



Research Paper

**HETEROSIS STUDIES FOR YIELD AND ITS COMPONENTS TRAITS IN
*RABI Sorghum (Sorghum bicolor L. MOENCH)***

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Abstract

Three male sterile lines, fifteen testers and their 45 crosses were evaluated with two replications. The male parent RSV 1009 exhibited significantly high mean value for grain yield/plant, plant height and days to maturity. The hybrid combinations viz., 185 A x RSV 458, 185 A x RSV 1093 and 185 A x RSV 1145 exhibited high mean value, high heterobeltosis and standard heterosis for grain yield and its component traits. So these hybrids can be evaluated for multilocation testing for commercial exploitation.

Key words: Heterosis, Rabi Sorghum.

INTRODUCTION

Sorghum [*Sorghum bicolor* (L.) Moench] is the fifth important cereal of the world after wheat, maize, rice and barley. World covers 39.6 million hectares area, producing 57.79 million tones with a productivity of 1404 kg per hectare. India contributes 9.45 % of the world's sorghum production. India covers 5.82 million hectares area, producing 5.39 million tones with a productivity of 926 kg per hectare. The heterosis study helps to exploit the vigour with available genetic variability that helps to achieve a quantum jump in *rabi* sorghum yield.

MATERIALS AND METHODS

The present study comprised of 3 male sterile lines viz., 185A, RMS 2010-10A and RMS 2010-24A and fifteen testers viz., RSR 2231, RR 2145, RSV 1059, RSV 799, CSV 216, RSV 1093, RSV 1200, RSV 912, RSV 458, RSV 1098, RSV 1130, RSV 1151, RSV 1145, RSLG 2291 and RSV 1009. The experiment was carried out at Sorghum Improvement Project, M.P.K.V., Rahuri during *rabi* 2013-2014. The resulted forty-five hybrids along with eighteen parents and one hybrid check (CSH-15R) were evaluated in a randomized block design with two replications by adopting 45 cm x 15 cm spacing. Randomly five competitive plants were selected from each plot for recording observations on days to 50 % flowering, plant height, number of internodes, panicle length, panicle girth, panicle weight, 1000-seed weight, days to maturity, fodder yield per plant, grain yield per plant and harvest index. The data was subjected to the analysis of variance (ANOVA) for various characters [8] and heterosis [3].

RESULT AND DISCUSSION

The analysis of variance revealed that the variation among the treatments were highly significant for all the studied characters (Table 1). Mean performance of parents, hybrids and standard check is presented in Table 2. The estimates of heterosis over better parent (BP) and standard check (SH) are presented in Table 3. In sorghum, positive heterosis is desirable for all studied characters except days to 50 per cent flowering and days to maturity for which negative heterosis are desirable. The manifestation of grain yield heterosis over better parent and standard check in the present investigation ranged from -49.28 % (RMS 2010-24A x RSR-2231) to 87.29% (185 A x RSV-458) and -21.04 % (RMS 2010-24A x RSR-2231) to 115.43 % (185 A x RSV-1093) respectively (Table 4). Similar results were also reported by other scientists [4, 18]. For fodder yield, heterobeltosis and standard heterosis ranged from -69.13 (RMS 2010-24A x RSV 912) to 47.19 (RMS 2010-10A x RSV-1059) percent and -62.63 (RMS 2010-24A x RSV 912) to 44.63 (185A x RSR-2231) percent respectively. Similar results also obtained by various scientists [14, 5, 11, 13,4].

The range of heterobeltosis and standard heterosis are presented in Table 4. Heterosis for grain yield is due to simultaneous heterosis in more than one components of yield. In present study better parent heterosis and standard heterosis for yield and its contributing traits are positive and significant. Plant height is desirable to develop high fodder yielding varieties. Seven hybrids exhibited positive and significant standard heterosis for plant height. These finding are conformity with other scientists [6, 1, 5, 13]. Panicle length, panicle girth and panicle weight are an important yield components. Significant positive heterobeltosis and standard heterosis for panicle length observed in ten and one crosses, respectively. Similar results were obtained by other scientists [10, 6, 1]. Ten and three hybrids showed significant positive better parent and standard heterosis for panicle girth, respectively [2, 17]. For panicle weight nine and seven hybrids exhibited significant positive heterobeltosis and standard heterosis respectively. These finding are in accordance with earlier workers [11, 7].

