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HETEROSIS FOR ECONOMIC TRAITS IN EARLY, MID EARLY AND VERY EARLY RICE CULTIVARS FOR THE CAUVERY DELTA ZONE

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ABSTRACT

Investigation was carried out for exploiting maximum hybrid vigour by combining earliness and yield potential in a single plant. The evaluation was based on the *per se* performance, *sca* and the standard heterosis. The hybrids AD 95134 x TRY 2 and BTCE 23/99 x ADT 43 were found suitable for simultaneous improvement of earliness and yield potential through heterosis breeding as these hybrids had desirable per se performance for grain yield per plant and biological yield per plant and earliness.

INTRODUCTION

Rice is the major crop in the tail end of Cauvery delta zone of Karaikal region. Late receipt of Cauvery river water in the canals for the past ten years have forced the farmers of this region to skip the *Kharif* crop and to raise only a single rice crop in *Rabi* (August-January) season. If very early varieties of less than 100 days duration are available, late *Kharif* is possible by the farmer of this region. Earliness together with higher yield potential would favour this requirement. The exploitation of hybrid vigour appears to be an alternative for making further breakthrough in rice yields. Hybrid rice yields 15-20 per cent more than the highest yielding pureline varieties of similar duration (Virmani *et al.*, 1996 and DRR, 2003). Therefore, it could be possible to produce rice hybrids combining both earliness and yield potential through such heterosis breeding.

MATERIAL AND METHODS

The eight very early (less than 100 days) genotypes (lines) comprising *viz.*, (L1) PNR 591-18, (L2) AD 95128, (L3) AD 95134 (L4) AD 95157, (L5) OR 1516-1-S1A, (L6) BTCE 23/99 (L7) AAUDAR 9309-14-4 and one released variety (L8) MDU 5 and four testers were *viz.*, (T1) ADT 43, (T2) TKM 9, (T3) TRY 2 and (T4) IR 64 were crossed in line x tester fashion to produce 32 hybrids. The parents and hybrids were raised during late *Kharif* at Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal. Observations were recorded on five randomly selected plants per replication both in parents and in hybrids for (1) days to flowering, (2) days to maturity, (3) plant height, (4) panicles per plant, (5) panicle length, (6) panicle weight, (7) grains per panicle, (8) ripened grain index, (9) 100-grain weight, (10) biological yield per plant, (11) harvest index, and (12) grain yield per plant.

Hybrids selected should be based on their mean performance, specific combining ability (*sca*) effects and standard heterosis. An attempt was made in the present study to improve earliness and yield potential.

RESULTS AND DISEUSSION

Eleven out of thirty two hybrids exhibited earliness. Among them two hybrids *viz.*, AD 95134 x IR 64 (L3 x T4) and AD 95128 x ADT 43 (L2 x T1) flowered and matured earlier than 90 days. Other nine hybrids *viz.*, AD 95128 x TRY 2 (L2 x T2), AD 95128 x IR 64 (L4 x T4), AD 95134 x TKM 9 (L2 x T3), AD 95134 x TRY 2 (L3 x T2), AD 95157 x TRY 2 (L4 x T3), AD 95157 x IR 64 (L4 x T1), OR 1516-1-S1A x TKM 9 (L5 x T4) and OR 1516-1-S1A x TRY 2 (L5 x T3) matured before 95 days. Hence these ten hybrids could be chosen for earliness (Table.1).

Considering the yield higher *per se* performance was observed in twelve hybrids.

