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PERFORMANCE OF RICE HYBRIDS AND THEIR PARENTS FOR SALINITY TOLERANT TRAITS IN DIFFERENT SEASONS UNDER SALINE CONDITIONS

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ABSTRACT

Ten parents and their 45 F_1 hybrids were studied in 4 environments *viz.,* Normal *Kharif*, Late *Kharif* in 2011, Normal r*abi* 2011-12 and Late r*abi,* 2012 with the objective of identifying stable parents and hybrids in addition to specific parents and hybrids for specific season. The analysis of variance (ANOVA) reveals significant mean squares for genotypes, parents, hybrids and parents x hybrids were noticed for majority of the characters studied in most of the seasons, indicating the existence of variability among the genotypes, parents and hybrids for the various traits studied in the present investigation. The results on mean performance for parents and hybrids for salinity tolerant traits and grain yield for different seasons indicated that higher grain yield per plant was recorded during normal rabi, while shoot length, shoot dry weight, shoot potassium content, root length and root dry weight were higher during normal kharif. While late rabi resulted in higher shoot sodium content.

Key words: Rice hybrids, parents, salinity, seasons, yield

INTRODUCTION

Rice is one of the significant cereal crop fulfilling the nutritional requirements of more than 70% of population and source of livelihood for above 150 million rural households in India. Though significant improvement in productivity has been achieved in rice over the years, a series of biotic and abiotic stresses limit its productivity worldwide. Abiotic stresses alone contribute to 50 per cent of the total yield losses. Among abiotic stresses, salinity, drought and extreme temperatures are major barriers limiting rice production. Various methods such as soil reclamation, excessive irrigation and soil drainage are used to minimize soil salinity; they are always laborious and expensive. Breeding for salt tolerance offers more promising, energy efficient, economical and socially acceptable approach than other processes of soil amelioration. Rice in Andhra Pradesh is grown during both *kharif* and *rabi* seasons, based on availability of water. The planting time also varies from normal to late during both the seasons based on the onset of rains or release of irrigation water through canals. The present investigation with 10 parents and their 45 hybrids was undertaken during normal and late *kharif* and *rabi* seasons with the objective of identifying stable parents and hybrids in addition to specific parents and hybrids for specific season.

MATERIALS AND METHODS

The experiment was conducted in 2 environments each in *kharif* and *rabi* seasons of 2011. Each season is further divided in to normal and late sowing situations prevailing in Agricultural Research Station, Machilipatnam, Krishna District depending on the release of canal water. Accordingly, the parents and their 45 F_1 hybrids were studied in these 4 environments *viz.,* Normal *Kharif*, Late *Kharif* in 2011, Normal r*abi* 2011-12 and Late r*abi,* 2012. One set of the seed of 10 parents and 45 F_1s were sown in nurseries on 16.07.2011(Normal *Kharif*) and 16.08.2011(Late *kharif)* during *kharif* season and 01.12.2011 (Normal *rabi*) and 02.01.2012 (Late *rabi*) during rabi season.

RESULTS AND DISCUSSION

The analysis of variance (ANOVA) in general reveals significant mean squares for genotypes, parents, hybrids and parents x hybrids were noticed for majority of the characters studied in most of the seasons, indicating the existence of variability among the genotypes, parents and hybrids for the various traits studied in the present investigation, in addition to existence of significant levels of heterosis for the various characters under study in the different seasons, as evidenced by the significant mean squares for parents x hybrids in the present study. (Table 1)

The results on mean performance for parents and hybrids studied in the present investigation for salinity tolerant traits and grain yield for different seasons indicated that higher grain yield per plant was recorded during normal rabi, while shoot length, shoot dry weight, shoot potassium content, root length and root dry weight were higher during normal kharif. While late rabi resulted in higher shoot sodium content. A variation in the best parent/hybrid with the season was also noticed for all characters under study indicating the interaction effect of genotype and season for the various characters studied in the present investigation. (Table 2)

1. Shoot length (cm)

Mean for hybrids was in general observed to be higher than parents during all seasons studied, indicating presence of heterosis for the trait. Alam *et al*. (2004) attributed the possible reasons for the increase in shoot and root growth under salinized conditions was due to increase of photosynthesis with more biomass of the plant, which in turn favours the supply of carbohydrates needed for growth, increase of turgor in expanding tissues resulting from increased levels of water potential in root growth medium.