Earliness is a desirable character that helps to develop early mature varieties. The better parent heterosis and standard heterosis for days to 50% flowering ranged from -14.38 (RMS 2010-10A x RSV-458) to 22.40 (RMS 2010-10A x RSV-912) percent and -12.59 (185 A x RSV-458) to 6.99 (RMS 2010-10A x RSV-912) percent respectively. Two and three hybrids showed significant negative better parent and standard heterosis for day to 50 % flowering respectively. The significant negative heterosis for days to 50% flowering was also observed by other scientists [19, 12]. Ten and sixteen hybrids showed negatively significant better and standard heterosis respectively for days to maturity [15, 7]. Two hybrids viz., 185 A x RSV 1093 and 185 A x RR 2145 showed positive significant standard heterosis over CSH-15R for harvest index [16, 7]. Only one hybrid showed positive significant standard heterosis for 1000 seed weight [1, 5, 13, 9, 12, 19]. The hybrid combinations viz., 185 A x RSV 458, 185 A x RSV 1093, 185 A x RSV 1145, RMS 2010-10A X RSLG 2291 showed significant heterosis for grain yield as well as for one or two important yield contributing characters. So these hybrids can be exploited for commercial hybrid development.

Table 1. Analysis of variance for eleven characters in *rabi* sorghum

Source of variations	D. F.	Days to 50% flowering	Plant height (cm)	No. of internodes	Panicle length (cm)	Panicle girth (cm)	Panicle weight (g)	1000 Seed weight (g)	Days to maturity	Fodder yield per plant (g)	Grain yield / Plant (g)	Harvest index (%)
Replications	1	11.28	196.49	0.48	3.16	0.03	343.45	181.00	11.88	3692.63	4.31	38.81
Treatments	63	20.47* *	1172.36**	1.07*	11.65**	5.20* *	526.29**	29.46**	8.19**	5107.64**	217.25**	52.55*

*, ** = Significant at 5% and 1% level respectively

Table 2: Mean performance of parents, hybrids and standard check for eleven characters in *rabi* sorghum.

Sr. No.	Parents/Hybrid/Check	Days to 50% flowering	Plant height (cm)	No. of internodes	Panicle length (cm)	Panicle girth (cm)	Panicle weight (g)	100 Seed weight (g)	Days to maturity	Fodder yield per plant (g)	Grain yield/Plant (g)	Harvest index (%)
Females		1	2	3	4	5	6	7	8	9	10	11
1	185 A	66.50*	157.29	8.80	21.02	13.42	57.00	29.86	124.50*	46.15	30.30	29.72
2	RMS 2010-10A	73.00	177.25	9.10	18.97	12.09	59.80	25.29	132.00	66.25	24.15	19.21
3	RMS 2010-24A	73.00	152.50	9.60	18.30	12.31	54.60	23.76	132.00	36.35	30.10	33.91*
Males												
4	RSR-2231	74.50	244.70	11.20	19.91	15.02	84.40	38.34	131.50	190.55	55.50	20.35
5	RR-2145	76.00	257.20	10.90	17.35	15.90	71.00	28.57	132.50	261.75*	39.25	12.46
6	RSV-1059	75.50	229.60	10.50	16.10	12.65	52.80	31.41	132.50	103.95	34.50	22.04
7	RSV-799	75.00	244.62	11.40	16.81	14.05	80.60	28.78	133.00	181.35	38.10	14.52
8	CSV-216	76.00	278.16*	11.00	18.81	14.48	79.40	27.61	132.50	222.80	50.75	17.43
9	RSV-1093	74.50	254.94	11.90	13.45	12.31	53.40	32.03	131.50	190.25	43.30	18.18
10	RSV-1200	75.50	254.53	11.40	15.43	13.06	69.50	33.45	132.50	220.35	47.40	16.83
11	RSV-912	62.50*	258.49	11.70	18.74	14.45	73.00	34.61	127.50*	176.85	47.70	20.74
12	RSV-458	76.50	222.93	11.10	13.92	9.66	37.24	35.70	132.50	200.75	19.20	8.08
13	RSV-1098	76.50	248.47	11.70	16.40	12.32	82.20	31.61	133.50	178.30	53.70	20.47
14	RSV-1130	76.50	260.93*	11.70	15.76	12.05	62.80	30.79	132.50	129.50	43.95	26.44
15	RSV-1151	75.00	260.02	11.60	17.34	15.13	94.60	27.59	131.50	200.45	54.25	18.49
16	RSV-1145	75.00	255.11	12.40*	17.03	14.04	70.60	31.56	130.50	190.85	41.75	16.53
17	RSLG-2291	75.00	235.03	11.10	18.35	15.69	83.20	33.89	132.00	206.25	55.65	19.06
18	RSV-1009	75.00	261.48*	11.70	18.10	15.92	90.80	35.38	129.50*	216.45	57.95*	20.36
19	185 A x RSR-2231	67.50*	232.73	10.90	22.25	14.45	78.80	35.58	127.50*	211.30	48.20	17.76
20	185 A x RR-2145	73.00	241.93	11.40	21.83	13.71	74.00	34.36	130.50	80.90	49.15	31.56*
21	185 A x RSV-1059	70.00	241.99	11.90	22.25	15.89	95.40	33.93	129.00*	96.60	43.70	22.77
22	185 A x RSV-799	69.00	243.53	10.70	21.65	16.02	81.60	35.14	127.00*	102.80	31.55	17.05
23	185 A x CSV-216	72.50	239.02	11.00	22.86	16.55	93.80	29.64	130.50	136.70	43.20	20.09
24	185 A x RSV-1093	71.00	250.31	11.70	24.44*	16.34	95.40	37.90	130.50	122.50	76.80*	35.98*
25	185 A x RSV-	69.00	22	11.70	22	17	10	32.0	128.5	72.0	51.8	29.66

