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Estimation of heterosis and inbreeding depression for yield and yield components in rice (*Oryza sativa* L.) under drought stress conditions

Mukh Ram, Nitesh Kumar, SP Singh, PK Singh and Prabir Kumar Bhattacharyya

Abstract
In the present experiment, the 9 genotypes of rice (3 highly tolerant, 3 moderately tolerant and 3 susceptible for drought tolerance) were crossed in 9x9 diallel cross to produce 36 F_1's (excluding reciprocals) under drought stress conditions during *Kharif*-2014 to study the nature and magnitude of heterosis and inbreeding depression. The optimum standard heterosis to the extent of 20-40% was noted in many crosses for all the 19 traits studied except days to 50% flowering and days to maturity, while relatively more heterosis was noted for days to maturity, leaf angle, grain yield per plant, harvest index, test weight, stomatal conductance and proline content under water stress environment, respectively. Inbreeding depression varied with the crosses and traits and found to be relatively more under drought stress conditions. The crosses Nagina-22 × SARJOO-52, Nagina-22 × Vandana, BPT-5204 × MTU-7029, RASI × Nagina-22, BPT-5204 × SARJOO-52, Vandana × RAU-4, RASI × Vandana, APO × SARJOO-52, Rajendra Bhagwati × BPT-5204 and MTU-7029 × SARJOO-52 with optimum standard heterosis over the seasons along with lower inbreeding depression for yield and its component traits were noted as promising crosses under drought stress condition. The crosses involving parents APO, Nagina-22, RAU-4, Sarjoo-52 and Vandana may be considered in the future breeding program, aiming to improve yield under drought stress conditions.

Keywords: Drought stress, heterosis, inbreeding depressions, rice, yield improvement

Introduction
In Asia, rice (*Oryza sativa* L.) is the staple nourishment (up to 60% of vitality consumption) crop. Drought stress pressure compromises sustainable agriculture with its fast and flighty impacts, making it especially hard for agricultural researchers and ranchers to react to difficulties of water stress. In the eastern Indian conditions of Jharkhand, Orissa, and Chhattisgarh, the normal yield misfortunes from extreme drought were 40% as reported by Pandey *et al*., 2005[1]. Drought stress in rainfed rice territories influences every part of plant development, changing anatomy, morphology, physiology, and biochemistry. Water stress ordinarily affects plant development and advancement and eventually influences yield. A hybrid is monetarily important just when it shows altogether elevated standard heterosis over the best locally adapted variety. Aside from high vigour and yield, the hybrids can be a potential hereditary source for better root framework with higher effectiveness to absorb moisture adequately for enduring dry spell conditions. The presence of heterosis for wanted qualities will be a boon to drought-tolerant breeding since the majority of the hybrids so far need resilience to abiotic stresses. The primary requirement of crop improvement is selection which is based on variability. Without variation, selection is ineffective. Hybridization, among others, is best means to create desirable variability and to fix the concerned gene. The success of commercial hybrids depends on choice of the superior parents coupled with high cross potentiality as evident for optimum heterosis. Therefore, it is highly imperative to obtain the basic information on the nature and magnitude of heterosis present in the crosses. The expression of *per se* heterosis in a given cross will have no real meaning commercially unless it is significantly superior over best standard check. Thusly, the present investigation was completed with the objective to contemplate the nature and extent of heterosis and inbreeding depression.

Materials and Methods
In the present experiment 3 highly tolerant (Rasi, Apo, Nagina-22), 3 moderately tolerant (Rajendra Bhagwati, Vandana, RAU-4) and 3 susceptible (BPT-5204, MTU-7029, Sarjoo-52) to drought stress thus a total of nine genotypes of rice were crossed in a diallel fashion to

produce 36 F_1 (excluding reciprocals) during the *Kharif season* 2014 at Agricultural Research Farm of Institute of Agricultural Sciences of Banaras Hindu University, Varanasi. Few seeds of each cross were raised to developed F2 generation at C.R.R.I., Cuttack, Orissa during the off-season *i.e. Rabi* 2014. All the 36 F_1's, F_2's, their Parents along with two standard check varieties namely Sahbhagi and Shushk Samrat, were grown at Rajiv Gandhi South Campus, Barkachha, Mirzapur in Kharif 2015 under drought stress conditions following Compact Family Randomized Block Design with three replications. The standard agronomic practices were adopted to maintain the crop. The observations were recorded for 19 yield components and drought-related traits. Heterosis was estimated as percent increase or decrease of F_1 value over Mid Parent (MP), Better Parent (BP), and Standard Check Variety (Sahbhagi and Shushk Samrat) in 36 F_1's.

Estimation of heterosis

Heterosis was calculated over superior parent (heterobeltiosis) and over the standard variety, i.e. check (economic heterosis), following the method described by Kempthorne, 1957 [2]

$$\text{Heterosis over superior parent} = \frac{\bar{F}_1 - \overline{SP}}{\bar{F}_1} \times 100$$

$$\text{Heterosis over standard variety (check)} = \bar{F}_1 - \overline{SV}$$

Where,

$\bar{F}_1$ = Mean value of the F_1generation

$\overline{SP}$ = Mean value of the superior parent

$\overline{SV}$ = Mean value of the standard variety (check)

Percentage heterosis over the superior parent and over the standard variety was calculated, as given below:

$$\text{Percentage heterosis over superior parent} = \frac{\bar{F}_1 - \overline{SP}}{\overline{SP}} \times 100$$

$$\text{Percentage heterosis over standard variety} = \frac{\bar{F}_1 - \overline{SV}}{\overline{SV}} \times 100$$

Test of significance for Heterosis

The test of significance of heterosis was accomplished by the 't' test, as given below

$$t = \frac{\bar{F}_1 - \overline{SP}}{\text{S.E.of heterosis over the superior parent}}$$

Where,

$$\text{S. E. of heterosis over superior parent} = \sqrt{s_1^2\left(\frac{1}{r} + \frac{1}{r}\right)}$$

s_1^2 = Error variance obtained by using F_1s and parents together

R = Number of replications

The calculated 't' value was compared with the table value of 't' at error degrees of freedom at P = 0.05 and P = 0.01. The difference between the two estimates was tested against C.D. C.D. = S.E. difference x t 5% at error degree of freedom.

$$\text{Here, S. E. difference will be} = \sqrt{\left(\frac{s_1^2}{r} + \frac{3}{2}\right)}$$

Where,

s_1^2 = Error variance obtained by using F_1s and parents together

R = Number of replications

Estimation of inbreeding depression

The inbreeding depression was calculated as follows:

$$\text{Inbreeding deppression} = \bar{F}_1 - \bar{F}_2 = \text{reduction in } F_2 \text{from} F_1$$

$$\text{Percent inbreeding depression} = \frac{\bar{F}_1 - \bar{F}_2}{\bar{F}_1} \times 100$$

$\bar{F}_2$ = Mean value of the F_2 generation

$\bar{F}_1$ = Mean value of the F_1 generation

The standard error of inbreeding depression was calculated as:

$$\text{S. E. (I)} = \sqrt{s_1^2\left(\frac{1}{r} + \frac{1}{10r}\right)}$$

s_1^2 = Error variance obtained by using F_1s and F_2s together.

Significance of inbreeding depression was tested by 't' test in terms of

$$T = \frac{\bar{F}_1 - \bar{F}_2}{\text{S.E.(I)}}$$

Thus, 't' values were compared at error degree of freedom at P = 0.05 and P = 0.01.

The differences of two estimates were tested against C.D. in terms of C.D. = S.E. difference **x 't'** 5% at error degree of freedom.

Results and discussions

Studies on Heterosis

Earliness in flowering is desirable and hence the cross combinations having negative heterosis for days to 50 percent flowering were desirable. For the days to fifty percent flowering the significant negative heterosis over mid parent was exhibited by 20 crosses. The crosse Nagina-22 × SARJOO-52 was most heterotic cross over mid parent. The crosses Vandana × RAU-4 (13.39), Nagina-22 × RAU-4 (12.58) were having next position after APO × NAGINA-22 for higher significant heterosis over standard check (Sahbhagi). Similarly, for days to maturity the crosses RASI × MTU-7029 showed highest significant negative heterosis over mid parent. The highly negatively significant heterobeltiosis was recorded by Vandana x RAU-4 (-25.51%). 15 crosses were negatively significant over standard check Sahbhagi (Table 1). For the plant height 7 crosses exhibited significantly negative heterosis over mid parent, 20 crosses over better parent and 19 crosses over slandered check Sahabhagi. RAU-4 × MTU-7029 recorded highest heterosis over mid parent, the cross RAU-4 × MTU-7029 over better parent. The cross NAGINA-22 × SARJOO-52 was negatively significant higher heterotic crosses over standard check. For the Number of effective tillers per plant the crosses BPT-5204 × MTU-7029 (16.96%) were most heterotic over mid parent, crosses RAU-4 × BPT-5204 showed higher heterosis over standard check Sahbhagi (Table 2).

The positive and significant heterosis for panicle length is desirable because longer panicle may have the capacity to hold more spikelets/panicle. Out of 36 crosses, 8 showed positively significant heterosis over mid parent with highest magnitude of 18.47% (BPT-5204 × SARJOO-52), 6 cross combinations showed positively significant heterosis over better parent with highest magnitude of 16.86% (APO × BPT-5204), 9 showed positive significant heterosis over standard check (Sahabhagi) with highest magnitude of 25.51% for

Vandana × MTU-7029. For the Panicle weight the crosses RASI × MTU-7029 was the most heterotic cross over mid parent. The crosses RAU-4 × BPT-5204 (23.80%), RASI × MTU-7029 (18.13%) and Vandana × RAU-4 (17.76%) were most heterotic crosses over better parent and cross APO × RAU-4 (21.06%), showed higher heterosis over standard check Sahabhagi (Table 3). The higher number of fertile Spikelets per panicle is one of the important traits which contribute directly to the grain yield enhancement. the crosses Rajendra Bhagwati × SARJOO-52 was most heterotic cross over mid parent, (RASI × APO) showed maximum better parent heterosis while highest heterosis over standard check observed in crosses BPT-5204 × MTU-7029 (Table 4). For the Total no. of spikelets per panicle 15 crosses showed positively significant heterosis over mid parent with highest magnitude of 27.95% (MTU-7029 × SARJOO-52) Whereas 11 cross combinations showed positively significant heterobeltiosis with highest magnitude of 14.13% (BPT-5204 × SARJOO-52) and 25 showed positive significant heterosis over SV (Shushk Samrat) with highest magnitude of 40.10% (BPT-5204 × MTU-7029).