2. Shoot dry weight (g)

Hybrids in general recorded higher mean than parents during all seasons studied, indicating presence of heterosis for the trait. With regard to reduction in shoot dry weight, Yeo and Flowers (1983) and Peiris and Rana Singhe (1993) reported that reduction in shoot dry weight under saline conditions might be due to reduction in dry matter accumulation, reduction in chlorophyll content and photosynthesis due to increased Na^+ concentration. Similarly, Sharma and Brar (2005) opined that the reduction in dry matter at higher salinity could be due to altered carbon and nitrogen metabolism. Roy *et al.* (1992), Zeng and Shannon (2000), Alam *et al.* (2004), Shereen *et al.* (2005), Djanaguiraman *et al.* (2003), Haq *et al.* (2009), Sexcion *et al.* (2009) and Hakim *et al.* (2010) were also reported the reduction in root and shoot dry weights with increasing salinity levels.

3. Shoot sodium content (%)

Mean for hybrids was in general observed to be lower than parents during all seasons studied, indicating presence of desirable negative heterosis for the trait. The accumulation of Na^+ ions in the shoot plays a major role in imparting salinity tolerance to majority of field crops and lower concentration of Na^+ is desirable. The cultivar, which is allowed higher amount of Na^+ ions into the shoot system, indicated the susceptible nature of this genotype to salt stress.

Gill (1990) also observed differential Na^+ accumulation in different parts of the plants of cultivar Jaya and wild rice and a greater salt injury in Jaya due to greater translocation to the shoot system. Lutts and Guerrir (1995) emphasized the need for selection of lines with low Na^+ in the leaves. Lee *et al.* (2003) also observed that tolerant *indica* cultivars were good Na^+ excluders with high K^+ absorption.

4. Shoot potassium content (%)

The hybrids in general recorded higher mean than parents during all seasons studied, indicating presence of positive heterosis for the trait. Potassium content in shoots reported to be higher in salt tolerant varieties. Further, it was observed that a good supply of K^+ to plants can minimize injurious effects of high Na^+ under salinity. Mass and Poss (1989) also observed decrease of K^+ content compared to Na^+ content in the genotypes along the salinity gradient. Lee *et al.* (2003) noticed that tolerant genotypes were good excluders of Na^+ ions with high K^+ absorption.

5. Root length (cm)

Mean for hybrids was in general observed to be higher than parents during all seasons studied, indicating presence of heterosis for the trait. Roots are in direct contact with the surrounding solution. As such they are first to encounter the saline medium and are potentially the first site of damage or of defense under salt stress. Plants that produce rapidly growing deep roots will avoid surface salts better than the plants with relatively shallow root system. Ability of the genotype to increase its root length, number and volume in response to salt stress is highly heritable. Genotypes having this capacity will absorb nutrients from deeper layers of the soil avoiding salinity at the rhizosphere. Hence, this trait must be considered while screening genotypes for salt stress.

6. Root dry weight (g)

Root dry weight was in general observed to be higher for hybrids, compared to parents during all seasons studied, indicating presence of heterosis for the trait. Dry weight of the seedlings reflects the accumulation of photosynthates by the genotypes. Genotypes exhibiting higher dry weight of seedlings under stress conditions are considered more tolerant than other genotypes.

7. Grain yield per plant (g)

Hybrids in general recorded higher mean than parents during all seasons studied, indicating presence of heterosis for the trait. The grain yield is the ultimate goal of any breeding programme and presence of wide variability as in the present investigation is a desirable feature under saline conditions. The grain yield of a variety may vary considerably due to the hostile environmental conditions, the emphasis should be for stability of yield i.e., for stable performance of a variety with reasonable yield level.