TABLE 1. Mean performance of the hybrids for earliness and yield potential related traits

Characters	1	2	3	4	5	6	7	8	9	10	11	12
Hybrids												
L1 x T1	70.33	97.67	82.30**	21.58	20.58	1.97	70.51	0.81	2.18*	40.79	0.53*	21.44
L1 x T2	69.67	98.00	96.45	24.43**	22.50	2.61*	90.00	0.91**	2.32**	64.28**	0.52*	33.49**
L1 x T3	72.00	98.67	90.70	21.55	23.18	2.23	90.71	0.83	2.19**	61.81**	0.36	22.47
L1 x T4	69.00	95.00	82.40**	23.00**	21.90	1.81	80.33	0.79	2.17*	52.78	0.43	22.88
L2 x T1	64.33**	89.67**	86.42*	20.83	23.12	1.83	94.33	0.89**	1.65	57.27	0.41	28.40*
L2 x T2	67.00*	94.67	89.76	28.88**	22.99	2.31	104.95*	0.88*	2.03	73.70**	0.46	33.94**
L2 x T3	63.67**	92.33**	78.04**	17.17	20.88	1.55	79.33	0.67	1.76	40.12	0.53*	21.14
L2 x T4	61.67**	92.33**	78.85**	21.00	22.17	1.75	65.33	0.87*	2.15	23.96	0.54**	13.04
L3 x T1	64.33**	96.33	107.51	15.78	23.62	2.85**	124.89**	0.82	1.65	60.14*	0.35	20.93
L3 x T2	64.00**	91.33**	86.43*	19.89	21.71	1.76	62.11	0.64	2.47**	56.13	0.45	25.12
L3 x T3	67.00*	93.67*	98.03	20.33	22.43	2.27	104.67*	0.90**	2.13	63.98**	0.48	30.56**
L3 x T4	62.00**	88.33**	80.80**	12.16	21.27	1.79	82.33	0.91**	2.34**	22.77	0.63**	14.38
L4 x T1	72.33	99.00	106.00	17.89	25.93**	3.04**	152.00**	0.96**	1.86	62.73**	0.50	31.11**
L4 x T2	66.67*	96.67	89.13	17.00	24.57	2.83**	80.67	0.71	1.93	66.01**	0.48	31.71**
L4 x T3	65.00**	92.00**	98.95	15.00	23.60	2.74**	108.67**	0.94**	2.17*	60.92**	0.39	23.49
L4 x T4	65.33**	93.33**	81.50**	14.76	23.90	2.36	99.50	0.86	2.04	51.49	0.47	24.46
L5 x T1	72.33	101.33	93.33	9.49	23.40	1.83	74.63	0.94**	2.07	29.00	0.48	13.89
L5 x T2	66.67*	90.67**	94.56	26.61**	22.94	2.25	95.44	0.87*	2.17*	60.94**	0.46	28.05
L5 x T3	66.67*	93.33**	105.62	18.87	22.51	2.43	70.00	0.54	2.31**	46.97	0.43	19.95
L5 x T4	68.67	92.67**	89.65	22.50*	23.05	1.92	102.00	0.82	2.26**	47.59	0.53*	25.15
L6 x T1	73.00	98.67	97.91	20.56	24.28	2.25	96.64	0.63	1.84	63.66**	0.49	31.08**
L6 x T2	73.67	100.67	98.07	18.28	24.31	2.31	110.00**	0.86	2.22**	62.22**	0.41	25.63
L6 x T3	74.00	101.00	95.84	15.27	23.54	2.28	100.13	0.82	2.19*	51.44	0.43	25.09
L6 x T4	75.67	101.67	98.72	19.57	25.73**	2.66**	109.33**	0.86	2.16*	63.26**	0.52*	32.56**
L7 x T1	71.67	97.67	101.55	24.22**	23.18	2.07	98.34	0.84	1.50	41.94	0.52*	21.75
L7 x T2	70.33	96.67	97.92	19.58	21.99	2.51	100.08	0.82	2.12	68.97**	0.41	28.54*
L7 x T3	70.67	97.33	84.82**	18.77	24.44	2.44	100.05	0.85	2.00	49.66	0.47	23.54
L7 x T4	70.33	99.00	86.51*	21.80	23.17	2.66**	112.94**	0.92**	1.99	51.64	0.59**	30.52**
L8 x T1	70.00	94.67	89.60	19.28	24.56	1.92	102.17	0.86	1.65	44.87	0.44	19.71
L8 x T2	68.33	94.00	91.83	27.00**	24.65	2.71**	112.78**	0.84	2.49**	75.93**	0.43	32.31**
L8 x T3	69.00	94.67	93.02	20.53	22.83	2.63**	98.00	0.91**	2.29**	68.47**	0.43	30.00**
L8 x T4	70.00	94.67	78.16**	20.50	22.10	1.66	78.01	0.85	1.61	35.38	0.42	14.81