Sr No.	Parents/Hybrid s/Check	Days to 50% flower ing	Plan t heig ht (cm)	No. of intern odes	Pani cle len gth (cm)	Pani cle girth (cm)	Pani cle wei ght (g)	100 0 See d wei ght (g)	Days to matu rity	Fodd er yiel d/ per plan t (g)	Gra in yiel d/ Pla nt (g)	Harv est inde x (%)
		1	2	3	4	5	6	7	8	9	10	11
5	1200	0	6.97		.04	.54*	1.60*	9	0*	5	5	
26	185 A x RSV-912	72.50	23.075	10.30	.21	.14	.5380	36.61	131.00	98.15	42.00	27.32
27	185 A x RSV-458	62.50*	21.349	11.30	.81	.15	.7260	32.01	125.00*	150.45	56.75*	26.31
28	185 A x RSV-1098	71.50	26.002	11.90	.05	.15	.9320	33.70	129.00*	140.65	51.20	22.03
29	185 A x RSV-1130	72.00	24.421	10.90	.81	.17	.9550	33.76	130.00	118.00	48.40	22.78
30	185 A x RSV-1151	71.50	23.695	10.90	.20	.15	.8040	34.86	130.00	88.30	44.55	27.01
31	185 A x RSV-1145	73.00	25.099	10.80	.40	.16	.920*	41.90	131.00	207.15	71.50*	22.67
32	185 A x RSLG-2291	71.50	22.682	11.30	.33	.16	.9420	34.31	131.00	145.20	46.65	19.71
33	185 A x RSV-1009	71.00	25.238	11.30	.12	.17	.37*4.80*	33.44	130.00	155.10	50.85	19.80
34	RMS 2010-10A x RSR-2231	74.50	23.795	10.90	.72	.13	.8240	32.84	132.50	163.25	47.15	19.26
35	RMS 2010-10A x RR-2145	75.00	26.460*	10.60	.84	.15	.8940	35.87	133.50	208.25	48.85	16.46
36	RMS 2010-10A x RSV-1059	74.50	22.830	11.80	.48	.12	.5340	36.77	132.00	153.00	29.85	14.55
37	RMS 2010-10A x RSV-799	71.00	27.192*	11.90	.55	.12	.7220	34.08	129.50*	151.05	44.75	20.04
38	RMS 2010-10A x CSV-216	73.50	25.661	11.20	.45	.14	.6040	34.58	129.50*	180.55	34.00	14.05
39	RMS 2010-10A x RSV-1093	72.00	26.326*	11.60	.80	.13	.5420	32.82	127.50*	191.45	36.95	15.39
40	RMS 2010-10A x RSV-1200	74.00	27.138*	11.70	.07	.14	.7080	33.11	129.00*	174.50	41.00	16.32
41	RMS 2010-10A x RSV-912	76.50	24.410	10.90	.14	.15	.9800*	34.27	133.50	155.85	46.95	18.49
42	RMS 2010-10A x RSV-458	62.50*	23.485	10.60	.61	.16	.9360	32.01	126.50*	145.85	42.80	17.90
43	RMS 2010-10A x RSV-1098	74.00	27.238*	11.60	.74	.17	.43*72.00	37.28	131.00	180.15	44.45	17.57
44	RMS 2010-10A x RSV-1130	74.00	26.185*	12.40	.52	.14	.7080	39.80	132.00	157.40	44.15	19.00
45	RMS 2010-10A x RSV-1151	74.00	25.320	11.40	.54	.13	.6240	38.97	131.50	161.70	36.20	16.18
46	RMS 2010-10A x RSV-1145	72.00	24.630	11.90	.20	.14	.7280	30.83	130.50	161.00	43.05	18.34
47	RMS2010-10A x RSLG-2291	73.50	26.439*	11.10	.72	.17	.220.60*	39.97	130.00	206.35	61.30*	19.31
48	RMS 2010-10A x RSV-1009	74.00	24.433	11.40	.23	.15	.3620	38.10	131.50	171.90	55.20	20.78
49	RMS 2010-24A x RSR-2231	72.00	23.094	9.30	.31	.14	.2380	34.47	130.00	92.55	28.15	18.08
50	RMS 2010-24A x RR-2145	76.00	23.110	11.10	.90	.14	.3320	27.66	134.00	109.75	34.90	17.78
51	RMS 2010-24A x RSV-1059	74.00	23.872	11.00	.40	.16	.1177.80	31.17	132.00	102.10	44.00	24.32
52	RMS 2010-24A x RSV-799	74.50	21.915	11.30	.52	.15	.6640	26.27	132.00	90.75	33.80	21.12