Results of the present investigation thus indicated that the rice varieties MTU1061 and MTU1001 had recorded greater means and widely adaptable over seasons reflecting their potential in development of stable and adaptable high yielding varieties with resistance to salinity. Further, BPT2231 during normal and late *kharif* and NLR40024 during late *kharif* and late *rabi* seasons, were identified as promising parents for season specific breeding programmes. NLR33359 X MTU1001 was identified as high yielding, stable and widely adaptable hybrid over season for saline soils. The hybrid NLR40024 XMTU1001 was identified as high yielding, stable and widely adoptable hybrid for late kharif and both normal and late rabi seasons. The hybrid, NLR33057 X NLR3041 was found promising for late *kharif* season, while NLR33358 X MTU1001 was noticed to be potential for both normal and late *rabi* under saline conditions. The hybrids MTU1061 X MTU1001 and MTU1001 X BPT2231 were noticed to be superior for normal kharif season.

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Table 1. ANOVA of parents and hybrids for salinity tolerant traits and grain yield in rice during normal *kharif*, late *kharif*, normal *rabi* and late *rabi* seasons under saline conditions

Source of variation	df	Shoot length at seedling stage				Shoot Dry Weight at seedling stage				Shoot sodium content at maximum tillering stage			
		Normal *kharif*	Late *kharif*	Normal *rabi*	Late *rabi*	Normal *kharif*	Late *kharif*	Normal *rabi*	Late *rabi*	Normal *kharif*	Late *kharif*	Normal *rabi*	Late *rabi*
Replication	2	42.01	25.21	2.32	4.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Genotypes	54	193.23**	214.71**	155.85**	133.39**	0.15**	0.04**	0.08**	0.07**	0.30**	0.27**	0.31**	0.33**
Parents	9	149.72**	103.58**	157.67**	122.87**	0.03**	0.03**	0.05**	0.03**	0.57**	0.46**	0.55**	0.24**
Hybrids	44	141.81**	242.17**	138.40**	123.88**	0.12**	0.04**	0.07**	0.07**	0.21**	0.21**	0.25**	0.35**
Parents x Hybrids	1	2847.39**	6.82**	907.20**	646.48**	2.57**	0.35**	0.81**	0.37**	1.49**	1.05**	0.76**	0.06**
Error	108	32.12	12.09	21.31	21.37	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01

*Significant at 5 per cent level **Significant at 1 per cent level

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Table 1 Contd….

Source of variation	**df**	**Shoot potassium content at maximum tillering stage**				**Root length at seedling stage**				**Root Dry weight at seedling stage**			
		Normal *kharif*	**Late *kharif***	**Normal *rabi***	**Late *rabi***	**Normal *kharif***	**Late *kharif***	**Normal *rabi***	**Late *rabi***	**Normal *kharif***	**Late *kharif***	**Normal *rabi***	**Late *rabi***
Replication	2	0.01	0.01	0.01	0.01	0.50	0.59	3.07	3.35	0.01	0.01	0.01	0.01
Genotypes	54	0.70**	0.64**	0.76**	0.61**	10.43**	16.07**	10.32**	13.25**	0.01	0.01**	0.01**	0.01**
Parents	9	0.10**	0.10**	0.11**	0.10**	5.82**	10.31**	2.90*	1.10**	0.01	0.01	0.01	0.01
Hybrids	44	0.84**	0.76**	0.91**	0.73**	11.26**	16.39**	12.07**	15.78**	0.01	0.01	0.01**	0.01**
Parents x Hybrids	1	0.01	0.01*	0.02**	0.01*	15.67**	53.68**	0.01	11.18**	0.01	0.01	0.01	0.01
Error	108	0.01	0.01	0.01	0.01	0.59	0.61	3.27	4.36	0.01	0.01	0.01	0.01

*Significant at 5 per cent level **Significant at 1 per cent level

Table1

Source of variation	**df**	**Grain yield plant^{-1}**			
		Normal *kharif*	**Late *kharif***	**Normal *rabi***	**Late *rabi***
Replication	2	0.63	0.36	0.09	1.72
Genotypes	54	48.4**	23.82**	75.59**	73.45**
Parents	9	16.22**	1.24*	4.87**	3.64*
Hybrids	44	53.64**	28.93**	85.91**	86.58**
Parents x Hybrids	1	107.61**	2.18*	311.90**	123.70**
Error	108	0.78	1.90	1.35	2.36

Contd….