**, * Values significantly deviating from grand mean in desirable direction at 1% and 5% levels, respectively.

TABLE 2. The sca effect of the hybrids for earliness and yield potential traits

Hybrids	Sca effect											
L1 x T1	-1.10	-0.99	-9.67**	0.05	-1.88**	-0.15	-18.73**	-0.03*	0.23**	-10.40**	0.07**	-1.68
L1 x T2	-0.27	0.89	7.04**	-1.10	0.11	0.30**	7.95**	0.09**	-0.06	-2.88	0.08**	3.44**
L1 x T3	1.85**	1.51*	1.19	0.29	1.67**	0.01	9.22**	0.02	-0.09**	5.25**	-0.07**	-2.20
L1 x T4	-0.48	-1.41*	1.44	0.76	0.11	0.16	1.56	-0.07**	0.07*	8.03**	0.08**	0.45
L2 x T1	-1.02	-3.91**	-0.85	-0.02	0.40	-0.00	2.00	0.05**	0.01	12.23**	-0.07**	2.47*
L2 x T2	3.15**	2.64**	5.05**	4.02**	0.35	0.30**	19.80**	0.07**	-0.03	12.69**	-0.01	6.08***
L2 x T3	-0.40	0.26	-6.78**	-3.42**	-0.87	-0.37**	-5.26*	-0.13**	-0.20**	-10.28**	0.07**	-1.34
L2 x T4	-1.73**	1.01	2.58	-0.57	0.13	0.07	-16.54**	0.01	0.22**	-14.64**	0.01	-7.20**
L3 x T1	-1.19	2.59**	10.32**	-0.16	0.94	0.72**	25.04**	-0.01	-0.24**	13.11**	-0.12**	0.14
L3 x T2	-0.02	-0.86	-8.21**	-0.05	-0.91	-0.56**	-30.55**	-0.16**	0.16**	-6.87**	-0.01	-2.61**
L3 x T3	2.77**	1.43*	3.28	4.67**	0.71	0.04	12.56**	0.11**	0.08**	11.58**	0.03	8.21**
L3 x T4	-1.56*	-3.16**	-5.39**	-4.46**	-0.74	-0.19	-7.05**	0.06**	0.16**	-17.82**	0.11**	-5.73**
L4 x T1	3.81**	2.43**	8.10**	2.84**	1.01	0.34**	35.44**	0.08**	0.12**	6.17**	0.04*	5.36**
L4 x T 2	-0.35	1.64*	-6.21**	-2.06*	-0.29	-0.07	-28.70**	-0.14**	-0.23**	-6.53**	0.04*	-0.97
L4 x T3	-2.23**	-3.07**	3.50*	0.22	-0.36	-0.07	-0.15	0.10**	0.10**	-1.01	-0.04*	-3.80**
L4 x T4	-1.23	-0.99	-5.40**	-1.00	-0.35	-0.20*	-6.59*	-0.04*	0.01	1.37	-0.03	-0.59
L5 x T1	2.56**	5.51**	-6.46**	-8.77**	-0.01	-0.24*	-17.24**	0.13**	0.13**	-13.48**	0.01	-5.92**
L5 x T2	-1.60*	-3.61**	-2.67	4.35**	-0.39	-0.01	10.76**	0.09**	0.19**	2.57	0.00	1.31
L5 x T3	-1.81**	-0.99	8.28**	0.88	0.07	0.25*	-14.12**	-0.22**	0.04	-0.80	-0.02	-1.42
L5 x T4	0.85	-0.91	0.86	3.54**	0.32	-0.01	20.60**	-0.00	0.03	11.63**	0.01	6.03**
L6 x T1	-2.27**	-3.16**	-3.73*	3.25**	-0.61	-0.09	-13.73**	-0.18**	-0.01	7.24**	0.03	4.44**
L6 x T2	-0.10	0.39	-1.01	3.03**	-0.51	-0.22*	6.81*	0.08**	0.04	-10.17**	-0.03	-7.95**
L6 x T3	0.02	0.68	-3.35	-1.77*	-0.39	-0.16	-2.50	0.05**	0.02	-10.35**	-0.00	-3.10**
L6 x T4	2.35**	2.09**	8.09**	1.55	1.51*	0.47**	9.42**	0.04**	0.03	13.28**	0.01	6.61**
L7 x T1	-0.27	-1.32*	4.85**	4.24**	-0.44	-0.32**	-10.82**	-0.03	-0.14**	-7.38**	0.02	-2.39*
L7 x T2	-0.10	-0.78	3.77*	-4.41**	0.89	-0.07	-1.94	-0.02	0.06	3.67*	-0.07**	-2.53*
L7 x T3	0.02	-0.16	-9.43**	-0.95	-0.67	-0.05	-1.41	0.01	0.03	-5.04**	0.00	-2.15
L7 x T4	0.35	2.26**	0.81	1.11	0.22	0.43**	14.21**	0.04**	0.06	8.75**	0.04*	7.07**
L8 x T1	-0.52	-1.16	-2.56	-1.44	0.60	-0.27**	-1.92	-0.02	-0.10**	-7.57**	0.02	-2.42*
L8 x T2	-0.69	-0.28	2.23	2.28**	0.76	0.34**	15.88**	-0.01	0.33**	7.52**	0.01	3.24**
L8 x T3	-0.23	0.34	3.32	0.09	-0.17	0.35**	1.66	0.07**	0.21**	10.66**	0.03	5.81**
L8 x T4	1.44**	1.09	-2.99	-0.93	-1.19	-0.41**	-15.61**	0.04**	-0.43**	10.61**	0.06**	-6.63**