For the traits like spikelet fertility percentage out of 36 crosses, 6, 8 and 10 cross combinations showed positive significant heterosis over mid parent, better parent and both the check Sahbhagi and Shushk Samrat respectively. For the test weight, the higher heterosis over mid parent for this trait was found in cross BPT-5204 × SARJOO-52, while highest heterobeltiosis observed in cross BPT-5204 × MTU-7029 (20.75%) (Table 5). Positive heterosis for grain yield per plant is important aspect. 18 crosses were positively highly significant for mid parent heterosis. The highest heterosis over standard check was recorded by Vandana × RAU-4 (35.35%) followed by RASI × Vandana (30.05%), Rajendra Bhagwati × Vandana (28.38%) and RASI × RAU-4 (22.52%). Ten crosses exhibited significant heterosis over standard check sahbhagi (Table 6). For the biological yield per plant the cross Rajendra Bhagwati × BPT-5204 (18.07%) exhibited highest heterosis over mid parent, the highest heterosis over better parent for this trait was recorded by APO × Rajendra Bhagwati (23.41%) and heterosis over standard check (Shushk Samrat) was observed highest in cross APO × RAU-4 (38.46%).

For the harvest index, a total of 15 crosses showed significant positive heterosis over mid parent. The maximum heterosis observed in cross APO × SARJOO-52 (34.40%) over better. The higher negatively significant heterosis over mid parent for leaf angle was found in cross Nagina-22 × BPT-5204 while highest heterobeltiosis observed in cross Rajendra Bhagwati × BPT-5204 (Table 7). If stay green appearance of the plant is also accompanied by the higher grain yield per plant under moisture stress conditions might be considered as desirable trait. Sixteen of 36 crosses showed positive and significant heterosis over mid parent. The most positive significantly heterosis was observed in Nagina-22 × BPT-5204. The maximum heterosis over better parent was observed in cross RASI × Rajendra Bhagwati (13.67%) while Economic heterosis was found to be positive and significant in twenty crosses and it ranged from 7.23% (Nagina-22 × SARJOO-52) to 40.36 (MTU-7029 × SARJOO-52). Out of 36 cross combination, 13 crosses showed significantly positive heterosis over mid parent for chlorophyll content, the higher magnitude was observed in cross MTU-7029 × SARJOO-52 (30.29%). The data for heterosis over better parent and standard check (Sahbhagi) revealed that only 11 and 13 out of 36 crosses showed positive significant respectively (Table 8).

For the stomatal conductance, the maximum values for heterobeltosis were observed in APO × SARJOO-52 (32.25%%). Eleven crosses showed significant positive heterosis over standard check (Sahbhagi), High economic heterosis was exhibited by APO × Nagina-22 (Table 9). For the Proline content twelve crosses showed significant positive heterosis over mid parent, twelve crosses over better parent and 13 crosses over standard check Shushk Samrat. The highest economic heterosis was observed in cross Nagina-22 × Vandana (24.53%). For the Relative water content fifteen crosses showed positive heterosis over mid parent, out of which ten were significant (Table 10). Twelve crosses exhibited positively significant heterosis over better parent, maximum heterosis over better parent was observed in Pant Nagina-22 × RAU-4 (13.27%), Nine out of 36 crosses showed positive significant heterosis over standard check.

Thus, in the present experiment, there were marked differences in nature and magnitude of heterosis between F_1 hybrids for all the traits under drought conditions. The wide range of heterosis was noted in crosses with respect to yield attributing traits indicating the presence of diversity among the parents. The desirable significant standard heterosis to the extent of 20-40% was noted in many crosses for all the 19 traits studied except days to 50% flowering and days to maturity, While relatively more heterosis was noted for days to maturity, leaf angle, grain yield per plant, harvest index, test weight, stomatal conductance and proline content under water stress environment. Similar observations were also made by several workers, such as Saini *et al.*,1974 [3], Bagheri *et al*., 2010 [4]., Singh *et al.*,2014 [5] Srivastava *et al* 2016 [6]. An increase in the magnitude of heterosis in unfavoured conditions was also noted to be a common phenomenon by Bhati *et al.*,2015 [7].

Studies on inbreeding depression

Inbreeding depression varied with the crosses and traits and found to be relatively more under water stress conditions. The yield traits like panicle length, number of grains per panicle, 1000 grain weight, harvest index and grain yield per plant showed optimum range of inbreeding depression (Table 11). For the grain yield per plant Twenty crosses had shown positive significant inbreeding depression ranging from 11.09% for APO × BPT-5204 to 39.03% for Nagina-22 × MTU-7029, whereas eight crosses revealed significant negative inbreeding depression ranging from -11.06% for RASI × Rajendra Bhagwati to -23.50% for Nagina-22 × SARJOO-52. For the Stay green trait ten crosses had shown positive significant inbreeding depression ranging from 3.32% for Vandna × BPT-5204 to 12.71% for Rajendra Bhagwati × MTU-7029. Whereas thirteen crosses revealed significant negative inbreeding depression ranging from -6.05% for Nagina-22 × Vandna to -14.79% for Rajendra Bhagwati × RAU-4 (Table 11). For the relative water content twelve crosses displayed significant negative inbreeding depression ranging from -5.04% for RASI × BPT-5204 to -31.42% for APO × SARJOO-52. While eight crosses represented significant positive inbreeding depression ranging from 6.09% for Vandna × RAU-4 to 18.93% for RAU-4 × MTU-7029.

The crosses Nagina-22 × SARJOO-52, Nagina-22 × Vandana, BPT-5204 × MTU-7029, RASI × Nagina-22, BPT-5204 × SARJOO-52, Vandana × RAU-4, RASI × Vandana, APO × SARJOO-52, Rajendra Bhagwati × BPT-5204 and MTU-7029 × SARJOO-52 with optimum standard heterosis over the seasons along with lower inbreeding depression for yield

and its component traits were noted as promising crosses under drought stress condition. The expression of heterosis, as well as inbreeding depression in crosses, appeared to be greatly affected by environmental conditions, especially in interacting crosses. In fact, heterosis seems to be composite phenomenon arising through various causes such as over-dominance, pseudo dominance brought about by linkage disequilibrium, epistasis, and even heterozygosity and overall due to interaction between genetic and environmental stimuli Hayman, 1955 [8]. Therefore, the variation observed for heterosis and inbreeding in drought stress condition are not unexpected. Similar findings were also reported by Alam *et. al.*,2004 [9] and Sharma *et. a*l.,2013 [10].

Table 1: Heterosis over Mid, Better and Check variety for Days to 50% Flowering & Days to Maturity

F1s	Days to 50% Flowering					Days to Maturity				
	Mean	Mid	Better	Sahbhagi	Shushk Samrat	Mean	Mid	Better	Sahbhagi	Shushk Samrat
RASI × APO	66.36	4.25*	-2.00	-5.65**	-1.45	93.64	-3.80*	-9.08**	-13.02**	-3.79*
RASI × Nagina-22	61.93	-4.08*	-8.55**	-11.95**	-8.03**	90.03	-7.48**	-12.59**	-16.38**	-7.50**
RASI × Rajendra Bhagwati	65.21	-7.86**	-11.68**	-7.29**	-3.16	100.38	-1.86	-2.54	-6.77**	-3.83*
RASI × Vandana	64.47	-1.16	4.80*	-8.34**	-4.26*	96.97	-0.80	-5.86**	-9.94**	-0.38
RASI × RAU-4	62.78	-4.51**	-7.29**	-10.73**	-6.76**	93.14	-3.74*	-9.58**	-13.50**	-4.31*
RASI × BPT-5204	76.49	-7.85**	-22.19**	8.76**	13.60**	108.08	-10.61**	-22.15**	0.39	11.04**
RASI × MTU-7029	73.50	-13.25**	-27.76**	4.50*	9.15**	107.22	-11.94**	-23.69**	-0.42	10.15**
RASI × SARJOO-52	74.76	-9.70**	-23.61**	6.30**	11.03**	114.71	5.72**	-18.26**	6.54**	17.85**
APO × Nagina-22	60.62	-2.83	4.33*	-13.82**	-9.98**	91.65	1.14	-0.04	-14.87**	-5.84**
APO × Rajendra Bhagwati	68.62	6.04**	-7.05**	-2.44	1.91	100.07	3.57*	-1.47	-7.06**	2.81
APO × Vandana	63.39	6.56**	8.05**	-9.87**	-5.85**	95.77	4.00*	3.54	-11.05**	-7.60**
APO × RAU-4	62.78	-1.24	7.57**	-10.74**	-6.76**	95.10	4.39**	3.72*	-11.67**	-2.30
APO × BPT-5204	70.28	-13.05**	-28.51**	-0.07	4.38*	109.55	-4.95**	-21.09**	1.75	-12.55**
APO × MTU-7029	76.08	-7.84**	-25.22**	8.17**	12.99**	105.85	-8.83**	-24.67**	-1.69	8.75**
APO × SARJOO-52	79.24	-1.71	-19.04**	12.66**	17.68**	111.94	-3.51**	-20.23**	3.97*	15.01**
Nagina-22 × Rajendra Bhagwati	65.21	-3.56*	-11.68**	-7.29**	-3.16	98.00	1.46	-3.50*	-8.98**	0.69
Nagina-22 × Vandana	61.72	-0.56	7.60**	-12.25**	-8.34**	94.86	3.04	2.55	-11.90**	-2.54
Nagina-22 × RAU-4	61.48	-1.77	-3.60	-12.58**	-8.69**	89.99	-12.48**	-24.57**	-16.42**	-7.55**
Nagina-22 × BPT-5204	87.67	9.79**	-10.82**	24.65**	30.21**	130.64	13.37**	-5.90**	21.33**	34.22**
Nagina-22 × MTU-7029	79.87	-2.08	-21.49**	13.56**	18.62**	111.41	-4.01**	-20.70**	3.48*	14.47**
Nagina-22 × SARJOO-52	66.34	-16.70**	-32.22**	-5.68**	-1.48	104.54	9.87**	-4.06*	-2.90	7.40**
Rajendra Bhagwati × Vandana	65.78	-3.66*	-10.90**	-6.47**	-2.31	99.01	2.04	-2.51	-8.04**	1.72
Rajendra Bhagwati × RAU-4	72.24	4.99**	-2.15	2.71	7.28**	100.70	4.86**	-0.84	-6.47**	3.46
Rajendra Bhagwati × BPT-5204	80.43	-6.55**	-18.19**	14.36**	19.45**	117.37	-2.35	-15.46**	9.01**	20.59**
Rajendra Bhagwati × MTU-7029	95.73	9.05**	-5.91**	36.10**	42.17**	128.73	6.36**	8.38**	19.57**	32.26**
Rajendra Bhagwati × SARJOO-52	80.01	-6.80**	-18.24**	13.76**	18.83**	105.86	-1.19	-1.79	-1.68	8.76**
Vandana × RAU-4	60.91	-3.70*	-4.49*	-13.39**	-9.53**	88.74	-3.02	-25.51**	-17.58**	-8.83**
Vandana × BPT-5204	79.90	-0.77	-18.73**	13.60**	18.66**	121.28	4.86**	-12.64**	12.64**	24.60**
Vandana × MTU-7029	78.38	-4.68**	-22.95**	11.45**	16.41**	112.60	-3.35**	-19.86**	4.58**	15.68**
Vandana × SARJOO-52	76.64	-4.56**	-21.69**	8.96**	13.82**	114.46	-1.68	-18.44**	6.31**	-17.59**
RAU-4 × BPT-5204	75.87	-6.39	-22.83**	7.87**	12.68**	117.36	2.35	-15.46**	9.01**	20.58**
RAU-4 × MTU-7029	82.02	-0.89	-19.38**	16.62**	21.82**	120.13	4.00**	14.50**	11.58**	23.42**
RAU-4 × SARJOO-52	75.68	-6.37**	-22.67**	7.60**	12.39**	109.26	-5.35**	-22.15**	1.48	12.25**
BPT-5204 × MTU-7029	90.70	-9.32**	-10.85**	28.96**	34.70**	129.89	-7.00**	-7.55**	20.64**	33.45**
BPT-5204 × SARJOO-52	95.04	-3.11**	-3.33*	35.12**	41.14**	131.54	-5.76**	-6.27**	22.18**	35.15**
MTU-7029 × SARJOO-52	93.35	-6.46**	-8.24**	32.73**	38.64**	133.77	4.73**	4.79**	24.25**	37.44**