Table 2 Mean performance of parents and hybrids in rice in different seasons under saline conditions

Parents/Hybrids	**Shoot Length at seedling stage (cm)**				**Shoot Dry weight at seedling stage (g)**				**Shoot sodium content at maximum tillering stage (%)**			
	Normal *kharif*	Late *kharif*	Normal *rabi*	Late *rabi*	Normal *kharif*	Late *kharif*	Normal *rabi*	Late *rabi*	Normal *kharif*	Late *kharif*	Normal *rabi*	Late *rabi*
Parents												
NLR33057	39.49	37.73	43.25	41.57	0.36	0.45	0.44	0.44	0.39	0.43	0.39	0.46
NLR33358	48.50	42.04	49.74	45.18	0.45	0.51	0.54	0.56	0.36	0.38	0.38	0.42
NLR33359	30.34	32.07	44.79	43.12	0.25	0.31	0.58	0.52	0.65	0.65	0.66	0.69
NLR40024	44.52	41.49	45.87	41.80	0.41	0.45	0.51	0.48	0.86	0.71	0.73	0.75
NLR3041	44.04	35.17	45.24	43.88	0.27	0.39	0.31	0.39	0.81	0.64	0.69	0.71
NLR33671	36.73	30.73	49.87	46.47	0.48	0.31	0.50	0.48	0.85	0.78	0.60	0.65
MTU1061	40.57	36.12	38.04	40.09	0.32	0.38	0.35	0.41	1.71	0.84	0.82	0.83
MTU1001	30.48	29.89	42.06	38.33	0.25	0.31	0.31	0.42	0.91	0.75	0.86	0.82
PUSA1121	27.82	22.35	30.25	28.85	0.23	0.31	0.30	0.34	0.58	1.67	1.71	1.21
BPT2231	32.22	32.25	29.23	28.04	0.21	0.20	0.17	0.19	1.48	1.31	1.44	1.29
Range												
Minimum	27.82	22.35	29.23	28.04	0.21	0.20	0.17	0.19	0.36	0.38	0.38	0.42
Maximum	48.50	42.04	49.87	46.47	0.48	0.51	0.58	0.56	1.71	1.67	1.71	1.29
Mean	**37.47**	**33.98**	**41.83**	**39.73**	**0.32**	**0.36**	**0.40**	**0.42**	**0.86**	**0.82**	**0.83**	**0.78**
Hybrids												
NLR33057 X NLR33358	40.10	33.10	51.60	40.46	0.54	0.43	0.61	0.60	0.43	0.44	0.53	0.54
NLR33057 X NLR33359	38.79	28.70	44.87	51.23	0.56	0.50	0.63	0.61	0.56	0.55	0.60	0.61
NLR33057 X NLR40024	47.74	32.10	53.24	46.53	0.36	0.53	0.58	0.52	0.65	0.76	0.79	0.80
NLR33057 X NLR3041	52.53	42.70	41.23	42.86	0.64	0.67	0.47	0.48	0.76	0.66	0.75	0.78
NLR33057 X NLR33671	33.40	22.70	32.82	48.80	0.59	0.33	0.62	0.53	0.67	0.67	0.71	0.82
NLR33057 X MTU1061	**55.40**	**42.13**	**56.82**	**50.76**	**0.79**	**0.56**	**0.59**	**0.62**	**0.30**	**0.30**	**0.31**	**0.35**

