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SELECTION MODEL IN RICE (*ORYZA SATIVA* L.)

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ABSTRACT

The study based on multiple selection criteria in F_2 population of six rice crosses revealed the desirable responses in most of the characters under study in F_3 generation. However, nonsignificant values of intergeneration rank correlation and best vs worst variance ratio indicated the absence of response to selection on the basis of grain yield per se. Further selections in two crosses, N22 x FH109 and N22 x IET 1444, are expected to give better responses in succeeding generation.

Key words: Multiple selection, early generation, selection response, rice.

Selection is an integral part of plant breeding methodology. Different selection techniques have led to improvement in cereals (wheat and rice) for higher yield; maize for higher oil and lysine content, sunflower and soybean for oil and sugarbeet for higher sugar content. A plateau in grain yield has compelled a search for better selection techniques. In rice, it is more important because of its cultivation in most varying conditions specially in a country like India. However, the selection techniques in several cases do not have a proper basis. The present investigation was aimed at studying effectiveness of multiple selection criteria in rainfed upland rice based on medium plant height, short duration, moderate tillering, synchronous development of tillers/panicle and adequate field resistance to diseases in F_2 generation.

MATERIALS AND METHODS

The present study has been conducted with 90 entries generated from F_2 population of six crosses involving ten parents suitable for rainfed upland condition. The selection of individual plants was made based on multiple selection criteria performed at field level (independent culling level) taking into account the traits medium height comparable to NDR 80 $\pm$ 5 cm, duration not later than N22, tillers not less than 5, synchronous tillering and

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panicle development with uniform height and adequate field resistance to diseases. From each cross, six best and six worst individual plants were identified on the basis of single plant yield. Thus, 12 F_3 populations were developed from each cross making in all 72 populations. These were evaluated in randomized block design with three replications along with parents, unselected bulk and two standard checks. The plot size for each treatment in each replication was 3.0 x 0.8 m. The details of experimental materials are given below:

Population type	Origin	Total
Parents	White Gora, Annpurna, N22, FH 109, IET-1444, KR5-142, IAC-25, FH 207, IET-2232, Panidhan-2	10
Unselected bulk	C_1 (White Gora x Annpurna), C_2 (White Gora x FH 207), C_3 (N_{22} x FH 109), C_4 (N_{22} x IET-1444), C_5 (KR5-142 x IAC-25), C_6 (IET-2232 x Panidhan-2)	6
Best and worst individuals	12 from each cross i.e. 6 best and 6 worst based on single plant yield data	72
Standard checks	NDR-80, NDR-81	2

The data recorded on days to flowering, panicle length, plant height, grains/ panicle, productive tillers/plant, test weight, and grain yield/plant were subjected to statistical analysis. Various selection parameters were computed as per standard procedures [1–4].

RESULTS AND DISCUSSION

Significant differences were observed among the treatments for all characters (Table 1).

The mean values presented in Table 2 for the best and worst groups, parents, and bulk populations revealed only numerical differences between the best and worst groups. This indicated that selection on the basis of grain yield/plant was not effective because the best and worst group was designated on the basis of single plant yield. But these best and worst groups differed significantly from the parental and bulk populations for most of the characters. This indicated that selection as a whole over the unselected populations was effective.

The knowledge of variability present in any population at genotypic and phenotypic levels is essential to start breeding programme because selection can act effectively only in sufficiently variable populations. The coefficient of variation (CV) was highest in bulk group for days to flowering, panicle length, plant height and grains/panicle (Table 2). This may be because of heterogeniety in the population due to segregation. The parental group also

Table 1. ANOVA (mean squares) of seven characters in Rice

Source	d.f.	Days to flowering	Panicle length	Plant height	Grains per panicle	Productive tillers per plant	Test weight	Yield per plant
Treatments	89	84.7**	11.1**	493.3**	3629.9**	7.63**	27.64**	38.8**
Replications	2	6.1	10.2	166.0	810.5	6.79	1.47	16.4
Error	178	20.7	3.4	55.0	347.9	3.33	0.87	13.6

**Significant at 1% level.

showed relatively higher CV values which might be due to their genetic divergence. The moderate CV values in the best and worst groups may be due to selection for certain common traits leading to uniformity. However, the CV values were more in the worst than in the best group. The similar trend was also observed regarding variance.