*Significant at 0.05 probability level; **Significant at 0.01 probability level

Table 2: Heterosis over Mid, Better and Check variety for Plant Height & No. of Effective Tillers/plant

F1	Plant Height					No. of Effective Tillers/plant				
	Mean	Mid	Better	Sahbhagi	Shushk Samrat	Mean	Mid	Better	Sahbhagi	Shushk Samrat
RASI × APO	94.53	-4.72*	-6.29**	-12.74**	-7.54**	11.70	-2.42	-2.47	6.17	7.99*
RASI × Nagina-22	98.99	1.22	8.94**	-8.62**	3.10	10.50	-10.95**	-12.35**	-4.69	-17.40**
RASI × Rajendra Bhagwati	101.10	2.21	0.80	-6.67**	5.31*	11.65	2.07	-2.75	5.75	-8.36*
RASI × Vandana	102.48	2.92	5.85**	-5.40*	6.75**	11.18	-5.55	-6.73	1.42	12.11**
RASI × RAU-4	98.30	-2.58	-5.72*	-9.26**	2.39	11.30	-3.84	8.70**	2.54	-11.14**
RASI × BPT-5204	106.22	-2.16	-11.17**	-1.95	10.63**	11.28	0.30	-5.87	2.36	-11.30**
RASI × MTU-7029	114.04	0.56	-11.78**	5.27*	18.78**	10.01	-7.70*	-16.44**	-9.13*	-21.26**
RASI × SARJOO-52	95.16	1.63	-2.44	-12.16**	-0.89	10.06	-6.56	-16.02**	-8.68*	-20.87**
APO × Nagina-22	96.09	-3.39	-4.74*	-11.30**	0.09	11.83	0.21	-1.42	7.32	7.00*
APO × Rajendra Bhagwati	100.89	0.30	8.01**	-6.87**	5.08*	11.32	-0.93	-5.67	2.69	-11.01**
APO × Vandana	104.76	3.47	3.08	-3.30	9.11**	11.38	-3.89	9.14**	3.27	10.51**
APO × RAU-4	98.58	-3.88	-5.44*	-9.00**	2.68	11.31	-3.78	-5.70	2.66	-11.04**
APO × BPT-5204	103.18	-6.39**	-13.71**	-4.75*	7.47**	10.30	-8.47*	-14.14**	-6.53	-19.00**
APO × MTU-7029	108.54	-5.67**	16.03**	0.20	13.06**	10.24	-5.67	-14.64**	-7.08	-19.48**
APO × SARJOO-52	106.38	11.63**	5.46*	-1.80	-10.80**	12.18	13.02**	1.53	10.53**	-4.22
Nagina-22 × Rajendra Bhagwati	99.09	-0.09	-1.20	-8.53**	3.21	12.15	8.24*	9.70**	10.28**	-4.43

Nagina-22 × Vandana	99.23	-0.61	-2.36	-8.40**	3.36	10.99	-5.62	-5.93	-0.27	13.58**
Nagina-22 × RAU-4	103.70	2.52	-0.53	-4.27	8.02**	10.39	-10.15**	-10.48**	-5.72	-18.30**
Nagina-22 × BPT-5204	110.31	1.37	-7.75**	1.83	14.90**	11.99	8.39*	3.27	8.77*	-5.74
Nagina-22 × MTU-7029	127.98	12.60**	-0.99	18.14**	33.31**	11.93	11.94**	2.81	8.29*	-6.16
Nagina-22 × SARJOO-52	88.23	-6.03**	-10.03**	-18.56**	-8.10**	11.77	11.26**	1.44	6.84	-7.42*
Rajendra Bhagwati × Vandana	103.41	2.43	1.75	-4.54*	-7.71**	11.21	-0.50	-4.05	1.72	-11.85**
Rajendra Bhagwati × RAU-4	92.45	-9.61**	-11.33**	-14.66**	-6.71**	11.46	2.46	-0.52	3.99	-9.88**
Rajendra Bhagwati × BPT-5204	107.55	-2.17	-10.05**	-0.72	12.03**	10.30	-3.59	-5.10	-6.56	-19.03**
Rajendra Bhagwati × MTU-7029	120.38	4.88**	-6.87**	11.12**	25.39**	11.89	15.64**	9.59*	7.89*	-6.50
Rajendra Bhagwati × SARJOO-52	101.10	6.42**	0.81	-6.67**	5.31*	11.42	11.96**	5.28	3.66	-10.17**
Vandana × RAU-4	107.85	4.77*	3.44	-0.45	12.33**	9.70	-16.42**	-17.00**	-12.01**	23.75**
Vandana × BPT-5204	105.48	-4.63*	-11.79**	-2.63	9.86**	12.08	8.83**	3.37	9.59*	-5.03
Vandana × MTU-7029	122.96	6.52**	-4.87**	13.51**	28.08**	11.17	4.44	-4.37	1.39	-12.14**
Vandana × SARJOO-52	93.76	-2.00	-7.74**	-13.45**	-2.34	9.21	-13.31**	-21.20**	-16.45**	-27.60**
RAU-4 × BPT-5204	114.03	1.89	-4.64*	5.26*	18.78**	12.33	11.94**	7.03	11.89**	-3.04
RAU-4 × MTU-7029	103.75	-11.14**	-19.74**	-4.23	8.06**	12.02	13.19**	4.31	9.04*	-5.50
RAU-4 × SARJOO-52	95.46	-1.57	-8.43**	-11.88**	-0.57	10.27	-2.55	-10.85**	-6.81	-19.24**
BPT-5204 × MTU-7029	130.72	5.07**	1.13	20.67**	36.16**	11.83	16.96**	12.53**	7.32	-7.00*
BPT-5204 × SARJOO-52	110.29	5.39**	-7.77**	1.81	14.88**	8.35	-16.81**	-20.58**	-24.26**	-34.36**
MTU-7029 × SARJOO-52	114.61	4.68*	-11.33**	5.80*	-19.38**	7.59	-21.19**	-21.83**	-31.09**	-33.29**

*Significant at 0.05 probability level; **Significant at 0.01 probability level

Table 3: Heterosis over Mid, Better and Check variety for Panicle Length & Panicle Weight

F1	Panicle Length					Panicle Weight				
	Mean	Mid	Better	Sahbhagi	Shushk Samrat	Mean	Mid	Better	Sahbhagi	Shushk Samrat
RASI × APO	20.76	-8.98**	-10.19**	1.47	-8.73*	3.22	-13.35*	-26.24**	-14.27*	-25.04**
RASI × Nagina-22	22.40	1.27	-3.13	9.45*	-1.55	3.09	-14.19*	-25.28**	17.73*	-28.06**
RASI × Rajendra Bhagwati	20.78	-7.15*	-10.14**	1.53	8.67*	3.10	-6.25	12.51*	-17.55*	-27.91**
RASI × Vandana	22.36	-1.50	-3.27	9.28*	-1.70	3.20	-10.15	-21.05**	-14.89*	20.58**
RASI × RAU-4	20.54	-6.74*	-11.17**	0.36	9.73**	3.34	-1.09	-9.32	11.17*	-22.33**
RASI × BPT-5204	21.08	0.12	8.84*	3.00	-7.36	3.10	1.31	0.98	-17.55*	-27.91**
RASI × MTU-7029	23.30	3.90	0.78	13.86**	2.42	3.63	26.00**	18.13*	-3.55	-15.66*
RASI × SARJOO-52	20.27	5.66	-12.33**	-0.94	-10.90**	3.43	15.90*	11.62	-8.87	-20.31**
APO × Nagina-22	19.90	-8.76**	-11.58**	-2.77	12.54**	3.99	-6.15	-8.62	6.21	-7.13
APO × Rajendra Bhagwati	19.67	-10.88**	-12.61**	-3.89	-13.55**	3.47	-12.30*	-20.59**	-7.71	-19.30**
APO × Vandana	22.85	2.03	1.54	11.66**	0.44	3.96	-5.90	-9.31	5.41	-7.83
APO × RAU-4	21.41	-1.39	-8.86*	4.63	-5.89	3.80	-5.63	-13.04*	21.06**	16.63*
APO × BPT-5204	18.71	-9.80**	16.86**	-8.57*	-17.76**	3.67	-1.08	16.02**	-2.39	-14.65*
APO × MTU-7029	20.37	-7.88*	-9.47*	-0.44	-10.45**	4.07	15.26*	-6.94	8.16	-5.43
APO × SARJOO-52	21.87	15.89**	-2.80	6.89	-3.85	3.63	0.65	-16.93**	-3.46	15.58*
Nagina-22 × Rajendra Bhagwati	21.65	1.29	0.06	5.78	-4.85	3.92	2.04	-5.31	14.26*	8.84
Nagina-22 × Vandana	22.48	3.60	0.87	9.86*	-1.19	4.05	-1.06	-2.09	7.80	-5.74
Nagina-22 × RAU-4	18.81	-10.49**	-10.90**	-8.08	-17.32**	4.12	5.41	-0.40	19.06**	14.11*
Nagina-22 × BPT-5204	20.63	2.93	-2.26	0.83	-9.30*	3.02	-15.99*	-27.05**	-19.68**	-29.77**
Nagina-22 × MTU-7029	20.27	-5.35	-6.70	-0.93	-10.89**	3.46	1.27	-16.51*	-8.07	-19.61**
Nagina-22 × SARJOO-52	16.42	-9.69*	-22.23**	-19.78**	-27.84**	3.06	-12.46*	-26.17**	-18.71**	-28.91**
Rajendra Bhagwati × Vandana	20.22	-7.92*	9.27*	-1.19	-11.12**	4.03	6.01	-0.66	7.09	-6.36
Rajendra Bhagwati × RAU-4	22.96	7.90*	6.12	12.18**	8.91*	3.74	3.51	1.54	15.53*	13.02*
Rajendra Bhagwati × BPT-5204	23.37	15.08**	8.03*	14.20**	2.73	4.03	22.14**	13.64*	7.09	6.36
Rajendra Bhagwati × MTU-7029	23.39	7.86*	7.62	14.29**	2.80	3.87	24.24**	9.22	2.93	-10.00
Rajendra Bhagwati × SARJOO-52	21.44	16.27**	-0.89	4.77	-5.76	3.58	12.11*	1.03	-4.79	-16.74**
Vandana × RAU-4	19.25	-10.91**	-13.64**	-5.95	15.40**	3.58	-7.54	17.76*	-4.88	-16.82**
Vandana × BPT-5204	20.57	-0.33	-7.72*	0.50	-9.60*	3.91	10.09	-3.54	3.99	-9.07
Vandana × MTU-7029	25.68	16.70**	15.24**	25.51**	12.89**	2.94	-12.86*	-27.55**	-21.90**	-31.71**
Vandana × SARJOO-52	21.46	14.33**	-3.72	4.85	-5.68	2.73	-20.83**	-32.65**	-27.39**	-36.51**
RAU-4 × BPT-5204	18.80	-5.76	10.12*	-8.11	-17.35**	3.54	5.25	23.80**	-5.76	-17.60**
RAU-4 × MTU-7029	19.89	-6.73	-8.47*	-2.80	-12.57**	3.29	3.40	-10.59	-12.41*	-23.41**
RAU-4 × SARJOO-52	17.25	-4.59	-17.53**	-15.69**	-24.16**	3.61	10.62	-1.99	-3.99	-16.05*
BPT-5204 × MTU-7029	21.59	6.04	-0.66	5.49	-5.11	3.47	20.86**	13.66*	-7.80	19.38**
BPT-5204 × SARJOO-52	20.28	18.47**	6.81	-0.91	-10.87**	3.17	7.47	3.83	-15.78*	-26.36**
MTU-7029 × SARJOO-52	18.77	1.51	-13.64**	-8.29*	-17.51**	2.91	5.12	2.23	-22.70**	-32.40**

