3	0	-2.8	23.4	10.9	57.1*	-0.5	-6.6	-0.6
3	Korwar GRS-1 x Kagi Moti Jola	8.4	2.7	18.9**	9.3	6.7	23.2	-0.2	-0.4	20.7**	3.9	0.6	-2.8	17.2	13.2	27.8	18.6	4.9	-2.1
4	Kagi Moti Jola x M 35-1	3.3	5.2	5.2	18.3	12.9	24.2	-1.9	-10.5*	8.5	2.0	-2.8	-2.8	26.4	23.3	29.8	-4.8	-18.2*	-18.2*
5	Atharga Kempu Jola x M 35-1	4.2	9.1	9.1	79.8**	73.2**	73.2**	0.2	-0.5	-0.5	10.5	8.3	8.3	109.7**	99.5**	99.5**	11.9	-0.3	-0.3
6	DSV 5 x Pop sorghum 228	8.5	5.7	13.3	43.6*	20.6	36.6	13.3*	8.5	8.0	11.7	3.1	0.8	31.5	13.1	39.1	-18.2*	-32.6**	-17.3
7	M 31-2A x Chitapur local	8.7	8.3	-4.5	56.0	36.9	10.2	13.0	6.3	-20.2**	11.7	10.9	-15.0	114.9*	80.3	24.4	32.2**	27.6**	18.9*
8	M 31-2A x Hattarakihal local	5.1	-0.9	-2.1	-1.1	-30.1	3.0	12.1	4.3	-8.9	9.2	-1.2	-7.8	-8.6	-34.8	5.4	5.4	-4.4	1.7
9	104 A x Pop sorghum 48	15.5*	-6.3	-2.3	31.7	25.4	65.3**	10.8*	3.3	32.4**	5.6	5.0	5.0	44.3*	42.0	68.4*	30.5**	4.9	4.6
10	104 A x Pop sorghum 43	-20.1**	-35.8**	-31.3**	-65.7**	-69.8**	-60.2*	-7.7	-18.7**	4.2	-28.1**	-28.1**	-28.9**	-27.5	-32.6	-22.6	38.4**	17.5*	17.2
	SE±	11.43	13.2	13.2	10.15	11.72	11.72	0.95	1.09	1.09	1.09	1.3	1.3	8.23	9.5	9.5	0.31	0.3	0.3
	CD at 5%	23.43	27.06	27.06	20.81	24.03	24.03	1.95	2.23	2.23	2.23	2.7	2.7	16.87	19.48	19.48	0.64	0.62	0.62
	CD at 1%	31.66	36.56	36.56	28.12	32.46	32.46	2.63	3.02	3.02	3.02	3.6	3.6	22.79	26.32	26.32	0.86	0.83	0.83

MP: Mid parent BP: Better parent CC: Check variety indicating the utility of the parent Chitapur local in isolating good restorer for *maldandi* cytoplasm. Chitapur local was also showed moderate level of resistance to shoot fly (19.5%), which is at par with the popular rabi variety M 35-1 (21.0%) (Biradar and Balikai, 2007). The results indicate the scope of isolating segregants with improved test weight and shoot fly resistance from this cross. Similar results on greater heterosis over midparent for test weight in *maldandi* cytoplasm based hybrids were reported by Pattanashetti *et al.* (2005). According to Reddy *et al.* (2006), the hybrids based on shoot fly resistant A lines and landrace pollinators possess the traits required for post rainy season adaptation (such as resistance to shoot fly and terminal drought) and grain traits (such as pearly white, lustrous and large grains), which are preferred by the farmers. Therefore, landrace based hybrids play role in rabi sorghum improvement programme and systematic study involving diverse parents is the need of hour.

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All India Co-ordinated Sorghum Improvement Project (AICSIP),
Regional Agricultural Research Station, Bijapur-586 101, India.
Email: sajjanarg@yahoo.com

G.M. SAJJANAR
B.D. BIRADAR
S.S. BIRADAR

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