53	RMS 2010-24A x CSV-216	75.00	203.79	10.70	22.70	15.34	94.40	28.47	132.50	90.00	54.80	29.76
54	RMS 2010-24A x RSV-1093	76.00	246.98	11.50	22.57	15.17	75.80	26.42	133.50	93.95	40.50	23.73
55	RMS 2010-24A x RSV-1200	76.00	227.71	11.10	20.72	12.64	65.60	30.18	132.00	96.40	29.70	18.27
56	RMS 2010-24A x RSV-912	74.50	193.17	9.40	21.32	15.28	66.20	29.11	130.50	54.60	30.15	24.99
57	RMS 2010-24A x RSV-458	70.50	207.15	9.60	20.20	14.26	76.80	31.71	129.50*	71.70	39.35	25.03
Sr. No.	Parents/Hybrid s/Check	Days to 50% flowering	Plant height (cm)	No. of internodes	Panicle length (cm)	Panicle girth (cm)	Panicle weight (g)	1000 Seed weight (g)	Days to maturity	Fodder yield per plant (g)	Grain yield/Plant (g)	Harvest index (%)
		1	2	3	4	5	6	7	8	9	10	11
58	RMS 2010-24A x RSV-1098	75.00	245.63	11.10	21.15	13.05	71.40	29.83	131.00	97.95	43.20	25.61
59	RMS 2010-24A x RSV-1130	75.50	237.44	11.00	21.50	14.68	86.20	31.19	130.50	140.90	41.80	18.42
60	RMS 2010-24A x RSV-1151	73.00	226.05	10.90	20.47	15.18	89.60	27.49	129.00*	136.25	47.80	22.98
61	RMS 2010-24A x RSV-1145	74.50	243.84	11.60	23.37	15.89	99.80*	28.35	128.50*	117.75	55.00	26.04
62	RMS2010-24A x RSLG-2291	72.00	226.12	10.90	23.28	16.36	91.60	30.27	129.00*	145.40	42.60	18.02
63	RMS 2010-24A x RSV-1009	74.00	235.40	10.90	22.40	15.46	106.40*	28.77	129.50*	206.85	54.05	16.92
	Check											
64	CSH-15(R)	71.50	228.48	10.70	20.90	14.82	71.20	36.51	131.50	146.10	35.65	18.64
	SE (m) ±	0.99	11.38	0.59	1.07	0.86	8.87	1.92	0.62	30.90	7.22	4.03
	CD at 5 %	2.79	32.16	1.66	3.03	2.44	25.07	5.42	1.76	87.32	20.41	11.38

*, ** = Significant at 5% and 1% respectively, CD= critical difference, SE= standard error.

Table 3. Estimates of heterosis over better parent (BP) and standard hybrid check (SH)

Sr. No.	Hybrids	Days to 50 % flowering		Plant height (cm)		No. of internodes		Panicle length (cm)		Panicle girth (cm)		Panicle weight (g)	
		B.P.	S.H.	B.P.	S.H.	B.P.	S.H.	B.P.	S.H.	B.P.	S.H.	B.P.	S.H.
1	185 A x RSR-2231	1.50	5.59*	-4.89	1.86	-2.68	1.87	5.88	6.46	-3.79	-2.5	-6.64	10.67
2	185 A x RR-2145	9.77*	2.10	-5.94	5.89	4.59	6.54	3.88	4.45	-13.77	-7.49	4.23	3.93
3	185 A x RSV-1059	5.26*	-2.10	5.39	5.91	13.33	11.21	5.88	6.46	18.41*	7.22	67.37**	33.99
4	185 A x RSV-799	3.76	-3.50	-0.45	6.59	-6.14	0.00	3.02	3.59	14.02	8.1	1.24	14.61
5	185 A x CSV-216	9.02*	1.40	14.07*	4.61	0.00	2.8	8.78	9.38	14.34	11.67	18.14	31.74
6	185 A x RSV-1093	6.77*	-0.70	-1.81	9.55	-1.68	9.35	16.3*	16.94*	21.76*	10.26	67.37**	33.99
7	185 A x RSV-	3.76	-3.50	-10.83	-0.66	2.63	9.35	4.85	5.43	30.7*	18.35*	46.19*	42.7*