The heritability estimates are valuable primarily in quantifying the extent of progress that could be achieved in breeding programmes. The heritability estimates (Table 2) were high (above 90%) in all the groups with regard to test weight, indicating minimum effect of environment on the expression of this trait and therefore selection may be practised effectively. The grain weight has been suggested as an efficient selection criteria in wheat improvement also [5]. In bulk population, heritability estimates ($\hat{h}^2$) were lower than that of the parents and selected populations which may be natural. The $\hat{h}^2$ values were higher in the best group than worst group for grain yield/plant, test weight, and panicle bearing tillers/plant, which may be because of selection pressure in the best group towards higher yield. Higher $\hat{h}^2$ in the worst group was observed for plant height, days to flowering and grains/panicle, which may be due to higher genetic variance of these characters in this group. The predicted selection response was higher than the realized selection response (Table 3). The lower values of realized responses may be because of insufficient sampling change in mean gene frequency between the time when population was initially sampled and when it was evaluated, as well as genotype–environment interaction. Similar results were also reported in maize [6, 7]. The realized selection response for days to flowering was higher in the worst group than in the best group. The response was positive for grains/panicle and was more in the best group. It may be due to indirect selection response for higher yield/plant. The realized response for test weight was higher in the worst group than in the best group. This may be due to fewer grains/panicle in the worst group leading to increase in seed size (Table 2).

Negative response in plant height was desirable because we aimed at selection of relatively shorter plant types. The positive response in grain yield per plant might have been

Table 2. Mean ($\bar{X}$), variance (σ^2), heritability ($\hat{h}^2$) and genetic advance (GA) for seven characters in rice

Character	Parents				Bulk				Best group				Worst group			
	$\bar{X}$	σ^2	$\hat{h}^2$	GA	$\bar{X}$	σ^2	$\hat{h}^2$	GA	$\bar{X}$	σ^2	$\hat{h}^2$	GA	$\bar{X}$	σ^2	$\hat{h}^2$	GA
Days to flowering	84.6	6.4	78.0	4.1 (4.8)	84.6	15.5	58.0	4.7 (5.5)	87.6	9.5	58.0	3.7 (4.2)	88.0	10.3	59.0	3.90 (4.4)
Panicle length	23.7	2.4	62.0	2.0 (8.3)	25.5	2.9	69.0	2.4 (9.4)	23.4	1.3	26.0	0.6 (2.6)	23.5	1.2	26.0	0.7 (3.0)
Plant height	80.3	7.0	71.0	12.0 (15.0)	91.2	129.5	63.0	7.8 (8.5)	82.3	25.2	69.0	7.2 (8.7)	85.5	86.6	70.0	13.4 (15.6)
Grains/panicle	149.1	496.1	67.0	30.6 (20.5)	164.4	500.1	67.0	30.9 (18.8)	175.8	11.0	68.0	14.7 (8.4)	167.7	256.0	69.0	15.0 (9.0)
Productive tillers/plant	7.3	1.8	47.0	1.3 (17.9)	7.5	0.6	36.0	0.6 (7.5)	7.9	0.2	43.0	0.4 (5.5)	7.6	0.4	41.0	0.6 (7.3)
Test weight	24.0	5.2	94.0	4.5 (18.5)	21.4	5.8	92.0	4.6 (21.3)	22.0	9.6	95.0	6.0 (27.2)	22.2	13.0	93.0	6.9 (31.1)
Grain yield/plant	17.3	12.7	73.0	5.3 (30.9)	16.4	4.3	65.0	2.8 (16.8)	18.0	5.2	67.0	3.2 (17.6)	17.3	5.8	66.0	3.3 (19.1)

Note. Predicted genetic advance as % of mean are given in parentheses.