*Significant at 0.05 probability level; **Significant at 0.01 probability level

Table 4: Heterosis over Mid, Better and Check variety for Fertile Spikelets/ Panicle & Total Spikelets/ Panicle

F1	Fertile Spikelets/ Panicle					Total Spikelets/ Panicle				
	Mean	Mid	Better	Sahbhagi	Shushk Samrat	Mean	Mid	Better	Sahbhagi	Shushk Samrat
RASI × APO	118.15	0.51	13.96**	-8.17**	6.44**	164.10	-2.36	-3.64*	-1.52	24.02**
RASI × Nagina-22	129.64	6.13**	-1.95	0.75	16.79**	158.84	-3.33*	6.73**	-4.68**	20.05**
RASI × Rajendra Bhagwati	112.16	-6.30**	-11.92**	-12.83**	1.04	167.34	1.83	-1.75	0.42	26.47**
RASI × Vandana	114.93	-4.83**	-11.21**	-10.68**	3.54	175.77	0.44	-2.17	5.48**	32.84**
RASI × RAU-4	113.49	4.71*	10.02**	-11.80**	2.24	163.79	0.13	-3.83*	-1.71	23.79**
RASI × BPT-5204	110.62	-7.85**	-13.60**	-14.02**	-0.34	171.33	-3.66*	7.57**	2.81	-20.48**
RASI × MTU-7029	123.31	2.62	-3.86	4.16*	-11.09**	167.64	-0.37	-1.57	0.60	26.70**
RASI × SARJOO-52	106.57	7.02**	-4.91*	-17.18**	-6.92**	158.88	15.00**	-6.71**	-4.66**	20.08**
APO × Nagina-22	130.11	4.95**	-1.60	1.12	17.22**	165.63	2.20	-0.11	-0.60	25.18**
APO × Rajendra Bhagwati	125.30	0.09	-1.60	-2.62	12.88**	160.26	-1.13	-3.36	-3.83*	21.12**
APO × Vandana	122.13	-3.25	5.65**	-5.08**	10.02**	173.95	0.70	-3.18	4.39*	31.46**
APO × RAU-4	120.10	3.59*	-4.78*	6.66**	8.20**	151.93	-5.82**	8.38**	-8.83**	14.83**
APO × BPT-5204	124.62	-0.73	-2.67	-3.15	-12.27**	176.03	0.25	5.03**	5.63**	-33.04**
APO × MTU-7029	125.18	-0.37	-2.40	-2.71	12.78**	165.92	-0.06	-0.18	-0.43	-25.40**
APO × SARJOO-52	111.55	6.18**	-9.33**	-13.31**	0.49	152.24	12.01**	-8.19**	-8.64**	4.06
Nagina-22 × Rajendra Bhagwati	129.31	-0.36	-2.20	8.50**	16.50**	165.17	4.32**	4.31*	-0.88	24.83**
Nagina-22 × Vandana	135.10	13.26**	12.18**	5.00*	21.71**	166.85	-1.27	-7.13**	0.13	26.10**
Nagina-22 × RAU-4	133.55	3.39*	10.07**	6.79*	20.31**	160.77	2.02	1.55	-3.52	21.50**
Nagina-22 × BPT-5204	133.60	2.67	5.04**	3.83	20.36**	165.29	-3.81*	-10.82**	-0.81	24.92**
Nagina-22 × MTU-7029	131.55	1.00	-0.51	2.24	-18.51**	173.67	7.03**	4.49*	4.22*	31.26**
Nagina-22 × SARJOO-52	93.57	-14.66**	-29.23**	-27.28**	-15.70**	139.83	5.80**	-11.68**	-16.09**	2.68
Rajendra Bhagwati × Vandana	128.34	-0.04	-0.85	-0.25	15.62**	165.28	-2.21	-8.01**	-0.82	24.91**
Rajendra Bhagwati × RAU-4	125.03	-1.34	-1.80	-2.82	12.64**	165.35	4.93**	4.42*	-0.77	24.97**
Rajendra Bhagwati × BPT-5204	125.10	-2.03	-2.30	-2.77	12.70**	187.36	9.02**	1.08	12.43**	-32.60**
Rajendra Bhagwati × MTU-7029	129.48	1.32	6.95**	4.63*	-16.65**	161.28	-0.62	-2.97	-3.22	21.89**
Rajendra Bhagwati × SARJOO-52	124.16	15.81**	-2.49	-3.51	11.85**	164.94	24.79**	4.16*	-1.02	-24.66**
Vandana × RAU-4	128.42	8.50**	-0.79	6.19*	15.70**	172.21	2.35	-4.15*	3.34	30.15**
Vandana × BPT-5204	125.40	-2.59	-3.12	-2.54	12.97**	187.50	2.73	1.15	12.52**	-28.70**
Vandana × MTU-7029	131.12	1.76	1.29	1.90	18.12**	181.06	4.69**	0.77	8.65**	36.84**
Vandana × SARJOO-52	112.24	3.67	-13.29**	-12.77**	1.11	156.52	9.57**	-12.89**	-6.07**	-18.29**
RAU-4 × BPT-5204	120.54	-5.15**	-5.86**	-6.32**	8.59**	182.59	6.72**	-1.49	9.57**	38.00**
RAU-4 × MTU-7029	126.92	-0.21	-1.04	-1.36	14.34**	164.10	1.60	-1.27	-1.52	24.02**
RAU-4 × SARJOO-52	116.06	8.87**	-7.98**	-9.80**	-4.56*	142.36	8.32**	-9.23**	-14.57**	-7.59**
BPT-5204 × MTU-7029	137.49	7.29**	7.19**	6.85**	23.86**	190.67	8.47**	12.07**	14.42**	40.10**
BPT-5204 × SARJOO-52	105.02	-2.36	-17.97**	-18.38**	-5.38*	159.17	9.26**	14.13**	-4.48*	20.30**
MTU-7029 × SARJOO-52	115.85	7.60**	-9.68**	-9.96**	-4.37	174.16	27.95**	4.78**	4.51*	-31.62**

*Significant at 0.05 probability level; **Significant at 0.01 probability level

Table 5: Heterosis over Mid, Better and Check variety for Spikelet Fertility% & Test Weight

F1	Spikelet Fertility%					Test Weight				
	Mean	Mid	Better	Sahbhagi	Shushk Samrat	Mean	Mid	Better	Sahbhagi	Shushk Samrat
RASI × APO	72.11	2.87	5.94*	6.66**	14.13**	18.12	-8.61*	-13.69**	-11.82*	-9.02*
RASI × Nagina-22	81.65	9.36**	20.26**	5.69*	-2.76	19.29	3.26	3.14	-6.13	-3.15
RASI × Rajendra Bhagwati	67.01	8.37**	-16.69**	13.26**	-20.20**	21.16	8.38	3.78	2.98	6.26
RASI × Vandana	65.38	-5.14*	-9.23**	-15.37**	-22.14**	18.68	-6.65	12.56**	-9.08*	-6.19
RASI × RAU-4	69.30	-5.23*	13.84**	10.30**	17.47**	20.54	-3.82	-14.61**	-0.05	3.13
RASI × BPT-5204	64.61	-4.27	-6.59*	-16.37**	-23.06**	21.34	1.55	-8.66	3.83	7.13
RASI × MTU-7029	73.59	2.94	-4.63	-4.75*	-12.37**	21.24	2.35	-7.02	3.36	6.64
RASI × SARJOO-52	67.09	-9.34**	-18.37**	-13.16**	-20.11**	19.92	3.27	0.02	-3.08	-10.80*
APO × Nagina-22	78.58	10.45**	5.90**	9.72**	6.42**	19.28	-2.86	-8.16	-6.18	-3.20
APO × Rajendra Bhagwati	78.18	1.00	-2.81	1.20	6.90**	19.87	-3.99	-5.37	-3.33	-0.25
APO × Vandana	70.20	-4.10	-5.61*	9.13**	16.40**	20.50	-3.21	-4.06	-0.24	2.93
APO × RAU-4	79.06	12.14**	-1.71	2.33	5.86**	21.78	-3.32	-9.47*	5.97	9.34*
APO × BPT-5204	70.82	-1.32	-4.78	-8.34**	-15.67**	22.40	0.99	-4.12	8.99*	12.45*
APO × MTU-7029	75.45	-0.42	-2.22	-2.34	-10.15**	18.75	-14.46**	-17.92**	-8.76	-5.86
APO × SARJOO-52	73.27	-6.40**	-10.86**	-5.16*	-12.75**	19.26	-5.85	-8.27	-6.29	-3.31
Nagina-22 × Rajendra Bhagwati	78.29	-4.50*	-6.25**	1.34	-6.77**	21.34	9.18*	4.66	3.86	7.16
Nagina-22 × Vandana	80.98	4.12*	14.03**	4.82*	-3.57	21.43	6.95	0.28	4.27	7.58
Nagina-22 × RAU-4	83.17	1.46	-0.41	7.65**	-0.96	24.39	14.10**	1.41	18.70**	22.48**
Nagina-22 × BPT-5204	80.84	5.89**	-3.20	4.63	-3.74	20.12	-4.33	-13.87**	-2.09	1.02
Nagina-22 × MTU-7029	75.74	-5.72**	-9.30**	-1.96	-9.80**	19.57	-5.78	-14.31**	-9.75*	-14.72*
Nagina-22 × SARJOO-52	66.90	-19.25**	-19.89**	-13.40**	-20.33**	21.25	10.04*	6.70	3.39	6.68
Rajendra Bhagwati × Vandana	77.65	1.86	-3.47	0.51	7.53**	23.72	13.60**	11.01*	15.43**	19.10**
Rajendra Bhagwati × RAU-4	75.63	-5.97**	5.98**	-2.10	9.93**	26.04	17.17**	8.26	26.72**	30.74**
Rajendra Bhagwati × BPT-5204	66.77	-10.74**	-17.00**	-13.58**	-20.49**	20.58	-5.93	-11.90**	0.15	3.33