Significant at 5% level, ** Significant at 1% level

(1)days to flowering, (2) days to maturity, (3) plant height , (4) panicles per plant, (5) panicle length, (6) panicle weight, (7) grains per panicle, (8) ripened grain index, (9) 100-grain weight, (10) biological yield/plant, (11) harvest index and (12) grain yield/plant.

Among them two hybrids *viz.*, PNR 591-18 x TKM 9 (L1 xT2) and BTCE 23/99 x IR 64 (L6 x T4) registered higher *per se* for seven traits including grain yield per plant in three hybrids *viz.*, MDU 5 x TKM 9 (L8 x T2), AD 95157 x ADT 43 (L4 x T1) and AAUDAR 9309 -14-4 x IR 64 (L7 x T4), had higher *per se* performance values for six traits including grain yield per plant . Another two hybrids *viz.*, AD 95128 x TKM 9 (L2 x T2) and MDU 5 x TRY 2 (L8 x T3) had higher per se for five traits including grain yield. The hybrid AD 95134 x TRY 2 (L3 x T3) recorded higher grain yield per plant with better *per se* performance for three component traits, while the hybrid AD 95157 x TKM 9 (L4 x T2) showed higher grain yield per plant with high mean performance for two component traits. Based on *per se* performance for earliness and yield potential two suitable hybrids *viz.*, AD 95134 x TRY 2 (L3 xT3) and AD 95128 x ADT 43 (L2 xT1) were identified as best hybrids.

Significant negative *sca* effects for earliness traits and plant height and significant positive *sca* effects for other yield traits. A perusal of *sca* effects of hybrids revealed that four hybrids *viz.*, AD 95134 x IR 64 (L3 x T4), AD 95157 x TRY 2 (L4 x T3), OR 1516-1-S1A x TKM 9 (L5 x T2) and BTCE 23/99 x ADT 43 (L6 x T1) had desirable *sca* effects for early flowering and maturity duration. These four hybrids may be considered as good specific combiners for earliness (Table 2).