Contd…,

Parents/Hybrids	Shoot Length at seedling stage (cm)				Shoot Dry weight at seedling stage (g)				Shoot sodium content at Maximum tillering stage (%)			
	Normal *kharif*	Late *kharif*	Normal *rabi*	Late *rabi*	Normal *kharif*	Late *kharif*	Normal *rabi*	Late *rabi*	Normal *kharif*	Late *kharif*	Normal *rabi*	Late *rabi*
NLR33057 X MTU1001	54.07	41.50	55.12	53.36	0.69	0.54	0.64	0.89	0.38	0.39	0.39	0.50
NLR33057 X PUSA1121	45.13	29.70	46.29	40.90	0.53	0.41	0.51	0.48	1.03	1.03	1.11	1.71
NLR33057 X BPT2231	44.22	42.00	37.45	35.63	0.61	0.53	0.48	0.43	1.04	1.11	1.07	1.41
NLR33358 X NLR33359	41.67	22.50	51.23	40.90	0.43	0.57	0.76	0.63	0.48	0.47	0.49	0.56
NLR33358 X NLR40024	44.07	43.80	44.85	39.32	0.49	0.53	0.63	0.36	1.00	1.02	1.07	1.21
NLR33358 X NLR3041	50.40	42.70	42.51	45.46	0.68	0.62	0.39	0.59	0.70	0.71	0.76	0.83
NLR33358 X NLR33671	48.97	22.50	49.65	45.96	0.42	0.41	0.65	0.65	0.79	0.77	0.80	0.83
NLR33358 X MTU1061	56.17	41.40	57.48	50.23	0.72	0.60	0.69	0.50	0.23	0.24	0.26	0.30
NLR33358 X MTU1001	45.84	31.50	50.23	50.70	1.18	0.42	0.68	0.67	0.31	0.44	0.34	0.39
NLR33358 X PUSA1121	42.00	31.10	43.95	41.00	0.42	0.32	0.50	0.42	0.50	0.48	0.53	0.62
NLR33358 X BPT2231	43.20	42.70	36.76	40.40	0.67	0.48	0.48	0.50	1.00	1.10	1.14	1.21
NLR33359 X NLR40024	53.55	23.23	52.45	51.80	0.62	0.36	0.65	0.50	0.52	0.52	0.53	0.56
NLR33359 X NLR3041	57.05	39.50	48.24	48.93	0.62	0.43	0.39	0.48	0.72	0.73	0.78	0.83
NLR33359 X NLR33671	38.57	20.90	43.97	43.26	0.52	0.42	0.46	0.59	0.75	0.72	0.75	0.83
NLR33359 X MTU1061	56.50	44.30	56.52	52.40	0.78	0.51	0.66	0.55	0.32	0.43	0.21	0.27
NLR33359 X MTU1001	51.74	53.17	52.34	50.06	0.78	0.72	0.58	0.49	0.43	0.22	0.46	0.49
NLR33359 X PUSA1121	39.70	22.60	41.94	40.96	0.59	0.47	0.41	0.42	0.51	1.30	0.55	0.62
NLR33359 X BPT2231	48.16	29.20	39.22	38.03	0.62	0.47	0.50	0.53	1.03	0.51	1.11	1.28
NLR40024 X NLR3041	48.27	42.10	48.64	49.30	0.71	0.56	0.52	0.64	0.79	1.09	0.81	0.82
NLR40024 X NLR33671	46.67	20.80	47.92	42.16	0.35	0.44	0.58	0.37	0.74	0.74	0.80	0.89
NLR40024 X MTU1061	58.17	39.20	57.95	51.76	1.10	0.48	0.78	0.49	0.30	0.44	0.35	0.40
NLR40024 X MTU1001	56.80	48.60	54.73	52.73	0.74	0.69	0.76	0.53	0.22	0.43	0.29	0.42