Rajendra Bhagwati × MTU-7029	80.28	1.88	-0.20	3.92	-4.39*	22.49	4.02	-1.56	9.42*	12.90*
Rajendra Bhagwati × SARJOO-52	75.28	-7.43**	-8.41**	-2.56	-10.36**	19.56	-2.94	-4.09	-4.82	-12.79*
Vandana × RAU-4	74.57	-2.18	7.28**	-3.47	11.19**	24.22	6.65	0.69	17.86**	21.61**
Vandana × BPT-5204	66.88	-5.27*	-7.16**	-13.44**	-20.36**	19.15	-14.38**	-18.04**	-6.83	-3.87
Vandana × MTU-7029	72.42	-2.92	-6.14**	-6.26**	-13.75**	20.51	-7.23	-10.23*	-0.21	2.96
Vandana × SARJOO-52	71.73	-6.98**	-12.73**	-7.16**	-14.58**	23.98	16.20**	12.25*	16.71**	20.42**
RAU-4 × BPT-5204	66.01	-11.75**	17.93**	14.56**	21.39**	21.31	-10.10**	-11.39**	3.71	7.01
RAU-4 × MTU-7029	77.35	-1.84	-3.83	0.12	-7.89**	22.07	-5.86	-8.23	7.41	10.83*
RAU-4 × SARJOO-52	81.53	0.27	-0.80	5.53*	-2.91	23.57	7.20	-2.02	14.68**	18.33**
BPT-5204 × MTU-7029	72.11	-1.44	-6.55**	-6.66**	-14.13**	28.21	22.10**	20.75**	34.26**	36.62**
BPT-5204 × SARJOO-52	65.99	-12.80**	-19.71**	-14.59**	-21.42**	26.44	22.22**	13.20**	28.68**	32.77**
MTU-7029 × SARJOO-52	66.52	-16.51**	-19.06**	-13.89**	-20.78**	20.46	-4.30	-10.43*	-11.44*	-21.73**

*Significant at 0.05 probability level; **Significant at 0.01 probability level

Table 6: Heterosis over Mid, Better and Check variety for Grain Yield/ Plant & Biological Yield/ Plant

F1	Grain Yield/ Plant					Biological Yield/ Plant				
	Mean	Mid	Better	Sahbhagi	Shushk Samrat	Mean	Mid	Better	Sahbhagi	Shushk Samrat
RASI × APO	23.89	13.31**	16.23**	15.10**	22.82**	113.54	8.60**	15.10**	5.11*	30.35**
RASI × Nagina-22	24.61	16.30**	-18.76**	12.53**	0.74	84.92	-5.10*	-18.04**	21.39**	-2.51
RASI × Rajendra Bhagwati	18.63	-26.29**	-34.68**	-33.80**	-23.75**	78.87	1.37	-1.72	-26.99**	-9.46**
RASI × Vandana	19.68	25.91**	-30.98**	30.05**	19.44**	82.33	-0.26	-8.26**	-23.78**	-5.48
RASI × RAU-4	21.80	20.86**	23.55**	22.52**	-10.76*	90.34	-6.21**	-22.98**	16.37**	3.72
RASI × BPT-5204	19.32	-21.43**	-32.26**	-31.34**	-20.93**	82.26	-6.99**	-18.98**	-23.84**	-5.56
RASI × MTU-7029	17.79	-18.30**	-37.61**	-36.77**	-27.18**	77.26	-2.72	-7.44*	-28.48**	-11.30**
RASI × SARJOO-52	16.21	-25.59**	-40.15**	-37.38**	-33.64**	81.16	-0.05	-6.76*	-24.87**	-6.82*
APO × Nagina-22	28.82	1.31	-4.89	2.40	17.94**	111.81	-5.79**	-16.40**	3.51	28.36**
APO × Rajendra Bhagwati	24.20	-0.46	-9.00*	-14.00**	-0.95	102.44	-4.26*	23.41**	-5.17*	17.61**
APO × Vandana	22.87	-10.69**	14.01**	-18.74**	-6.41	109.21	-2.27	-18.35**	1.10	25.38**
APO × RAU-4	26.88	10.08**	1.07	-4.49	10.00*	120.60	-3.91*	9.82**	11.65**	38.46**
APO × BPT-5204	23.87	1.03	-10.24**	-15.17**	-2.31	110.03	-6.46**	17.73**	11.86**	-26.33**
APO × MTU-7029	25.53	22.64**	-4.00	-9.28*	4.49	106.45	-1.98	-20.40**	-1.45	-22.21**
APO × SARJOO-52	25.63	23.05**	-3.63	-8.93*	4.88	102.54	-7.12**	23.33**	-5.07*	17.72**
Nagina-22 × Rajendra Bhagwati	23.42	10.50**	22.71**	16.79**	-4.16	90.23	1.85	12.91**	16.47**	3.59
Nagina-22 × Vandana	22.82	16.87**	24.67**	18.89**	16.59**	104.97	8.58**	1.32	-2.82	20.52**
Nagina-22 × RAU-4	31.45	10.60**	3.82	11.77**	28.73**	106.62	-3.47	9.10**	-1.30	22.41**
Nagina-22 × BPT-5204	28.54	12.03**	-5.79	1.43	16.82**	111.18	8.39**	7.31**	12.92**	27.64**
Nagina-22 × MTU-7029	26.22	15.65**	-13.47**	-6.83	7.30	86.84	7.16**	16.18**	19.60**	-3.30
Nagina-22 × SARJOO-52	19.15	-15.54**	-36.78**	-31.94**	-21.61**	104.71	9.84**	1.06	-3.06	-20.21**
Rajendra Bhagwati × Vandana	20.15	9.59*	18.12**	28.38**	17.52**	80.42	-5.38*	-10.39**	-25.55**	-7.68*
Rajendra Bhagwati × RAU-4	25.49	4.87	-4.11	9.42**	4.32	104.89	6.20**	10.57**	-2.90	20.42**
Rajendra Bhagwati × BPT-5204	22.38	4.85	1.59	-20.47**	-8.40*	107.31	18.07**	5.69*	-0.65	23.20**
Rajendra Bhagwati × MTU-7029	17.84	-3.73	-19.00**	-36.59**	-26.97**	86.55	5.74*	3.69	-19.88**	-0.64
Rajendra Bhagwati × SARJOO-52	20.37	9.82*	-7.55	-27.62**	-16.64**	78.75	-5.85*	-9.53**	-27.09**	-9.59**
Vandana × RAU-4	18.19	28.93**	31.56**	35.35**	25.54**	112.25	8.44**	7.29**	13.92**	28.87**
Vandana × BPT-5204	21.65	-4.36	-12.04**	-23.06**	-11.39**	94.16	-1.55	-7.27**	-12.83**	8.10**
Vandana × MTU-7029	21.04	6.12	-14.52**	-25.23**	-13.89**	88.09	1.71	-1.84	-18.45**	1.13
Vandana × SARJOO-52	18.41	-7.18	-25.19**	-34.57**	-24.64**	87.59	-0.91	-2.40	-18.92**	0.55
RAU-4 × BPT-5204	24.57	4.01	-7.57	-12.69**	0.56	110.79	1.26	-5.54*	2.57	27.20**
RAU-4 × MTU-7029	25.37	21.90**	-4.56	-9.84**	3.83	99.59	-0.79	-15.09**	-7.81**	14.33**
RAU-4 × SARJOO-52	24.51	17.71**	-7.80*	-12.90**	0.31	102.19	1.02	-12.87**	-5.40*	-17.32**
BPT-5204 × MTU-7029	20.54	15.07**	-0.58	-27.01**	-15.93**	83.57	-9.66**	-17.70**	-22.64**	-4.06
BPT-5204 × SARJOO-52	16.43	-7.99	-20.46**	-38.60**	-32.74**	100.00	6.06*	-1.51	-7.42**	14.81**
MTU-7029 × SARJOO-52	18.34	-21.84**	21.76**	-34.84**	-24.95**	96.04	12.65**	10.33**	-11.09**	10.26**

*Significant at 0.05 probability level; **Significant at 0.01 probability level

Table 7: Heterosis over Mid, Better and Check variety for Harvest Index & Leaf Angle

F1	Harvest Index					Leaf Angle				
	Mean	Mid	Better	Sahbhagi	Shushk Samrat	Mean	Mid	Better	Sahbhagi	Shushk Samrat
RASI × APO	21.11	26.91**	34.27**	19.02**	24.77**	36.33	-7.40*	-9.96*	-16.67**	-11.30**
RASI × Nagina-22	28.98	-13.67**	-23.47**	11.20*	3.30	35.84	-2.99	-11.19**	-17.81**	-6.59
RASI × Rajendra Bhagwati	23.63	-27.66**	-37.61**	9.34*	15.78**	38.84	-1.11	-3.75	-10.92**	-13.23**
RASI × Vandana	23.91	26.79**	16.88**	-8.27	14.79**	36.94	-5.27	-8.46*	-15.28**	-9.72*
RASI × RAU-4	24.15	-20.22**	-36.24**	-7.35	-13.94**	36.35	-2.08	-9.92*	-16.63**	-5.26
RASI × BPT-5204	23.50	-19.32**	-37.96**	-9.85*	-16.25**	55.95	-1.93	-24.13**	28.32**	25.82**
RASI × MTU-7029	23.03	-17.60**	-39.19**	-11.64**	-17.92**	57.51	18.11**	0.83	31.91**	29.90**
RASI × SARJOO-52	19.97	-27.62**	-40.26**	-23.37**	-28.81**	55.59	13.50**	-3.50	27.49**	24.88**
APO × Nagina-22	25.77	14.88**	11.95**	-1.11	-8.14	37.61	4.99	-1.34	-13.74**	-1.97
APO × Rajendra Bhagwati	23.72	0.21	-13.61**	-9.00*	-15.47**	38.49	0.86	10.75*	-11.73**	0.31