Higher magnitude of desirable *sca* effect for grain yield per plant was noted in six hybrids *viz.*, AD 95134 x TRY 2 (L3 x T3), AAUDAR 9309-14-4 x IR 64 (L7 x T4), BTCE 23/99 x ADT 43 (L6 x T1), AD 95128 x TKM 9 (L2 x T2), MDU 5 x TKM 9 (L8 x T2) and AD 95157 x ADT 43 (L4 x T3). All these hybrids had high sca effects for atleast five yield traits. Three hybrids *viz.,* OR 1516-1-S1A x ADT 43 (L5 x T1), MDU 5 x TRY 2 (L8 x T3), and PNR 591-18 x TKM 9 (L1 x T2) also recorded high diserable *sca* effects for and five component traits including grain yield per plant. Two hybrids *viz.,* BTCE 23/99 x ADT 43 (L6 x T1) and AD 95128 x ADT 43 (L2 x T1) had significant positive sca effect for grain yield.

The hybrid BTCE 23/99 x ADT 43 (L6 x T1) found to be best specific combiner for earliness, yield per plant and also for three traits related with yield potential. Another hybrid AD 95128 x ADT 43 (L2 x T1) also deserves consideration because of higher *per se* for grain yield per plant, biological yield per plant and earliness to maturity this hybrid registered favourable high *sca* effects.In the present study, very early duration group, MDU 5 was used as the check variety for estimating standard heterosis for earliness traits in the hybrids. Whereas, IR 64, which recorded the highest grain is used as the check for yield related traits.

Gong *et al.* (1993), Singh and Maurya (1997), Singh (2000) and Nuruzzman *et al.* (2002) recorded higher negative heterosis for days to flowering and days to maturity. In the present study, heterosis for earliness, was significant negative heterosis for days to flowering and days to maturity in fifteen hybrids. These hybrids had negative heterosis for ripened grain index, panicle length and grains per panicle. Vishwakarma *et al.* (1998) and Ramesha *et al.* (1999) reported earliness and higher ripened grain index; Sathya *et al.* (1999) and Singh (2000) for panicle length and grains per panicle by Yolanda and Das (1995) These results indicate that it would be very difficult to include these three traits in single hybrid and having high heterosis for yield for earliness and grain yield.

Alternatively, high positive standard heterosis was manifested in fifteen hybrids for biological yield per plant, in eleven hybrids for grain yield per plant, nine hybrids for harvest

TABLE 3. The standard heterosis of the hybrids for earliness and yield potential traits