Table 3. Realized selection responses in six different crosses for seven traits in rice

Crosses	Days to flowering		Panicle length		Plant height		Grains/ panicle		Tillers/ plant		Test weight		Grain yield/plant	
	B	W	B	W	B	W	B	W	B	W	B	W	B	W
C_1	3.89	3.49	-3.04	-0.87	-4.22	2.32	5.60	10.45	0.43	0.73	1.90	1.00	5.19	6.84
C_2	2.89	2.92	-1.05	-2.01	-13.90	-14.27	-18.87	-35.77	1.18	0.69	-0.78	-0.60	0.03	-3.92
C_3	2.22	1.50	-1.92	-0.51	-16.25	-8.69	6.65	38.70	1.89	0.78	-3.35	-1.99	3.13	4.82
C_4	3.91	3.72	-0.49	-1.49	-8.89	-12.26	14.47	3.46	0.66	1.22	3.17	3.64	5.72	4.23
C_5	3.78	6.17	0.03	-0.64	-5.56	-6.18	24.60	6.23	0.10	-0.38	2.76	4.48	1.38	-0.27
C_6	1.22	3.67	-0.25	-0.67	6.34	4.00	39.22	4.30	-1.56	-2.06	0.37	-0.89	-6.03	-6.36
R (pooled)	2.98	3.41	-2.12	-2.03	-8.92	5.67	11.45	3.30	0.45	0.16	0.69	0.96	1.67	0.91
R in %	(3.40)	(3.07)	(-9.05)	(-8.63)	(-10.83)	(-6.63)	(6.51)	(1.97)	(2.68)	(2.09)	(3.13)	(4.32)	(9.27)	(5.24)

Note. R—Realized selection response pooled over crosses for respective characters.

Underlined values indicate the highest realized response for the concerned character.

resulted because of increase in number of grains per panicle, ear bearing tillers per plant and test weight (Table 3).

Among the best groups, C_6 (IET-2232 x Panidhan-2) showed realized selection response in desirable direction for days to 50% flowering and grains per panicle; C_5 (KR5-142 x IAC-25) for panicle length; C_3 (N22 x FH 207) for plant height and ear bearing tillers per plant; and C_4 (N22 x IET 1444) for grain yield per plant. The differential nature of realized responses in the crosses may be explained by the genotypic differences between parents and varied genetic interaction. Among the worst groups, the desirable responses were observed in C_1, C_2, C_3, C_4, C_5, respectively for grain yield/plant, plant height, days to 50% flowering, panicle length, grains/panicle, panicle bearing tillers/plant, and test weight. It is suggested that the crosses, which gave higher values of realized selection response to particular character, may be utilized in breeding programme. The data also revealed that selection in C_3 and C_4 provide better segregates because these crosses showed high realized selection response for most of the characters irrespective of the best or worst group.

The absence of rank correlation between F_2 individuals and F_3 families derived from them may be because of noneffectiveness of selection based on grain yield/plant in early generation. The ranking in F_2 was done on the basis of grain yield. The other causes may be the presence of heterotic effects, dominance, epistasis in F_2 and subsequent generations, and genotype x environment interaction.

The combined analysis of variance of the best and worst groups was done in each cross separately. The F values for best vs worst were nonsignificant in all the crosses. This further indicated that selection on the basis of grain yield/plant alone was not effective as the best and worst were designated on the basis of grain yield per plant. The following conclusions were drawn from the present experiment.

1. Selection based on yield/plant or individual character was not effective.

2. The multiple character selection criteria appears to be effective and gives positive response.

3. Correlated responses both in positive and negative directions were observed for certain traits for which selection was not made.

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