Parents/Hybrids		**Shoot Length at seedling Stage (cm)**				**Shoot Dry weight at seedling stage (g)**				**Shoot sodium content at Maximum tillering stage (%)**			
		Normal *kharif*	Late *kharif*	Normal *rabi*	Late *rabi*	Normal *kharif*	Late *kharif*	Normal *rabi*	Late *rabi*	Normal *kharif*	Late *kharif*	Normal *rabi*	Late *rabi*
NLR40024 X PUSA1121		42.74	32.20	42.95	39.06	0.54	0.40	0.63	0.42	0.56	0.73	0.61	0.70
NLR40024 X BPT2231		46.10	21.30	37.32	36.00	0.62	0.49	0.54	0.39	0.97	0.56	1.03	1.14
NLR3041 X NLR33671		46.10	17.60	43.98	40.76	0.61	0.44	0.49	0.43	0.70	1.00	0.75	0.80
NLR3041 X MTU1061		57.84	32.50	56.84	50.03	0.86	0.49	0.78	0.68	0.34	0.42	0.33	0.38
NLR3041 X MTU1001		53.80	32.80	54.69	53.26	0.72	0.65	0.77	0.72	0.35	0.44	0.44	0.48
NLR3041 X PUSA1121		38.47	16.40	46.08	41.00	0.30	0.35	0.34	0.44	0.56	0.60	0.60	0.62
NLR3041 X BPT2231		45.10	30.00	38.25	35.66	0.69	0.44	0.58	0.48	0.87	0.56	0.96	1.12
NLR33671 X MTU1061		53.17	35.23	55.94	49.96	0.72	0.41	0.79	0.59	0.30	0.88	0.30	0.33
NLR33671 X MTU1001		53.04	38.80	53.82	51.10	0.69	0.37	0.73	0.71	0.36	0.30	0.40	0.44
NLR33671 X PUSA1121		44.64	19.70	43.61	40.83	0.59	0.18	0.47	0.53	0.68	0.41	0.70	0.81
NLR33671 X BPT2231		54.30	30.50	41.32	34.63	0.63	0.42	0.60	0.44	1.08	0.69	1.15	1.27
MTU1061 X MTU1001		62.77	41.20	60.83	60.76	1.31	0.61	1.19	1.22	0.42	0.18	0.47	0.51
MTU1061 X PUSA1121		45.17	38.90	42.98	41.51	0.39	0.60	0.35	0.51	0.53	0.44	0.51	0.58
MTU1061 X BPT2231		45.60	30.53	49.05	36.30	0.58	0.49	0.61	0.42	0.39	0.56	0.40	0.43
MTU1001 X PUSA1121		51.84	43.70	51.69	49.61	0.71	0.38	0.40	0.55	0.55	0.39	0.53	0.58
MTU1001 X BPT2231		56.45	30.60	52.95	38.72	0.66	0.59	0.49	0.49	0.47	0.54	0.51	0.54
PUSA1121 X BPT2231		37.97	32.10	43.86	33.80	0.60	0.39	0.38	0.48	1.30	0.46	1.36	1.44
Range	Minimum	33.40	16.40	32.82	33.80	0.30	0.32	0.34	0.36	0.22	0.18	0.21	0.27
	Maximum	62.77	53.17	60.83	60.76	1.31	0.72	1.19	1.22	1.30	1.30	1.15	1.71
Mean		**48.31**	**34.34**	**47.92**	**44.86**	**0.64**	**0.48**	**0.59**	**0.55**	**0.61**	**0.61**	**0.65**	**0.73**
S.E.M. ±		3.27	2.01	2.66	2.67	0.02	0.03	0.03	0.03	0.02	0.03	0.02	0.02
C.D (at 5% level)		9.17	5.63	7.47	7.48	0.05	0.08	0.08	0.08	0.05	0.08	0.06	0.05
C.V.		12.24	10.36	9.86	10.52	5.03	11.22	8.95	8.87	4.95	7.78	5.92	4.02

