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Effectiveness of F_2 and F_3 plant selection for yield and its components in rice

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ABSTRACT

Effectiveness of plants selected in early segregating F_2 and F_3 populations was estimated in their corresponding F_3 and F_4 generation of two rice crosses, Jhona 349 X IET-12944 and Narendra 80 X Lalmati. Both the F_2 and F_3 selected plants showed consistency in increment of response to selection and realized heritability in their corresponding F_3 and F_4 generation for grain yield/plant and 100-grain weight, whereas these estimates were inconsistent for spikelets/main panicle and in undesirable direction for panicle/plant. Among intergeneration correlations, the F_2 selected plants showed inconsistent significant correlation with their F_3 progenies over crosses for all the characters, while F_3 selected plants had significant correlations with their F_4 progenies for 100-grain weight and grain yield/plant in both the crosses. The higher estimates of selection parameters like response to selection and realized heritability as well as significant correlation for grain yield/plant and 100-grain weight in F_4 generation suggested that selection for these two polygenic traits should preferably be started from F_3 generation.

Key words: *Selection response, realized heritability, correlation, early generation, rice*

For rapid and effective genetic improvement for any economic trait, early generation selection would be advantageous because a genotype possessing all the desirable genes either in homozygous or heterozygous condition occurs most often in the early segregating generations (F_2 and F_3).The scientific rationale of early selection has been critically examined by Yonezawa and Yamagata (1981a and 1981b) and they observed some key points such as (i) genetic potentiality of crosses is determined essentially in F_2 and F_3 generations (ii)some morphological-physiological traits are predictive of yielding capacity of plants and lines (iii) with a larger F_2 population, the selection among and within crosses is useful (iv) cross-combinations are therefore assessed by the presence or absence of the promising phenotypes, and (v) F_2 population should be entirely discarded if no promising phenotype is found. These important considerations on early selection (F_2-F_3 generations) may led to development of high yielding cultivar. The effectiveness of early generation selection was observed through significant and positive correlations between F_2 and F_3 (Pawar *et al.* 1989) and between F_2 and F_3 and F_3 and F_4 (Saini and Gautam, 1990) in wheat. The numerous report on intergeneration association are available in other crops, but adequate information is not available on this aspect in rice. Similarly estimates of heritability of a trait is important in determining its response for yield and its components have been reported by some workers (Gravais and McNew,1993; Takeda and Saito,1983; Kato,1997). Considering the above views, the objectives of this study were to generate more information on effectiveness of plant selection in both F_2 and F_3 generation by estimating selection response, realized heritability and integeneration correlation coefficients for yield and its components in two crosses of rice.

MATERIALS AND METHODS

The F_2 and F_3 population, each representing 600 plants derived from two rice crosses namely, Jhona 349 X

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IET-12944 (Cross I) and Narendra 80 X Lalmati (Cross II) were space planted at Crop Research Station of N. D. University of Agril. and Tech., Faizabad. At the time of harvest, 90 plants (exercising 15% selection pressure) were selected in both F_2 and F_3 populations. These plants were harvested individually from each F_2 and F_3 population. Data on individual plants were recorded for spikelets main panicle^{-1}, panicles plant^{-1}, 100-grain weight and grain yield plant^{-1}. The seeds of 90 F_2 and 90 F_3 plants of both crosses were sown to raise the seedlings of F_3 and F_4 populations. The 30 days old seedlings of each of the 90 F_3 and 90 F_4 single plant progenies per replication were transplanted in randomized block design with three replications. These 90F_3 and F_4 single plant progenies along with parents were grown in one row of 5m length accommodating 25 plants per replication at 20x20 cm spacing between hills. The observations for each character were recorded on five randomly taken plants of parents and 20 plants of each 90 F_3 and 90 F_4 plant progenies replication^{-1}. Selection differential and response to selection were worked out as suggested by Singh and Singh (1994) while realized heritability was estimated as per Falconer and Mackey (1996). Early evaluation was also done by computing the correlation coefficients of F_2 selection with their progenies in F_3 and of F_3 selection with their progenies in F_4.