	1200												
8	185 A x RSV-912	16.0* *	1.40	-10.73	0.99	-11.97	-3.74	0.93	1.48	-2.84	-5.26	-26.3	-24.44
9	185 A x RSV-458	-6.02* *	-12.59 **	-4.24	-6.56	1.80	5.61	-0.98	-0.43	17.14	6.07	23.86	-0.84
10	185 A x RSV-1098	7.52* *	0.00	4.65	13.8	1.71	11.2 1	0.17	0.72	16.39	5.4	13.38	30.9
11	185 A x RSV-1130	8.27* *	0.70	-6.41	6.88	-6.84	1.87	8.54	9.14	27.57 **	15.5 2	52.07 *	34.13
12	185 A x RSV-1151	7.52* *	0.00	-8.87	3.71	-6.03	1.87	0.88	1.44	0.13	2.23	-15.01	12.92
13	185 A x RSV-1145	9.77* *	2.10	-1.61	9.85	-12.9	0.93	11.35	11.9 6	20.37 *	14.0 4	54.67 **	53.37 **
14	185 A x RSLG-2291	7.52* *	0.00	-3.49	-0.72	1.80	5.61	1.5	2.06	4.91	11.0 7	13.22	32.3
15	185 A x RSV-1009	6.77* *	-0.70	-3.48	10.46	-3.42	5.61	10.02	10.6 2	9.08	17.1 7*	15.42	47.19 *
16	RMS 2010-10A x RSR-2231	2.05	4.2* *	-2.76	4.15	-2.68	1.87	4.04	-0.89	-7.92	-6.68	-2.37	15.73
17	RMS 2010-10A x RR-2145	2.74	4.90* *	2.88	15.81 *	-2.75	-0.93	15.1	4.47	-2.26	4.86	25.92	25.56
18	RMS 2010-10A x RSV-1059	2.05	4.20* *	-0.57	-0.08	12.38	10.2 8	-2.61	-11.6	-3.99	-18.0 5*	-10.7	-25.00
19	RMS 2010-10A x RSV-799	-2.74	-0.70	11.16	19.01 *	4.39	11.2 1	8.33	-1.67	-13.59	-18.0 8*	-10.42	1.40
20	RMS 2010-10A x CSV-216	0.68	2.80	-7.75	12.31	1.82	4.67	-2.77	-11.7 5	-2.28	-4.55	-23.93	-15.17
21	RMS 2010-10A x RSV-1093	-1.37	0.70	3.27	15.22 *	-2.52	8.41	9.65	-0.48	6.82	-11.2 7	-9.36	-23.88
22	RMS 2010-10A x RSV-1200	1.37	3.50	6.62	18.78 *	2.63	9.35	11.07	0.81	8.77	-4.18	1.87	-0.56
23	RMS 2010-10A x RSV-	22.4* *	6.99* *	-5.57	6.84	-6.84	1.87	21.96 **	10.6 9	10.1	7.35	34.25	37.64 *

	912												
24	RMS 2010-10A x RSV-458	-14.38**	-12.59**	5.35	2.79	-4.5	-0.93	13.92	3.4	32.67**	8.23	56.52*	31.46
25	RMS 2010-10A x RSV-1098	1.37	3.5	9.62	19.21**	-0.85	8.41	-6.48	-15.12*	41.48**	17.61*	-12.41	1.12
26	RMS 2010-10A x RSV-1130	1.37	3.5	0.35	14.6*	5.98	15.89*	-2.37	-11.39	22.83*	0.2	12.74	-0.56
Sr. No.	Hybrids	Days to 50 % flowering		Plant height (cm)		No. of internodes		Panicle length (cm)		Panicle girth (cm)		Panicle weight (g)	
		B.P.	S.H.	B.P.	S.H.	B.P.	S.H.	B.P.	S.H.	B.P.	S.H.	B.P.	S.H.
27	RMS 2010-10A x RSV-1151	1.37	3.5	-2.62	10.82	-1.72	6.54	2.98	-6.53	-7.63	-5.7	-34.04*	-12.36
28	RMS 2010-10A x RSV-1145	-1.37	0.7	-3.45	7.8	-4.03	11.21	6.48	-3.35	4.13	-1.35	3.12	2.25
29	RMS2010-10A x RSLG-2291	0.68	2.8	12.49	15.72*	0.00	3.74	19.77*	8.71	9.75	16.19	32.93*	55.34**
30	RMS 2010-10A x RSV-1009	1.37	3.5	-6.56	6.94	-2.56	6.54	6.64	-3.21	-3.55	3.61	3.74	32.3
31	RMS 2010-24A x RSR-2231	-1.37	0.7	-5.62	1.08	-16.96*	-13.08	7.28	2.2	-5.29	-4.01	-30.33*	-17.42
32	RMS 2010-24A x RR-2145	4.11*	6.29*	-10.15	1.15	1.83	3.74	14.21	0.00	-9.91	-3.34	14.37	14.04
33	RMS 2010-24A x RSV-1059	1.37	3.5	3.97	4.48	4.76	2.8	11.48	-2.39	27.35**	8.70	42.49	9.27
34	RMS 2010-24A x RSV-799	2.05	4.2*	-10.41	-4.08	-0.88	5.61	17.6*	2.97	11.46	5.67	-13.9	-2.53
35	RMS 2010-24A x CSV-	2.74	4.9*	-26.74**	-10.81	-2.73	0.00	20.68*	8.61	5.98	3.51	18.89	32.58