Contd…,

Parents/Hybrids		Shoot potassium content at Maximum tillering stage (%)				Root Length at seedling stage (cm)				Root Dry weight at seedling stage (g)			
		Normal *kharif*	Late *kharif*	Normal *rabi*	Late *rabi*	Normal *kharif*	Late *kharif*	Normal *rabi*	Late *rabi*	Normal *kharif*	Late *kharif*	Normal *rabi*	Late *rabi*
NLR40024 X BPT2231		0.31	0.36	0.35	0.35	10.02	6.57	9.87	9.69	0.10	0.08	0.10	0.11
NLR3041 X NLR33671		0.55	0.58	0.42	0.42	9.97	5.21	8.31	7.48	0.10	0.08	0.07	0.08
NLR3041 X MTU1061		1.40	1.42	1.74	1.41	14.94	6.70	13.27	12.83	0.17	0.07	0.14	0.14
NLR3041 X MTU1001		1.50	1.60	1.55	1.54	13.67	7.94	14.09	13.95	0.15	0.09	0.16	0.15
NLR3041 X PUSA1121		0.50	0.59	0.53	0.52	8.48	5.02	8.12	7.46	0.10	0.08	0.08	0.07
NLR3041 X BPT2231		0.29	0.32	0.37	0.38	10.21	6.51	10.54	6.74	0.12	0.07	0.07	0.08
NLR33671 X MTU1061		1.77	1.79	1.73	1.68	10.65	7.03	12.78	12.94	0.11	0.10	0.13	0.14
NLR33671 X MTU1001		1.50	1.57	1.47	1.43	10.84	6.67	11.43	11.63	0.12	0.07	0.14	0.13
NLR33671 X PUSA1121		0.54	0.61	0.53	0.59	9.57	5.00	7.23	7.82	0.10	0.08	0.07	0.07
NLR33671 X BPT2231		0.34	0.38	0.39	0.41	13.21	6.85	9.98	7.21	0.14	0.07	0.08	0.08
MTU1061 X MTU1001		1.78	1.78	0.65	2.20	14.87	13.41	14.64	14.25	0.16	0.17	0.16	0.16
MTU1061 X PUSA1121		1.56	0.61	1.35	1.32	9.65	10.12	9.32	8.94	0.10	0.13	0.13	0.10
MTU1061 X BPT2231		0.93	0.78	1.03	1.09	8.73	6.09	10.71	11.28	0.11	0.09	0.09	0.10
MTU1001 X PUSA1121		1.57	0.60	1.40	1.41	10.95	5.46	7.63	6.69	0.12	0.08	0.07	0.08
MTU1001 X BPT2231		1.49	0.52	1.11	1.10	11.23	6.87	9.57	10.01	0.12	0.10	0.09	0.12
PUSA1121 X BPT2231		0.36	0.39	0.21	0.22	8.31	6.12	8.47	8.73	0.10	0.08	0.08	0.09
Range	Minimum	0.27	0.31	0.21	0.22	6.46	5.00	7.23	6.69	0.09	0.07	0.07	0.07
	Maximum	1.79	1.83	1.74	2.20	14.94	13.57	14.64	14.76	0.17	0.17	0.18	0.16
Mean		**0.88**	**0.86**	**0.86**	**0.79**	**12.67**	**10.10**	**11.18**	**10.81**	**0.14**	**0.12**	**0.14**	**0.12**
S.E.M.±		0.02	0.03	0.02	0.03	0.44	0.45	1.04	1.20	0.02	0.02	0.02	0.02
C.D (at 5% level)		0.06	0.09	0.04	0.09	1.24	1.27	2.93	3.38	0.05	0.05	0.05	0.06
C.V.		4.85	7.66	3.40	6.87	7.08	9.36	16.18	19.53	26.64	32.97	25.30	28.97

Parents/Hybrids	**Grain yield plant^{-1}(g)**			
	Normal *kharif*	Late *kharif*	Normal *rabi*	Late *rabi*
Parents				
NLR33057	7.03	8.52	8.37	7.89
NLR33358	6.27	9.45	8.44	8.14
NLR33359	7.97	9.14	8.50	8.43
NLR40024	9.80	10.75	10.19	10.16
NLR3041	8.01	9.10	8.12	7.63
NLR33671	7.53	9.67	8.44	9.09
MTU1061	13.06	10.06	11.37	10.59
MTU1001	10.15	10.06	11.22	9.43
PUSA1121	7.25	9.78	8.19	7.31
BPT2231	12.41	10.75	9.80	9.41
Range				
Minimum	6.27	8.52	8.12	7.31
Maximum	13.06	10.75	11.37	10.59
Mean	**8.95**	**9.67**	**9.27**	**8.81**
Hybrids				
NLR33057 X NLR33358	7.21	9.62	9.82	9.23
NLR33057 X NLR33359	8.05	8.33	18.72	6.97
NLR33057 X NLR40024	6.33	8.91	8.90	8.42
NLR33057 X NLR3041	9.84	15.32	7.32	8.51
NLR33057 X NLR33671	7.94	6.82	12.82	6.93
NLR33057 X MTU1061	17.04	12.42	10.40	10.29