Charaters	1	2	3	4	5	6	7	8	9	10	11	12
Hybrids												
L1 x T1	-0.48	-2.00*	-7.26*	9.34	- 14.14**	-15.35*	-35.16**	-13.20**	1.39	-26.15**	16.03**	-14.11*
L1 x T2	-1.42	-1.67	8.68**	23.82**	-6.13	12.00	-17.23**	-2.64	7.65**	6.37**	15.07*	34.06**
L1 x T3	1.88	-1.00	2.21	9.21	-3.32	-4.14	-16.58**	-11.17**	1.77	11.89**	-19.71**	-10.05
L1 x T4	-2.36	-4.68**	-7.15*	16.55**	-8.65*	-22.34**	-26.12**	-15.56**	0.81	-4.44	-4.49	-8.41
L2 x T1	-8.97**	-10.03**	-2.61	5.57	-3.57	-21.58**	-13.25**	-4.71*	-23.35**	3.68	-9.34	-6.35
L2 x T2	-5.19**	-5.02**	1.15	46.37**	-4.09	-0.53	-3.49	-5.35*	-5.74**	33.43**	1.62	35.85**
L2 x T3	-9.91**	-7.36**	-12.05**	-13.0*	-12.92**	-33.21**	-27.04**	-28.05**	-18.01**	-27.36**	16.32**	-15.39**
L2 x T4	-12.74**	-7.36**	-11.14**	6.42	-7.54*	-24.66**	-39.92**	-7.21**	-0.12	-56.63**	19.63**	-47.82**
L3 x T1	-8.97**	-3.34**	21.15**	-20.05**	-1.46	22.31**	14.86**	-12.06**	-23.40**	8.87	-23.09**	-16.20*
L3 x T2	-9.44**	-8.36**	-2.60	0.79	-9.44*	-24.52**	-42.88**	-31.41**	14.54**	1.62	-1.32	0.56
L3 x T3	-5.19**	-6.02**	10.47**	3.04	6.42	-2.61	3.74	-3.43	0.90	15.83**	6.10	22.34**
L3 x T4	-12.27**	-11.37**	-8.95**	-38.28	-11.28**	-22.92**	-24.28**	-2.53	8.75**	-58.78**	39.19**	-42.44**
L4 x T1	2.35	-0.67	19.45**	-9.34	8.18*	30.76**	39.79**	2.57	-13.44**	13.57**	9.41	24.52**
L4 x T 2	-5.66**	-3.01**	0.44	-13.85*	2.47	21.67**	-25.81**	-24.05**	-10.34**	19.50*	5.88	26.94**
L4 x T3	-8.02**	-7.69**	11.51**	-23.9**	-1.56	17.87**	-0.06	1.07	0.65	10.29*	-14.85*	-5.96
L4 x T4	-7.55**	-6.35**	-8.16**	-25.9**	-0.29	1.40	-8.49*	-8.10**	-5.11*	-6.78	4.56	-2.08
L5 x T1	2.35	1.67	5.17	-51.9**	-2.41	-21.15**	-31.37**	0.21	-4.01	-47.50**	5.81	-44.39**
L5 x T2	-5.66**	-9.03**	6.56	34.8**	-4.30	-3.31	-12.23**	-6.64**	0.70	10.32*	1.91	12.30
L5 x T3	-5.66**	-6.35**	19.02**	-4.39	-6.10	4.34	-35.62**	-41.79**	7.15**	-14.97**	-5.96	-20.14**
L5 x T4	-2.83*	-7.02**	1.02	-14.02*	-3.85	-17.50**	-6.20	-12.67**	4.83*	-13.85**	16.62**	0.67
L6 x T1	3.30*	-1.00	10.33**	4.17	1.27	-3.18	-11.12**	-32.87**	-14.57**	15.25**	7.72	24.41**
L6 x T2	4.24**	1.00	10.51**	-7.35	1.40	0.93	-1.16	-7.85**	3.36	12.60**	-9.26	2.58
L6 x T3	4.71**	1.34	8.00**	-22.64**	-1.87	-2.12	-7.91*	-11.92**	1.73	-6.88	-5.07	0.44
L6 x T4	7.07**	2.01*	11.24**	-0.84	7.31	14.49	0.55	-7.78**	0.31	14.53**	13.68*	30.35**
L7 x T1	1.41	-2.01*	14.44**	22.75**	-3.30	-11.20	-9.56**	-10.24**	-30.26**	-24.07**	14.41**	-12.92*
L7 x T2	-0.48	-3.01**	10.34**	-0.76	1.96	7.78	-7.96*	-11.67**	-1.52	24.86**	-8.75	14.26*
L7 x T3	-0.00	-2.34*	-4.41	-4.88	-8.27*	4.64	-7.99*	-9.53**	-7.01**	-10.10*	4.71	-5.78
L7 x T4	-0.48	-0.67	-2.51	10.49	-3.36	14.51*	3.87	-1.61	-7.70**	-6.52	30.00**	22.17**
L8 x T1	-0.95	-5.02**	0.97	-2.31	2.46	-17.65**	-6.04	-7.99**	-23.18**	18.77**	-3.24	-21.11**
L8 x T2	-3.31**	-5.69**	3.48	36.82**	2.82	16.59**	3.72	-10.10**	15.90**	37.46**	-6.18	29.33**
L8 x T3	-2.36	-5.02**	4.83	4.05	-4.76	13.16*	-9.87**	-2.57	6.22**	23.95**	-4.85	18.07**
L8 x T4	-0.95	-5.02**	-11.92**	3.89	-7.81*	-30.18**	-28.25**	-9.10**	-25.44**	-35.95**	-7.65	-40.72**