	216												
36	RMS 2010-24A x RSV-1093	4.11*	6.29*	-3.12	8.09	-3.36	7.48	23.31**	7.97	23.19*	2.33	38.83	6.46
37	RMS 2010-24A x RSV-1200	4.11*	6.29*	-10.54	-0.34	-2.63	3.74	13.22	-0.86	-3.18	14.71	-5.61	-7.87
38	RMS 2010-24A x RSV-912	19.2*	4.2*	25.27**	15.45*	19.66**	12.15	13.77	1.99	5.71	3.07	-9.32	-7.02
39	RMS 2010-24A x RSV-458	-3.42	-1.4	-7.08	-9.34	-13.51	10.28	10.38	-3.35	15.84	-3.78	40.66**	7.87
40	RMS 2010-24A x RSV-1098	2.74	4.9*	-1.14	7.51	-5.13	3.74	15.57	1.20	5.93	11.94	-13.14	0.28
41	RMS 2010-24A x RSV-1130	3.42	5.59*	-9.0	3.92	-5.98	2.8	17.49*	2.87	19.21	-0.98	37.26	21.07
42	RMS 2010-24A x RSV-1151	0.00	2.1	13.07*	-1.07	-6.03	1.87	11.83	-2.08	0.33	2.43	-5.29	25.84
43	RMS 2010-24A x RSV-1145	2.05	4.2*	-4.42	6.72	-6.45	8.41	27.68**	11.79	13.18	7.22	41.36*	40.17*
44	RMS 2010-24A x RSLG-2291	-1.37	0.7	-3.79	-1.03	-1.8	1.87	26.87**	11.39	4.27	10.39	10.1	28.65
45	RMS 2010-24A x RSV-1009	1.37	3.5	-9.97	3.03	-6.84	1.87	22.4*	7.18	-2.92	4.28	17.18	49.44**
	SE (m) ±	1.40	1.40	16.14	16.14	0.83	0.83	1.52	1.52	1.21	1.21	12.64	12.64
	CD at 5 %	2.83	2.83	32.53	32.53	1.68	1.68	3.08	3.08	2.45	2.45	25.48	25.48
	CD at 1 %	3.78	3.78	43.46	43.46	2.25	2.25	4.11	4.11	3.28	3.28	34.04	34.04

Table 3.Contd.....

Sr. No	Hybrids	1000 seed weight (g)		Days to maturity		Fodder yield per plant (g)		Grain yield per plant (g)		Harvest index (%)	
		B.P.	S.H.	B.P.	S.H.	B.P.	S.H.	B.P.	S.H.	B.P.	S.H.
1	185 A x RSR-2231	-7.21	-2.55	2.41*	-	10.89	44.63*	-13.15	35.2	-40.23*	-4.72
2	185 A x RR-2145	15.07	-5.88	4.82*	-0.76	69.09*	-44.63	25.22	37.87	6.21	69.31*
3	185 A x RSV-1059	8.04	-7.05	3.61*	-1.9**	-7.07	-33.88	26.67	22.58	-23.37	22.16
4	185 A x RSV-799	17.68	-3.74	2.01*	-	-43.31	-29.64	-17.19	-11.5	-42.62*	-8.53
5	185 A x CSV-216	-0.74	-18.81*	4.82*	-0.76	-38.64*	-6.43	-14.88	21.18	-32.39	7.78
6	185 A x RSV-1093	18.33*	3.82	4.82*	-0.76	-35.61	-16.15	77.37*	115.43*	21.08	93.03*
7	185 A x RSV-1200	-4.07	-12.09	3.21*	-	-67.3**	-50.68	9.39	45.44	-0.2	59.09
8	185 A x RSV-912	5.78	0.29	5.22*	-0.38	-44.5	-32.82	-11.95	17.81	-8.06	46.57
9	185 A x RSV-458	-10.34	-12.33	0.4	-	-25.06	2.98	87.29*	59.19*	-11.46	41.15
10	185 A x RSV-1098	6.6	-7.7	3.61*	-1.9**	-21.12	-3.73	-4.66	43.62	-25.88	18.16
11	185 A x RSV-1130	9.65	-7.52	4.42*	-1.14	-8.88	-19.23	10.13	35.76	-23.34	22.21
12	185 A x RSV-1151	16.74	-4.51	4.42*	-1.14	-55.95*	-39.56	-17.88	24.96	-9.1	44.9
13	185 A x RSV-1145	32.75*	14.77*	5.22*	-0.38	8.54	41.79	71.26*	100.56*	-23.73	21.59
14	185 A x RSLG-2291	1.24	-6.03	5.22*	-0.38	-29.6	-0.62	-16.17	30.86	-33.67	5.74
15	185 A x RSV-1009	-5.48	-8.4	4.42*	-1.14	-28.34	6.16	-12.25	42.64	-33.37	6.22
16	RMS 2010-10A x RSR-2231	-14.36	-10.05	0.76	0.76	-14.33	11.74	-15.05	32.26	-5.36	3.33
17	RMS 2010-10A x RR-2145	25.53*	-1.75	1.14	1.52*	-20.44	42.54	24.46	37.03	-14.32	-11.7
18	RMS 2010-10A x RSV-1059	17.07	0.71	0.00	0.38	47.19*	4.72	-13.48	-16.27	-34.01	-21.97
19	RMS 2010-10A x RSV-799	18.44	-6.64	1.89*	-1.52*	-16.71	3.39	17.45	25.53	4.29	7.48
20	RMS 2010-10A x CSV-216	25.24*	-5.27	1.89*	-1.52*	-18.96	23.58	-33.0	-4.63	-26.89	-24.65
21	RMS 2010-10A	2.45	-10.11	3.04*	3.04*	0.63	31.04	-14.67	3.65	-19.89	-17.44