APO × Vandana	20.93	11.52**	20.70**	19.68**	15.39**	37.38	-1.32	-1.94	-14.27**	-2.57
APO × RAU-4	22.30	4.85	-1.59	-14.43**	20.51**	35.20	-2.23	-7.65*	-19.26**	-18.25**
APO × BPT-5204	21.69	7.78	6.48	-16.77**	22.68**	60.83	8.77**	17.50**	39.53**	37.56**
APO × MTU-7029	24.00	26.66**	20.74**	-7.90	-14.45**	40.59	-14.69**	28.84**	-6.90	5.79
APO × SARJOO-52	24.99	34.40**	25.72**	-4.11	-10.92**	41.22	-13.87**	28.44**	-5.46	7.44
Nagina-22 × Rajendra Bhagwati	26.01	-8.28*	-11.13**	-0.19	-7.28	36.60	2.06	-4.18	-16.05**	-14.60**
Nagina-22 × Vandana	21.76	23.27**	25.67**	-16.52**	22.45**	38.34	-7.74*	1.86	-12.07**	-0.08
Nagina-22 × RAU-4	29.51	13.63**	11.81**	13.21**	9.17*	34.14	1.28	0.73	-21.70**	-11.02*
Nagina-22 × BPT-5204	25.66	3.39	-12.32**	-1.53	-8.53*	40.79	-23.94**	40.68**	-6.44	6.32
Nagina-22 × MTU-7029	30.21	27.74**	3.20	15.90**	7.66	37.32	-17.59**	34.58**	-14.41**	-2.74
Nagina-22 × SARJOO-52	18.30	-21.43**	-37.48**	-29.79**	-34.77**	55.59	22.01**	-3.48	27.51**	40.90**
Rajendra Bhagwati × Vandana	25.06	-8.68*	-8.71*	9.84*	-10.67**	37.48	-1.16	-1.88	-14.04**	-12.31**
Rajendra Bhagwati × RAU-4	24.28	-3.09	-11.55**	-6.83	13.45**	39.74	10.26*	4.04	-8.85*	3.59
Rajendra Bhagwati × BPT-5204	20.86	-12.78**	-24.03**	-19.98**	-25.66**	47.11	-15.83**	-36.12**	8.04*	-22.78**
Rajendra Bhagwati × MTU-7029	20.60	-9.42*	-24.98**	-20.97**	-26.59**	49.13	3.18	-13.86**	12.69**	28.06**
Rajendra Bhagwati × SARJOO-52	25.86	15.52**	-5.82	-0.79	-7.84	54.78	14.36**	-4.90	25.64**	39.78**
Vandana × RAU-4	16.21	25.30**	32.93**	27.82**	-42.24**	35.34	-7.18*	-6.09	-18.94**	-17.88**
Vandana × BPT-5204	23.00	-3.80	-16.18**	-11.77**	-18.03**	58.86	5.70*	-20.17**	35.01**	35.42**
Vandana × MTU-7029	23.87	5.02	-13.00**	-8.42	-14.92**	43.29	-8.56**	-24.11**	-0.72	12.82**
Vandana × SARJOO-52	21.01	16.09**	23.41**	-19.38**	-25.10**	55.18	15.87**	-4.21	26.55**	38.81**
RAU-4 × BPT-5204	22.18	3.07	-2.13	-14.90**	-20.95**	45.99	-14.53**	37.62**	5.49	19.88**
RAU-4 × MTU-7029	25.47	25.22**	12.40*	-2.26	-9.21*	53.31	17.26**	-6.53*	22.28**	38.96**
RAU-4 × SARJOO-52	24.02	20.17**	5.99	-7.84	-14.39**	42.94	-6.14*	-25.46**	-1.52	11.91**
BPT-5204 × MTU-7029	24.63	28.28**	20.88**	-5.51	-12.23**	65.56	0.26	-11.09**	30.37**	39.88**
BPT-5204 × SARJOO-52	16.44	-12.77*	-19.32**	-36.94**	-41.42**	64.34	-2.02	-12.74**	27.57**	37.70**
MTU-7029 × SARJOO-52	19.07	7.95	5.83	-26.82**	-32.02**	57.67	0.61	11.12**	32.27**	36.31**

*Significant at 0.05 probability level; **Significant at 0.01 probability level

Table 8: Heterosis over Mid, Better and Check variety for Stay Green & Chlorophyll Content

F1	Stay Green					Chlorophyll Content				
	Mean	Mid	Better	Sahbhagi	Shushk Samrat	Mean	Mid	Better	Sahbhagi	Shushk Samrat
RASI × APO	71.92	0.09	-1.34	-26.17**	-15.54**	29.40	-18.33**	7.51**	-15.19**	-24.39**
RASI × Nagina-22	67.19	-7.21**	7.83**	-31.02**	-21.09**	30.86	-13.87**	-26.47**	-10.98**	-20.63**
RASI × Rajendra Bhagwati	78.23	-4.32*	13.67**	-19.70**	-8.13**	31.95	0.09	-6.43	-7.85	-17.84**
RASI × Vandana	75.21	-2.04	6.75**	-22.79**	-11.67**	30.55	-8.49*	-17.61**	-11.87**	-21.42**
RASI × RAU-4	71.79	-5.15*	-8.52**	-26.30**	-15.69**	38.10	30.29**	26.66**	-9.69*	19.49**
RASI × BPT-5204	99.06	7.07**	-11.66**	1.69	16.33**	28.93	-0.09	-2.56	-16.55**	-25.60**
RASI × MTU-7029	100.12	9.79**	-8.55**	2.78	17.58**	30.88	6.32*	4.02	-10.91**	-20.57**
RASI × SARJOO-52	97.46	8.36**	-8.89**	0.04	14.45**	30.64	2.52	1.85	-11.63**	-21.21**
APO × Nagina-22	76.69	7.45**	6.63*	-21.27**	-9.94**	39.76	-5.63	-6.01	14.70**	12.26**
APO × Rajendra Bhagwati	81.13	0.51	-10.47**	16.72**	-4.73*	36.71	-3.97	-13.24**	5.88	-5.60
APO × Vandana	77.36	2.14	6.09**	-20.59**	-9.15**	39.43	-0.68	-6.81*	13.73**	11.40**
APO × RAU-4	75.86	1.62	-3.33	-22.13**	-10.91**	42.48	2.48	9.42**	22.55**	9.26**
APO × BPT-5204	83.42	-8.81**	-25.61**	-14.37**	-2.04	39.19	11.14**	-7.36*	13.06**	0.80
APO × MTU-7029	92.22	2.30	-15.76**	-5.33*	8.30**	36.10	2.10	-14.67**	4.13	-7.16*
APO × SARJOO-52	94.05	5.80**	-12.08**	-3.45	10.45**	36.91	1.98	-12.76**	6.47	-5.08
Nagina-22 × Rajendra Bhagwati	79.36	-2.35	-12.42**	-18.53**	-6.80**	35.63	-6.38*	-15.11**	2.77	8.38*
Nagina-22 × Vandana	75.44	-1.12	-6.47**	-22.56**	-11.41**	38.25	-3.22	-8.85**	10.35*	-1.62
Nagina-22 × RAU-4	77.48	3.03	8.27**	20.46**	-9.01**	41.28	0.00	-1.63	19.09**	6.17
Nagina-22 × BPT-5204	107.72	17.05**	-3.94*	10.58**	26.50**	34.64	-1.29	17.45**	-0.07	-10.90**
Nagina-22 × MTU-7029	100.19	10.46**	-8.49**	2.85	17.65**	40.06	13.84**	-4.55	15.55**	3.02
Nagina-22 × SARJOO-52	91.31	2.08	-14.64**	-6.27**	7.23**	39.59	9.91**	-5.66	14.21**	1.83
Rajendra Bhagwati × Vandana	88.12	2.91	-2.75	-9.54**	3.49	34.69	-2.59	-6.45	0.07	10.78**
Rajendra Bhagwati × RAU-4	92.05	8.88**	1.59	-5.50**	8.10**	34.41	-7.94*	-15.26**	-0.75	-11.51**
Rajendra Bhagwati × BPT-5204	97.15	-4.17*	-13.37**	-0.27	14.08**	37.18	19.24**	8.90*	7.26	-4.37
Rajendra Bhagwati × MTU-7029	110.35	10.29**	0.79	13.28**	29.59**	29.43	-5.91	-13.81**	-15.12**	-24.32**
Rajendra Bhagwati × SARJOO-52	98.12	-0.68	8.27**	9.73**	15.23**	34.05	6.04*	8.27**	-1.78	-12.43**
Vandana × RAU-4	75.54	-5.06*	-6.34*	-22.45**	-11.29**	43.16	11.10**	6.29	24.49**	10.99**
Vandana × BPT-5204	102.81	6.65**	-8.31**	5.54**	20.74**	32.54	-0.35	-12.25**	-6.13	-16.31**
Vandana × MTU-7029	102.62	7.94**	-6.27**	5.34*	20.51**	34.15	4.29	7.91*	-1.49	12.17**
Vandana × SARJOO-52	86.64	-7.65**	-19.01**	-11.06**	1.75	36.38	8.33*	-1.90	4.94	-6.44
RAU-4 × BPT-5204	101.56	6.56**	-9.43**	4.26*	19.27**	40.73	18.35**	11.30**	17.48**	4.74
RAU-4 × MTU-7029	101.13	7.61**	7.63**	4.82*	18.76**	41.52	20.33**	2.26	19.77**	6.78
RAU-4 × SARJOO-52	95.21	2.69	-10.99**	-2.26	11.81**	33.28	-5.83	-18.04**	-4.00	-14.41**
BPT-5204 × MTU-7029	116.09	4.76**	3.53	19.17**	36.33**	34.72	22.61**	22.21**	0.14	-10.72**
BPT-5204 × SARJOO-52	116.68	6.50**	4.05*	19.77**	37.02**	34.66	18.91**	15.24**	-0.01	-10.85**
MTU-7029 × SARJOO-52	119.52	10.44**	9.17**	22.70**	40.36**	31.31	-10.93**	12.90**	9.90*	-2.01

*Significant at 0.05 probability level; **Significant at 0.01 probability level

Table 9: Heterosis over Mid, Better and Check variety for Stomatal Conductance and Proline Content

