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Selection Efficiency for Grain Yield and its Attributing Traits in Early Segregating Generations of Rice (*Oryza sativa* L.) under Aerobic Condition

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ABSTRACT

The aim of this study was to estimate the inter-generation correlation and narrow sense heritability between F_2 and F_3 generations in two rice crosses viz., BI 27 X IR 49 and BI 43 X IR 49 under aerobic condition to assess the worth of early generation selection. High values of correlation and narrow sense heritability was observed for characters like productive tillers per hill, number of tillers per hill, grains per panicle, panicle length and test weight in both the crosses, indicating the strong association for these traits between F_2 and F_3 generation and hence, have better chances of improvement through selection. Characters grain yield, plant height and days to fifty per cent flowering in both the crosses, per cent fertility in cross I and straw yield per plant and harvest index in cross II showed low correlation and heritability values, suggesting there is high influence of genotype X environment interaction, and hence postponing the selection for these traits to later generations can be advantageous. It is concluded that selection in early generations will be more effective for yield component traits than yield per se.

Key words: *Inter-generation Correlation, Heritability, Aerobic Rice, Additive Variance.*

INTRODUCTION

The objective of any crop improvement programme is to develop high yielding cultivars with improved quality and desirable agronomic characters. To achieve this goal, the breeder has the option of selecting suitable genotypes in early segregating generations or postponing the selection until advanced generations when the progenies are nearly homozygous. Early generation evaluation and selection is used widely as a means of saving resources and hastening the breeding process. Fisher and Rebetze[1] opined that early generation selection (EGS) helps to improve the breeding efficiency by reducing the number of genotypes to be tested in subsequent generations, thereby enhancing the genetic gain per unit cost. In EGS, selection is practiced in segregating F_2 generation based on high mean and high heritability. The rationale behind EGS is that there exists positive correlation between the yields of early generation and their progenies in the later generation.

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Inter-generation correlation and narrow sense heritability estimates between the segregating generations helps to understand the worth of EGS for yield and its associated traits. Many empirical evidences indicate differently on the efficiency of EGS for grain yield, some reported direct selection for grain yield is effective[2,3,4], while some say selection in early generation is ineffective[5,6,7,8]. In the present study, we studied the worth of EGS by estimating inter-generation correlation (r) and narrow sense heritability (h^2_{ns}) between F_2 and F_3 generation in two crosses of rice grown under aerobic condition. In aerobic method, rice is grown as upland crop by direct seeding under nonpuddled aerobic soils with supplementary irrigation and fertilizers[9]. The main advantage of aerobic rice is saving of water up to 50 per cent compared to irrigated rice.

MATERIAL AND METHODS

The material in the present study comprised of F_2 and F_3 populations of the two rice crosses *viz*., BI-27/IR-49 (Cross I) and BI-43/IR-49 (Cross II). While, the female parents BI-27 and BI-43 are the fixed lines derived from crossing of Budda and IR-64, the male parent IR-49 is a long slender high yielding variety introduced from International Rice Research Institute (IRRI), Philippines. Budda, a drought tolerant landrace from Shimoga district in Karnataka, was used as donor for drought tolerance to derive BI series of lines for growing under aerobic condition[9]. Field experiments were conducted in farmer's field at *Shettigere* village during 2006-08 under aerobic condition. The *Shettigere* village is located 20 km north of Bangalore between latitude 12^0 10' 55" N and longitude $77^0$40' 18" E at an average elevation of 900 m above mean sea level with temperature ranging from around 24^0 C in winter to 35^0 C during summer.

Hybridization of the parents was taken up during *Summer* season of 2006 and the F_1 plants were raised ruing *Kharif* season 2006 to collect the F_2 seeds. 600 F_2 seeds generated from each cross were directly sown in the main field under aerobic condition during *Summer* 2007 with single seed per hill at a spacing of 30 cm between rows and 10 cm between the plants within a row in augmented design wherein parents and checks (Rasi and KRH 2) were replicated and F_2 segregants were unreplicated. The observations on days to first flowering, plant height (cm), number of tillers, number of panicles (productive tillers) per plant, panicle length (cm), grains per panicle, per cent fertility, test weight (g), length to breadth ratio, harvest index, straw yield per plant (g) and grain yield per plant (g) were recorded on each of the individual F_2 plants and on five plant basis in parents and check varieties. Standard package of practices was followed for raising a good and healthy crop.

From each F_2 population, agronomically superior plants (nearly 25%) were selected for advancing to F_3 generation. F_3 population comprising of 135 families in cross I and 130 families in cross II were raised during *Kharif* 2007 in Randomized Complete Block Design (RCBD) replicated twice in a single row of 3 m length along with their parents and checks. Similar observations as in F_2 were recorded on five randomly chosen plants per family in each replication. Mean values were used to estimate the parent offspring correlation and regression between F_2 and F_3 generations.

Intergeneration correlation coefficients (r) and heritability in narrow sense (h^2_{ns}) were calculated for each of the character between F_2-F_3 generation. In each case the progeny means ($\bar{x}$) of F_3 generation were regressed on the individual plants (y) of the F_2 generation following the pedigree of plant to progeny rows.

$$\text{Intergeneration correlation (r)} = b_{yx} \times \frac{\sigma_x}{\sigma_y}$$

Where,

$$b_{yx} = \frac{\text{Covariance of xy}}{\text{Variance of x}}$$

σ_x = Standard deviation of x (offspring)

σ_y = Standard deviation of y (parent)

The heritability values in narrow sense were calculated as per the following formula given by Smith and Kinmann[10].