	x RSV-1093			*	*						
22	RMS 2010-10A x RSV-1200	-1.02	-9.3	-2.27*	-1.9**	-20.81	19.44	-13.5	15.01	-15.07	-12.47
23	RMS 2010-10A x RSV-912	-1.0	-6.14	4.71*	1.52*	-11.87	6.67	-1.57	31.7	-10.87	-0.83
Sr. No	Hybrids	1000 seed weight (g)		Days to maturity		Fodder yield per plant (g)		Grain yield per plant (g)		Harvest index (%)	
		B.P.	S.H.	B.P.	S.H.	B.P.	S.H.	B.P.	S.H.	B.P.	S.H.
24	RMS 2010-10A x RSV-458	-10.32	-12.31	-4.17*	-3.8**	-27.35	-0.17	77.23	20.06	-6.82	-3.97
25	RMS 2010-10A x RSV-1098	17.94*	2.12	-0.76	-0.38	1.04	23.31	-17.23	24.68	-14.19	-5.77
26	RMS 2010-10A x RSV-1130	29.25*	9.01	0.00	0.38	21.54	7.73	0.46	23.84	-28.14	1.93
27	RMS 2010-10A x RSV-1151	41.25*	6.74	0.00	0.00	-19.33	10.68	-33.27	1.54	-15.8	-13.22
28	RMS 2010-10A x RSV-1145	-2.33	-15.56*	0.00	-0.76	-15.64	10.2	3.11	20.76	-4.53	-1.61
29	RMS2010-10A x RSLG-2291	17.94*	9.48	-1.52*	-1.14	0.05	41.24	10.15	71.95*	0.52	3.59
30	RMS 2010-10A x RSV-1009	7.67	4.36	1.54*	0.00	-20.58	17.66	-4.75	54.84	2.04	11.45
31	RMS 2010-24A x RSR-2231	-10.11	-5.59	-1.14	-1.14	-51.43*	-36.65	-49.28*	-21.04	-46.67*	-3.0
32	RMS 2010-24A x RR-2145	-3.2	24.24*	1.52*	1.9**	58.07*	-24.88	-11.08	-2.1	47.56*	-4.61
33	RMS 2010-24A x RSV-1059	-0.75	-14.61	0.00	0.38	-1.78	-30.12	27.54	23.42	-28.28	30.45
34	RMS 2010-24A x RSV-799	-8.71	28.04*	0.00	0.38	-49.96*	-37.89	-11.29	-5.19	-37.71*	13.3
35	RMS 2010-24A x CSV-216	3.10	22.02*	0.38	0.76	59.61*	-38.4	7.98	53.72	-12.23	59.66
36	RMS 2010-24A x RSV-	-17.51*	27.63*	1.52*	1.52*	-50.62*	-35.69	-6.47	13.6	-30.03	27.28