F_1	Stomatal Conductance					Proline Content				
	Mean	Mid	Better	Sahbhagi	Shushk Samrat	Mean	Mid	Better	Sahbhagi	Shushk Samrat
RASI × APO	1237.49	-2.85	-5.36	12.40**	-5.49	0.78	-2.89	6.00*	-0.42	8.29*
RASI × Nagina-22	1290.07	10.33**	-3.11	17.17**	-1.47	0.76	-5.57*	8.76**	12.97**	5.76*
RASI × Rajendra Bhagwati	1139.22	2.38	8.14*	3.47	12.99**	0.74	-2.41	-4.70	-5.51	8.23**
RASI × Vandana	1124.00	1.20	9.36**	2.09	-14.15**	0.76	-4.58	6.91*	-2.97	6.76*
RASI × RAU-4	1229.37	-2.09	-3.28	11.66**	-6.11	0.76	-8.10**	12.69**	-3.81	6.58*
RASI × BPT-5204	1047.93	2.11	-15.50**	-4.82	-19.96**	0.52	-11.43**	-33.76**	-34.32**	-36.21**
RASI × MTU-7029	1060.33	4.03	-14.50**	-3.69	19.02**	0.66	15.88**	15.81**	16.53**	-18.93**
RASI × SARJOO-52	937.27	-9.71**	24.42**	-14.87**	28.42**	0.56	5.30*	-27.78**	-28.39**	-30.45**
APO × Nagina-22	1333.00	-12.02**	0.11	21.07**	1.81	0.86	2.99	17.79**	9.32**	6.17*
APO × Rajendra Bhagwati	1157.47	0.96	11.48**	5.13	11.60**	0.83	5.29*	-0.40	5.51	22.47**
APO × Vandana	1211.70	5.88	7.33*	10.05*	-7.46*	0.79	-4.84*	18.60*	0.80	-2.88
APO × RAU-4	1256.90	10.51**	-3.87	14.16**	-4.00	0.84	15.27**	20.72**	7.20*	24.12**
APO × BPT-5204	1176.53	11.00**	-10.02**	6.86*	-10.14**	0.43	-29.51**	-38.40**	-37.34**	-40.91**
APO × MTU-7029	1179.34	12.00**	-9.81**	7.12	9.93**	0.54	-8.43**	-34.80**	-30.93**	-32.92**
APO × SARJOO-52	885.86	-17.34**	32.25**	19.54**	32.34**	0.33	-40.65**	-36.00**	-35.63**	-28.85**
Nagina-22 × Rajendra Bhagwati	1279.19	10.42**	-3.93	16.18**	-2.30	0.83	4.64	-1.20	15.08**	2.06
Nagina-22 × Vandana	1015.79	-12.16**	-23.71**	-7.74	-22.42**	0.77	-6.64**	7.57**	-1.69	24.53**
Nagina-22 × RAU-4	1284.72	-1.27	-3.52	16.69**	-1.88	0.81	-4.50*	-6.15*	23.39**	12.41**
Nagina-22 × BPT-5204	1130.24	15.44**	-15.12**	2.66	-13.68**	0.66	8.45**	-2.69	15.68**	-18.11**
Nagina-22 × MTU-7029	840.20	-21.10**	30.90**	-23.69**	35.83**	0.39	-33.89**	-38.99**	-30.00**	-31.44**
Nagina-22 × SARJOO-52	864.61	-20.22**	-35.07**	-21.47**	-33.97**	0.63	11.83**	-24.70**	-19.92**	-22.22**
Rajendra Bhagwati × Vandana	1007.89	2.50	2.28	-8.46*	-23.02**	0.82	4.90*	0.50	9.24**	21.23**
Rajendra Bhagwati × RAU-4	1025.17	-9.13**	-19.35**	-6.89	-21.70**	0.77	-4.35	11.15**	-2.12	14.94**
Rajendra Bhagwati × BPT-5204	818.84	-8.91*	16.90**	-25.63**	27.46**	0.61	7.96*	-17.94**	-22.46**	-24.69**
Rajendra Bhagwati × MTU-7029	1026.39	15.08**	4.16	-6.78	-21.61**	0.52	-5.78*	-30.49**	-34.32**	-36.21**
Rajendra Bhagwati × SARJOO-52	809.51	-11.11**	-17.85**	-26.48**	-38.17**	0.45	-12.26**	-29.01**	-32.37**	-40.03**
Vandana × RAU-4	1176.48	4.47	-7.44*	6.86*	-10.15**	0.83	-1.58	24.23**	5.51	2.47
Vandana × BPT-5204	907.00	1.14	-7.56*	-17.62**	-30.73**	0.45	-25.41**	-35.12**	-32.80**	-34.44**
Vandana × MTU-7029	838.99	-5.71	-14.50**	-23.80**	-35.92**	0.65	11.36**	-20.33**	-16.95**	-19.34**
Vandana × SARJOO-52	802.54	-11.67**	-18.21**	-27.11**	-38.71**	0.61	9.31**	-26.02**	-22.88**	-25.10**
RAU-4 × BPT-5204	936.94	-10.06**	26.29**	-14.90**	-28.44**	0.66	5.32*	-23.85**	16.10**	18.52**
RAU-4 × MTU-7029	1005.49	-2.82	-20.89**	-8.67*	-23.21**	0.54	-11.48**	-37.69**	-31.36**	-33.33**
RAU-4 × SARJOO-52	1152.92	9.44**	-9.29**	4.72	-11.95**	0.37	-36.02**	-37.31**	-32.97**	-34.32**
BPT-5204 × MTU-7029	803.17	-0.28	-1.14	-27.05**	-38.66**	0.41	11.71*	6.90*	-37.46**	-38.97**
BPT-5204 × SARJOO-52	893.96	8.47	6.94	-18.80**	-31.72**	0.39	-0.78	0.86	-30.42**	-37.85**
MTU-7029 × SARJOO-52	970.24	18.74**	16.07**	-11.88**	-25.90**	0.32	0.52	-3.49	-38.90**	-40.08**

*Significant at 0.05 probability level; **Significant at 0.01 probability level

Table 10: Heterosis over Mid, Better and Check variety for Relative Water Content

F_{1S}	Relative Water Content				
	Mean	Mid	Better	Sahbhagi	Shushk Samrat
RASI × APO	78.81	-1.81	-1.97	5.95**	9.63**
RASI × Nagina-22	81.86	0.62	-0.88	5.90**	2.18
RASI × Rajendra Bhagwati	73.45	-2.55	8.34**	4.98*	8.32**
RASI × Vandana	70.41	-3.41	12.13**	8.91**	12.11**
RASI × RAU-4	78.82	-1.58	-1.63	1.97	-1.61
RASI × BPT-5204	76.42	-2.72	4.63*	-1.13	-4.61*
RASI × MTU-7029	68.54	1.28	-14.47**	-11.33**	-14.45**
RASI × SARJOO-52	70.45	4.51*	-12.09**	-8.87**	-12.07**
APO × Nagina-22	82.37	1.08	8.26**	6.55**	21.81**
APO × Rajendra Bhagwati	72.17	13.60**	-4.02	6.64**	9.92**
APO × Vandana	78.56	7.57**	-2.28	1.63	-1.94
APO × RAU-4	75.44	-5.96**	6.16**	-2.41	5.83**
APO × BPT-5204	77.36	-1.69	-3.77	0.08	-3.44
APO × MTU-7029	74.98	10.59**	-6.73**	-3.00	-6.40**
APO × SARJOO-52	47.50	-29.67**	-40.92**	-38.55**	-40.71**
Nagina-22 × Rajendra Bhagwati	79.78	4.16*	-3.39	3.21	-0.41
Nagina-22 × Vandana	77.19	4.14*	-6.53**	-0.14	-3.64
Nagina-22 × RAU-4	79.88	-1.76	13.27**	9.34**	12.29**
Nagina-22 × BPT-5204	71.03	-10.97**	-13.99**	-8.11**	-11.34**
Nagina-22 × MTU-7029	66.93	-2.85	-18.95**	-13.41**	-16.45**
Nagina-22 × SARJOO-52	53.17	-22.52**	-35.61**	-31.21**	-33.63**
Rajendra Bhagwati × Vandana	61.93	-9.11**	-12.29**	-19.89**	-22.70**
Rajendra Bhagwati × RAU-4	80.55	6.94**	0.64	4.21	0.55
Rajendra Bhagwati × BPT-5204	77.24	4.68*	0.34	-0.07	-3.58

Rajendra Bhagwati × MTU-7029	55.45	-11.86**	-21.47**	-28.27**	-30.79**
Rajendra Bhagwati × SARJOO-52	58.33	-6.88**	-17.38**	-24.54**	-27.19**
Vandana × RAU-4	80.87	11.00**	1.03	4.62*	10.94**
Vandana × BPT-5204	72.88	2.19	5.32*	-5.71*	-9.02**
Vandana × MTU-7029	63.25	4.65	-3.68	-18.18**	-21.05**
Vandana × SARJOO-52	52.72	-12.38**	-19.71**	-31.79**	-34.19**
RAU-4 × BPT-5204	75.07	-4.38*	6.21**	-2.88	6.30**
RAU-4 × MTU-7029	76.83	-4.41*	10.23**	-0.61	-4.10
RAU-4 × SARJOO-52	73.40	8.96**	-8.30**	-5.05*	-8.38**
BPT-5204 × MTU-7029	55.46	-16.10**	-27.96**	-28.26**	-30.78**
BPT-5204 × SARJOO-52	60.29	-8.41**	-21.68**	-22.00**	-24.74**
MTU-7029 × SARJOO-52	48.08	-12.49**	-12.92**	-37.80**	-39.99**