Narrow sense heritability h^2_{ns} (F_2-F_3) = 2/3 b_{yx}

$$\text{Where as, } b_{yx} = \frac{\text{Covariance of xy}}{\text{Variance of x}}$$

RESULTS AND DISCUSSION

The intergeneration correlation and heritability estimates for twelve agronomic characters in two crosses are presented in Table 1. Inter-generation correlation between F_2 and F_3 generation was calculated by regressing the progeny means of F_3 generation on the individual plants of the F_2 generation from which they are derived. Significant and positive inter-generation correlation (r) was observed for all the parameters in both the crosses except for plant height and days to fifty per cent flowering. It was highest for number of productive tillers per hill (0.658), followed by panicle length (0.651), number of tillers per hill (0.536), straw yield per plant (0.511) and test weight (0.511) in cross I, where as in cross II high correlation values were observed for panicle length (0.719) followed by number of tillers per hill (0.695), grains per panicle (0.685), per cent fertility (0.585) and number of productive tillers per hill (0.559). This is indicative of strong association for these traits between F_2 and $F_{2:3}$ generation. Similar findings were previously reported in rice by *Kanbar et al.*[11] for number of tillers per hill and productive tillers per hill and *Govintharaj et al.*[12] for productive tillers per hill and panicle length.

Moderate correlation values were recorded for grains per panicle, harvest index and length to breadth ratio in cross I, while in cross II characters test weight, length to breadth ratio, harvest index and straw yield per plant exhibited moderate correlation values. Inter-generation correlation was non significant and low for grain yield per plant in both the crosses. Hence, selection for grain yield has little significance in early generations when the genetic differences are masked by high genotype X environment interaction. Earlier, Virupakshappa[13], Gupta *et al.*[14], Rahman and Bahl[15], Arunachalam[16] and Padi and Ehlers[17], also reported that selection for grain yield in F_2 has little significance.

In case of days to fifty per cent flowering and plant height, poor inter-generation associations were observed, which was non significant and positive in cross I and non significant and negative in cross II, suggesting that selection in F_2 was not effective for these characters. Poor and negative association for these characters was in agreement with the findings of Kanbar *et al.*[11] in rice. Low values may be attributed to genotype X environment interaction as days to fifty per cent flowering and plant height are very sensitive to the climatic conditions like temperature, light and water deficit.

Narrow sense heritability estimates helps to understand the nature of inheritance of a trait from generation to generation. Higher estimate of narrow sense heritability was reported for number of tillers per hill, number of productive tillers per hill, panicle length, grains per panicle and test weight in both the crosses. Since narrow sense heritability is an indicative of additive genetic variance which is heritable and hence, selection for these traits will be effective in early generations. For characters like days to fifty per cent flowering, plant height and grain yield per plant in both the crosses, per cent fertility in cross I and harvest index and straw yield per plant in cross II, narrow sense heritability was low, suggesting that genetic differences are masked by genotype X interaction. Therefore, these characters cannot be improved through direct selection.

Table 1: Inter-generation correlation coefficients (r) and narrow sense heritability (h^2) between F_2 and F_3 generations for yield and yield components in the two crosses of rice

Characters	Cross I (BI 43 X IRRI 49)		Cross II (BI 43 X IRRI 49)	
	Cross I (n = 135)		Cross II (n = 130)	
	r	$h^2_{(ns)}$	r	$h^2_{(ns)}$
DFF	0.177	9.87	- 0.139	4.400
PHT	0.152	4.20	- 0.110	6.333
NOT	0.536**	44.07	0.695**	48.86
NPT	0.658**	34.80	0.559**	32.06
PL	0.651**	34.47	0.719**	42.66
G/P	0.443**	31.20	0.685**	42.46
% F	0.271**	15.07	0.585**	34.53
T. Wt	0.511**	28.93	0.482**	30.53
L/B ratio	0.414**	20.30	0.471**	23.90
HI	0.425**	20.27	0.424**	13.00
SY/P	0.511**	24.13	0.359**	11.06
GY/P	0.167	9.80	0.139	16.86

DFF = Days to fifty per cent flowering; PHT = Plant height (cm); NOT = Number of tillers per hill; NPT = productive tillers per hill; PL = Panicle length (cm); G/P = Grains per panicle; %F= Per cent fertility; T. Wt = Test weight (g); L/B ratio = Length to breadth ratio; HI = Harvest Index; SY/P = Straw yield per plant (g); GY/P = Grain yield per plant (g).
n= number of lines advanced from F_2 to F_3

CONCLUSION

Inter-generation correlation and heritability values were higher in case of number of tillers per hill, number of panicles per hill, grains per panicle and test weight between F_2 and F_3 in both the crosses. Whereas, non significant correlation and low values of heritability were observed for grain yield, days to fifty per cent flowering and plant height. Therefore in early segregating generations like F_2, selection for component traits can be more fruitful than direct selection on grain yield per se.

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