	1093												
37	RMS 2010-24A x RSV- 1200	-9.78	-17.33*	0.00	0.38	-	56.25*	-34.02	-37.34	-16.69	-	46.11*	-1.98
38	RMS 2010-24A x RSV- 912	-15.91	-	20.27*	2.35*	-	69.13*	-	62.63*	-36.79	-15.43	-26.29	34.07
39	RMS 2010-24A x RSV- 458	-11.16	-13.14	1.89*	-1.52*	-	64.28*	-50.92	30.73	10.38	-26.19	34.25	
40	RMS 2010-24A x RSV- 1098	-5.65	-18.3*	-0.76	-0.38	-	45.06	-32.96	-19.55	21.18	-24.47	37.39	
41	RMS 2010-24A x RSV- 1130	1.30	-14.56	-1.14	-0.76	8.80	-3.56	-4.89	17.25	-	45.67*	-1.18	
42	RMS 2010-24A x RSV- 1151	-0.36	-	24.71*	-1.9**	-1.9**	-32.03	-6.74	-11.89	34.08	-32.22	23.28	
43	RMS 2010-24A x RSV- 1145	-10.19	-	22.35*	-1.53*	-	2.28*	-38.3	-19.4	31.74	54.28	-23.2	39.7
44	RMS 2010-24A x RSLG- 2291	-10.67	-17.08*	-	2.27*	-1.9**	-29.5	-0.48	-23.45	19.5	-	46.87*	-3.35
45	RMS 2010-24A x RSV- 1009	-18.68*	-	21.19*	0.0	-1.52*	-4.44	41.58	-6.73	51.61	-	50.11*	-9.25
	SE (m) ±	2.73	2.73	0.88	0.88	42.18	42.18	10.24	10.24	5.52	5.52		
	CD at 5 %	5.51	5.51	1.78	1.78	85.01	85.01	20.65	20.65	11.12	11.12		
	CD at 1 %	7.36	7.36	2.38	2.38	113.57	113.57	27.58	27.58	14.86	14.86		

*, ** = Significant at 5% and 1% respectively, CD= critical difference, SE= standard error.

Table 4. Range of better parent heterosis and standard heterosis for grain yield and its contributing characters.

Name of Characters.	Range	
	BP	SH
1. Days to 50 % flowering	-14.38 (RMS 2010-10A x RSV-458) to 22.40 (RMS 2010-10A x RSV-912)	-12.59 (185 A x RSV-458) to 6.99 (RMS 2010-10A x RSV-912)
2. Plant height (cm)	-26.74 (RMS 2010-24A x CSV-216) to 12.49 (RMS 2010-10A x RSLG-2291)	-15.45 (RMS 2010-24A x RSV-912) to 19.21 (RMS 2010-10A x RSV-1098)
3. No. of internodes	-19.66 (RMS 2010-24A x RSV 912) to 13.33 (185 A x RSV 1059)	-13.08 (RMS 2010-24A x RSR 2231) to 15.09 (RMS 2010-10A x RSV-1130)
4. Panicle length	-6.48 (RMS 2010-10A x	-15.12 (RMS 2010-10A x RSV 1098) to 16.94

(cm)	RSV-1098) to 27.68 (RMS 2010-24A x RSV 1145)	(185 A x RSV-1093)
5. Panicle girth (cm)	-13.77 (185 A x RR-2145) to 41.48 (RMS 2010-10A x RSV-1098)	-18.08 (RMS 2010-10A x RSV 799) to 18.35 (185 A x RSV 1200)
6. Panicle weight (g)	-34.04 (RMS 2010-10A x RSV 1151) to 67.37 (185 A x RSV- 1059)	-24.44 (185 Ax RSV-912) to 55.34 (RMS 2010- 10A x RSLG-2291)
7. 1000 seed weight (g)	-18.68 (RMS 2010-24A x RSV-1009) to 41.25 (RMS 2010-10A x RSV-1151)	-28.04 (RMS 2010-24A x RSV-799) to 14.77 (185 A x RSV-1145)
8. Days to maturity	-4.17 (RMS 2010-10A x RSV-458) to 5.22 (185 Ax RSV-912)	-4.94 (185 A x RSV 458) to 1.90 (RMS 2010-24A x RR-2145)
9. Fodder yield per plant (g)	-69.13 (RMS 2010-24A x RSV 912) to 47.19 (RMS 2010-10A x RSV-1059)	-62.63 (RMS 2010-24A x RSV 912) to 44.63 (185A x RSR-2231)
10. Grain yield per plant (g)	-49.28 (RMS 2010-24A x RSR-2231) to 87.29 (185 A x RSV-458)	-21.04 (RMS 2010-24A x RSR-2231) to 115.43 (185 A x RSV-1093)
11. Harvest index (%)	-50.11 (RMS 2010-24A x RSV 1009) to 21.08 (185 A x RSV-1093)	-24.65 (RMS 2010-10A x CSV-216) to 93.03 (185 A x RSV 1093)

BP= better parent heterosis, SH= standard heterosis

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