RESULTS AND DISCUSSION

The progenies of 90 F_2 and F_3 plants selected on the basis of yield and its components were evaluated in F_3 and F_4 generation (Table 1). The plants selected from both F_2 and F_3 population showed gradual increment of response to selection and realized heritability in their corresponding F_3 and F_4 generations for grain yield/ plant and 100-grain weight. The high estimates of realized heritability for grain weight were also reported by Takeda and Saito (1983) and Surek and Beser (2005). These results indicates that selection was effective in both F_2 and F_3 stages and that the selection at F_3 stage was relatively more effective than at F_2 stage. Effectiveness of high heritable character like test weight has also been suggested in early generation in rice by Sun (1979), Subrahmanyam *et al*. (1986) and Surek and Beser (2005). The estimates of realized heritability were high for spikelets main panicle^{-1} and it was medium to low for grain yield. The lowest realized heritabilities were estimated for panicle plant^{-1}. The similar results for realized heritabilities were also observed for number of panicles plant^{-1} and number of spikelets panicle^{-1} by Kato (1997). However, different magnitude of realized responses were observed for these two characters in both the crosses which may be explained by the genotypic difference between parents and varied genetic variation. Similar results were also reported by Mishra *et al*. (1993). It is suggested that the crosses which showed higher values of realized selection response to particular character may be utilized in breeding programme.

The effectiveness of plant selection was compared through correlation coefficients with their corresponding F_2-F_3 and F_3-F_4 generation (Table 2).

Table 1. Estimates of various selection parameters in F_3 (F_2 selections) and F_4 (F_3 selections) progenies for yield and its components in two crosses of rice.

Parameter	Spikelets main panicle^{-1}		Panicles plant^{-1}		100-grain weight		Grain yield plant^{-1}	
	Cross I	Cross II	Cross I	Cross II	Cross I	Cross II	Cross I	Cross II
			F_2 Selections					
Selection differential	25.30	34.98	2.17	1.22	0.04	0.17	6.48	5.24
Mean (F_3)	118.6	107.2	4.12	5.42	2.18	2.17	16.20	15.40
Selection response (F_3)	19.02	24.15	-0.68	-0.63	0.03	0.12	3.91	3.20
Realized heritability (F_3)	0.75	0.69	-0.31	-0.51	0.75	0.70	0.60	0.61
			F_3 Selections					
Selection differential	15.79	63.86	1.40	1.58	0.07	0.18	7.80	8.43
Mean (F_4)	104.5	120.6	4.56	5.86	2.27	2.28	19.6	16.30
Selection response (F_4)	7.07	42.16	-0.17	0.48	0.06	0.15	5.60	5.81
Realized heritability(F_4)	54.27	78.27	-12.14	30.37	0.85	0.83	71.17	68.92

Table 2. Correlation coefficients (r) between F_2/F_3 and F_3/F_4 for yield and its components in two crosses of rice

Characters	F_2-F_3		F_3-F_4	
	Cross I	Cross II	Cross I	Cross II
Spikelets main panicle^{-1}	0.38*	0.26	0.29	0.52*
Panicles plant^{-1}	-0.16	-0.40*	-0.09	0.21
100-grain weight	0.32	0.47*	0.51*	0.67*
Grain yield plant^{-1}	0.25	0.40*	0.42*	0.52*

* Significant at P-5% level

The F_2 selected plants showed significant association in F_3 progenies for spikelets main panicle^{-1} in cross I; and for 100-grain weight and grain yield plant^{-1} in cross II. Singh and Singh (1997) also observed significant intergeneration (F_2 and F_3) correlation coefficients for grain weight in wheat. Similarly, the F_3 selection was effective due to significant correspondence with their progenies in F_4 generation for 100-grain weight and grain yield in both the crosses and for spikelets main panicle^{-1} in cross II only. Moreover, both 100-grain weight and grain yield plant^{-1} exhibited significant and positive correlation coefficients between F_2 and F_3 in cross I and F_3 and F_4 in both the crosses, indicating strong associations between these two traits. Dhanraj *et al*. (1987) and Jangale *et al*. (1987) also observed positive and significant associations between grain yield and 100-grain weight. It was observed that number and magnitude of significant correlations towards desirable direction were high in F_4 than F_3 generation probably the proportion of homozygous plants and loci will be high in F_3 generation. The significant correlation between F_3 plants and their F_4 progenies were also reported by Whan and Rathjan (1981) in wheat and by Rana and Gupta (1993) in pea.

The overall results of this study revealed that F_3 based selection had not only high magnitude of selection differential, realized heritability and realized response but also significant correlation coefficients for grain yield plant^{-1} and 100-grain weight between F_3 and F_4 generations. Benin *et al*. (2005) also emphasized that simultaneous selection of plants with higher yield and average grain weight might be performed in early generation with higher levels of heterozygotes. Therefore, it is advisable that selection in rice should be practiced as early as in F_3 generation for test weight as well as for complex character like yield.

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