Parents/Hybrids	Grain yield plant^{-1}(g)			
	Normal *kharif*	Late *kharif*	Normal *rabi*	Late *rabi*
NLR33057 X MTU1001	15.36	7.59	13.50	13.36
NLR33057 X PUSA1121	6.46	8.41	8.20	7.38
NLR33057 X BPT2231	9.81	10.62	7.72	8.67
NLR33358 X NLR33359	7.47	11.32	10.40	10.29
NLR33358 X NLR40024	7.64	9.89	8.10	7.79
NLR33358 X NLR3041	8.34	12.68	7.92	9.99
NLR33358 X NLR33671	7.95	8.32	20.21	6.78
NLR33358 X MTU1061	12.85	10.33	17.10	16.93
NLR33358 X MTU1001	10.95	9.92	28.30	28.01
NLR33358 X PUSA1121	7.04	7.43	12.54	6.75
NLR33358 X BPT2231	8.44	9.54	7.64	10.70
NLR33359 X NLR40024	7.15	6.94	18.32	11.98
NLR33359 X NLR3041	8.31	9.63	7.95	18.12
NLR33359 X NLR33671	7.35	7.57	7.80	7.03
NLR33359 X MTU1061	15.45	9.76	16.90	16.73
NLR33359 X MTU1001	18.35	21.04	31.53	32.79
NLR33359 X PUSA1121	8.14	10.31	12.13	8.46
NLR33359 X BPT2231	8.75	9.23	9.44	7.11
NLR40024 X NLR3041	8.05	11.64	7.94	10.23
NLR40024 X NLR33671	7.94	8.46	17.51	10.37
NLR40024 X MTU1061	14.34	13.42	15.70	14.24
NLR40024 X MTU1001	17.85	20.45	20.90	19.36

Parents/Hybrids	**Grain yield plant^{-1}(g)**			
	Normal *kharif*	Late *kharif*	Normal *rabi*	Late *rabi*
NLR40024 X PUSA1121	17.43	9.22	13.50	12.41
NLR40024 X BPT2231	9.40	9.83	9.43	7.03
NLR3041 X NLR33671	8.84	7.42	12.86	8.21
NLR3041 X MTU1061	8.32	9.02	10.60	9.87
NLR3041 X MTU1001	15.95	11.42	14.70	12.32
NLR3041 X PUSA1121	8.15	5.36	12.96	7.38
NLR3041 X BPT2231	9.43	7.63	8.30	9.24
NLR33671 X MTU1061	14.57	9.29	9.70	9.36
NLR33671 X MTU1001	15.33	8.72	12.13	10.26
NLR33671 X PUSA1121	7.65	5.64	11.54	5.74
NLR33671 X BPT2231	10.55	9.15	7.90	8.19
MTU1061 X MTU1001	22.49	11.88	18.20	15.23
MTU1061 X PUSA1121	11.35	10.15	12.73	10.41
MTU1061 X BPT2231	15.94	9.52	16.80	9.31
MTU1001 X PUSA1121	10.45	7.44	9.43	6.97
MTU1001 X BPT2231	20.84	13.16	11.70	14.56
PUSA1121 X BPT2231	9.74	7.79	9.13	7.42
Range Minimum	6.33	5.36	7.32	5.74
Maximum	22.49	21.04	36.53	32.79
Mean	**11.04**	**9.97**	**12.83**	**11.05**
S.E.M. ±	0.51	0.80	0.67	0.89
C.D (at 5 % level)	1.43	2.23	1.88	2.49
C.V.	8.30	13.90	9.55	14.43