Significant at 5% level, ** Significant at 1% level index, in eight hybrids for panicle weight, seven hybrids for 100-grain weight and six hybrids for panicles per plant. Seven hybrids produced desirable negative heterosis over the check variety for plant height. High desirable standard heterosis was reported by Gong *et al.* (1993), Ramalingam *et al.* (1994), Murthy and Kulkarni (1996), Reddy *et al.* (1996), Elsy (1997), Ganesan *et al.* (1997), Souframanien *et al.* (1998), Ramesha *et al.* (1999), Janardhanam *et al.* (2001) and Nuruzzaman *et al.* (2002) for different traits in rice (Table 3).

The hybrid AD 95128 x TKM 9 (L2 x T2) recorded the highest positive standard heterosis for grain yield per plant (35.85 per cent), panicles per plant (46.37 per cent) and next best heterosis for biological yield (33.43 per cent). Two other hybrids *viz.*, PNR 591-18 x TKM9 (L1 xT2) and BTCE 23/99 x IR 64 (L6 x T4) exceeded 30 per cent heterosis for grain yield per plant.

Six hybrids showed more than 20 per cent heterosis for grain yield per plant. Among them, the hybrids, MDU 5 x TKM 9 (L8 x T2) and AD 95134 x IR 64 (L3 x T4) recorded higher magnitude of heterosis for panicle weight and biological yield per plant. Similarly, the hybrid AAUDAR 9309-14-4 x IR 64 (L7 x T4) produced high desirable heterosis for panicle weight and harvest index, while the hybrid AD 95157 x TKM 9 (L4 x T2) for panicle weight and biological yield. Two other hybrids *viz.*, BTCE 23/99 x ADT 43 (L6 x T1) and AD 95134 x TRY 2 (L3 x T3) registered higher heterosis for biological yield. These six hybrids could be selected as good hybrids based on standard heterosis for improvement of yield.

As more than 10 per cent standard heterosis for grain yield per plant was noticed in MDU 5 x TRY 2 (L8 x T3) and AAUDAR 9309-14-4 x TKM 9 (L7 x T2), these two hybrids could also be considered as suitable hybrids for heterotic exploitation.

Nine hybrids recorded high favorable *per se*, *sca* and standard heterosis for grain yield per plant. Among them, the hybrid MDU 5 x TKM 9 (L8 xT2) expressed significant for yield component traits *viz.*, panicles per plant, panicle weight, 100-grain weight and biological yield per plant; AD 95157 x ADT 43 (L4 x T1) for panicle weight, grains per panicle and biological yield per plant; MDU 5 x TRY 2 (L8 x T3) for panicle weight, 100-grain weight and biological yield per plant; AD 95128 x TKM 9 (L2 x T2) for panicles per plant and biological yield per plant; BTCE 23/99 x IR 64 (L6 x T4) for panicle weight and biological yield per plant; AAUDAR 9309-14-4 x IR 64 (L7 x T4) for panicle weight and harvest index; BTCE 23/99 x ADT 43 (L6 x T1) and AD 95134 x TRY 2 (L3 x T3) for biological yield per plant and PNR 591-18 x TKM 9 (L1 x T2) for harvest index. The above nine hybrids deserve their utility in heterosis breeding programme to maximise yield potential.

None of the hybrid revealed high *per se*, *sca* and standard heterosis for earliness as well as yield potential. However, the hybrids, AD 95134 x TRY 2 (L3 x T3) and BTCE 23/99 x ADT 43 (L5 x T1) appear to be suitable for simultaneous improvement of earliness and yield potential through heterosis breeding as these hybrids had favourable values of all the three parameters for grain yield per plant and biological yield per plant, the most important yield attributing trait. In addition, the AD 95134 x TRY 2 (L3 x T3) hybrid had high desirable mean and heterosis and the hybrid BTCE 23/99 x ADT 43 (L5 x T1) high desirable *sca* effects for the earliness to flowering and maturity.

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