*Significant at 0.05 probability level; **Significant at 0.01 probability level

Table 11: Inbreeding Depression in rice crosses under drought stress condition

Hybrid	Days to 50% Flowering	Days to Maturity	Plant Height	Effective Tillers/plant	Panicle Length	Panicle Weight	Fertile Spiklets/ Panicle	Total Spiklets/ Panicle	Spiklet Fertility%
RASI × APO	1.47	-3.38*	-4.02	7.55*	-16.73**	1.76	10.13*	7.15*	3.13
RASI × Nagina-22	-1.45	-2.80	3.19	0.03	2.23	-2.91	13.18**	0.59	12.70**
RASI × Rajendra Bhagwati	-3.81**	-4.53*	-1.26	12.99*	-2.73	-3.98	-6.26*	-3.01*	-3.18
RASI × Vandna	-1.13	0.63	1.45	8.62*	6.20	-10.94*	-6.85*	-1.22	-5.57*
RASI × RAU-4	-4.19*	-6.25*	0.90	0.62	-2.89	-4.89	-2.32	-1.31	0.01
RASI × BPT-5204	-2.79	-4.54*	3.28	-2.54	-2.77	0.86	-8.38*	-5.07*	-3.12
RASI × MTU-7029	-8.90*	-13.11**	5.50	-3.56	13.19*	8.82*	5.82*	-1.61	7.32*
RASI × SARJOO-52	-8.57**	1.81	-4.21	-2.82	5.77	2.43	6.71*	6.42*	0.33
APO × Nagina-22	-5.96*	-2.04	-5.37	4.54	0.75	-7.51*	3.31*	3.76*	-0.47
APO × Rajendra Bhagwati	-0.34	-0.11	-1.74	-0.53	-5.59	-13.35**	2.20	-1.09	4.22*
APO × Vandna	-0.84	0.15	4.76	4.89	6.26	-2.36	-2.32	3.83*	-6.46*
APO × RAU-4	-1.44	1.13	0.19	-1.12	1.53	-7.11*	-1.40	-6.12*	4.42*
APO × BPT-5204	-12.82**	-7.29*	-2.22	-5.21	-19.12*	-1.45	0.42	0.04	0.41
APO × MTU-7029	-6.78*	-6.26*	9.58*	6.41	-19.14*	21.07**	-4.10*	-1.73	-2.36
APO × SARJOO-52	-10.80*	-12.27**	7.51*	14.01*	27.55**	12.21**	3.85*	-3.73*	7.31**
Nagina-22 × Rajendra Bhagwati	-1.30	-0.41	-2.06	9.24*	11.40**	5.87	2.12	2.15	-0.03
Nagina-22 × Vandna	0.83	-0.91	-4.22	-0.49	15.85**	6.99*	0.99	-1.86*	2.81
Nagina-22 × RAU-4	-3.10	-4.83*	1.67	-5.04	-4.70	14.71**	2.46	-0.20	2.73
Nagina-22 × BPT-5204	5.80*	0.54	3.90	9.01*	6.24	-3.86	6.89*	-3.99*	10.48**
Nagina-22 × MTU-7029	4.07*	-7.95**	15.06**	6.65*	13.78*	7.72*	5.05*	7.55**	-2.72
Nagina-22 × SARJOO-52	-29.45**	-11.74**	-13.81**	18.66*	-16.02**	-26.39**	-29.64**	-18.25**	-9.65**
Rajendra Bhagwati × Vandna	-5.41*	-3.71*	7.84*	8.98*	-20.59**	11.09**	3.91*	-4.90*	8.37*
Rajendra Bhagwati × RAU-4	2.61	1.79	-11.84*	5.32	12.37*	4.46	-2.49	2.66	-5.31
Rajendra Bhagwati × BPT-5204	-8.00*	2.89	-6.05*	-15.09*	16.12**	20.29**	-2.51	9.59**	-13.40**
Rajendra Bhagwati × MTU-7029	19.84**	10.25**	-6.90*	14.61*	18.26*	20.41*	4.22*	-7.11**	10.55**
Rajendra Bhagwati × SARJOO-52	-13.84**	-19.15**	8.68*	18.00*	15.89**	18.81*	1.00	-4.93*	5.66**
Vandna × RAU-4	-4.51*	-7.34*	7.18**	-19.35*	-24.04*	-8.02*	-2.99	8.01**	-11.96**
Vandna × BPT-5204	4.21*	8.02**	-3.27	14.55*	11.95**	19.18*	-2.62	2.77*	-5.55**
Vandna × MTU-7029	-11.30**	-7.61**	12.19**	15.00**	20.82**	-27.00**	5.53**	6.40**	-0.92
Vandna × SARJOO-52	6.44*	6.36**	-7.77*	-17.42**	12.24*	-23.22**	12.19**	16.84**	-5.61*
RAU-4 × BPT-5204	-10.02*	-4.46**	-9.0*	16.98**	-14.63**	16.37**	-8.63**	6.85**	-16.63**
RAU-4 × MTU-7029	7.35*	6.06**	-6.65*	10.76**	-10.83*	23.48*	3.20*	4.15**	-1.00
RAU-4 × SARJOO-52	-13.13**	-10.31**	-5.99*	1.07	-13.16*	18.56**	14.60**	7.19*	8.01**
BPT-5204 × MTU-7029	-6.81**	-7.47*	7.68**	23.20**	12.71*	15.87**	8.44**	4.25**	4.39*
BPT-5204 × SARJOO-52	-5.60*	-0.60	2.73	13.10**	29.57**	15.37**	-2.90	12.84**	-18.05**
MTU-7029 × SARJOO-52	-2.85	-3.21*	16.75**	-29.82**	13.57*	8.37*	5.99*	16.75**	-12.91**
Average	-3.45	-2.97	1.06	4.73**	3.58*	3.99*	1.36	1.87	-0.49

*Significant at 0.05 probability level; **Significant at 0.01 probability level

Hybrid	Test Weight	Grain Yield/ Plant	Biological Yield/ Plant	Harvest Index	Leaf Angle	Stay Green	Chlorophyll Content	Stomatal Conductance	Proline Content	Relative Water Content
RASI × APO	-3.55	31.21**	-10.07*	37.62**	-3.71	1.78	-11.62*	-0.34	3.40	2.56
RASI × Nagina-22	1.83	-9.52	-7.46*	-1.89	-2.42	-2.15	0.89	0.86	-3.49	2.13
RASI × Rajendra Bhagwati	10.52	-11.06*	-0.35	-10.85*	7.83	-4.02	1.68	1.85	3.59	1.96
RASI × Vandna	-11.08*	11.45*	-10.45**	19.79*	-1.77	4.85*	-19.26**	9.89**	-2.18	0.45
RASI × RAU-4	0.71	11.73*	-9.93*	19.64*	3.40	-9.29*	-6.14	-4.59	-1.32	-1.81
RASI × BPT-5204	7.16	5.28	-21.66**	22.09**	10.74*	5.35*	-2.52	-7.43	-0.65	-5.04*
RASI × MTU-7029	-3.56	13.21*	-6.92	18.72*	14.39*	5.94*	-8.39	3.43	23.35**	11.07**
RASI × SARJOO-52	4.90	4.38	5.86	-1.67	8.88*	0.82	5.65	4.98	24.85**	-8.79*
APO × Nagina-22	-6.38	-2.52	-9.05**	6.00	5.87	4.78*	-3.86	6.06	7.75*	-0.20

APO × Rajendra Bhagwati	-1.68	0.91	-18.05**	16.37*	7.93	-10.67**	1.52	-1.00	5.22	-2.52
APO × Vandna	1.30	-12.35*	-1.06	-11.21*	1.59	6.68**	0.23	8.35*	-3.39	13.39**
APO × RAU-4	6.34	-11.57*	1.87	-13.60**	-6.87	-0.75	5.99	-3.51	6.32	-5.78*
APO × BPT-5204	-5.22	11.09*	-2.83	-13.38*	8.98*	-7.92*	10.24*	13.55**	-19.38*	4.86
APO × MTU-7029	-17.78*	37.47**	0.97	36.88**	4.70	-7.89*	12.38*	0.014	9.82*	18.21**
APO × SARJOO-52	-5.07	29.28**	2.20	27.71**	-13.66*	-12.66**	17.05**	-7.84	-28.00**	-31.42**
Nagina-22 × Rajendra Bhagwati	12.21*	9.11	-4.09	12.98*	12.61*	-9.09*	-8.69	7.86*	-9.27*	1.83
Nagina-22 × Vandna	6.16	-16.53**	5.96*	-24.12**	11.82**	-6.05*	7.23*	-16.40**	-4.31	-1.85
Nagina-22 × RAU-4	18.71**	2.10	2.10	-2.19	3.84	2.08	6.04*	4.44	-9.43*	-0.33
Nagina-22 × BPT-5204	-24.57**	20.87**	5.99*	15.72*	-20.82**	9.40**	16.11*	11.58**	39.70**	-1.65
Nagina-22 × MTU-7029	-14.92*	39.03**	-13.50**	38.29**	-36.65**	-0.80	15.59**	-10.92*	-27.12**	1.90
Nagina-22 × SARJOO-52	17.26**	-23.46**	11.10*	-38.85**	31.01**	-14.79**	11.60**	-40.12**	38.62**	-25.46**
Rajendra Bhagwati × Vandna	17.81**	18.28*	-3.56	20.95*	-10.40*	2.81	-8.64	22.10**	4.07	-12.91*
Rajendra Bhagwati × RAU-4	10.98	27.28**	-9.26**	33.33**	9.06*	8.18**	-17.10**	-18.22*	-4.762	8.45**
Rajendra Bhagwati × BPT-5204	-5.72	15.88*	9.21*	7.29	-38.29**	-4.51	19.94**	-18.79**	18.58**	8.52**
Rajendra Bhagwati × MTU-7029	6.389	14.57*	-2.84	16.912*	-13.05*	12.711**	-26.44**	22.86**	21.29**	-18.18**
Rajendra Bhagwati × SARJOO-52	-18.89**	17.64*	-4.14	20.86**	10.80**	-12.04**	-18.32**	-24.92*	10.29*	-13.67**
Vandna × RAU-4	16.72**	-22.28**	7.12**	-31.61**	-13.89*	-6.37*	17.59**	-10.59*	-14.02*	6.09**
Vandna × BPT-5204	-15.95**	18.46*	-3.62	21.22*	29.43**	3.32*	9.58*	8.94*	-13.33*	-4.76
Vandna × MTU-7029	-21.34**	23.35**	-7.50*	28.53**	12.04*	-3.40	14.81*	-9.81	6.63	9.71**
Vandna × SARJOO-52	11.54*	-12.09*	-7.87*	-3.97	19.80**	-13.03**	13.68**	-7.36	32.42**	-16.10**
RAU-4 × BPT-5204	-23.66**	17.15**	2.46	14.97*	-12.32*	-9.35**	17.80*	-13.80*	26.77**	-5.20
RAU-4 × MTU-7029	-16.39**	27.42**	9.80**	19.51**	28.19**	3.95*	15.37**	18.70**	-29.63**	18.93**
RAU-4 × SARJOO-52	12.08*	-11.30*	13.11**	-27.85*	-23.09**	-7.83**	12.59*	-10.34*	-43.96**	-5.77*
BPT-5204 × MTU-7029	16.96*	26.40**	-13.48**	35.21**	-8.84**	-3.48	15.40*	-15.03*	29.84**	-9.09*
BPT-5204 × SARJOO-52	18.77**	6.11	1.86	4.30	4.79	-0.17	6.59*	11.46*	26.50**	-3.65
MTU-7029 × SARJOO-52	-14.92*	19.63*	14.44**	5.80	8.75*	1.00	18.35*	20.81**	15.46*	-10.43*
Average	0.59	9.51**	-1.63	11.03**	2.62	-1.81	4.73**	-0.42	5.73	-1.43

*Significant at 0.05 probability level; **Significant at 0.01 probability level

Conclusion

Based on the results, it might be concluded that selection of crosses may be made considering the component traits in addition to grain yield for their exploitation in breeding programs. Though relatively more heterosis was observed for grain yield and other related traits, its expression, as well as inbreeding depression in the said traits, appears to be greatly affected by environmental conditions, therefore selection of the segregants in early generations may be avoided. Drought related traits like days to maturity, spikelets fertility percentage, leaf angle, chlorophyll content, stomatal conductance, relative water content, and proline content, independently or in combination, might be the basis of selection under moisture stress condition. The crosses involving parents APO, Nagina-22, RAU-4, Sarjoo-52 and Vandana may be considered in the future breeding program, aiming to improve yield under moisture stress conditions.

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