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EFFECTIVENESS OF DIFFERENT SELECTION METHODS IN SEGREGATING POPULATION OF RICE (*O. SATIVA* L.) IN ARC 10372 x IR 36 IN DIFFERENT ENVIRONMENTS

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ABSTRACT

Effectiveness of different selection methods (pedigree, bulk and SSD) in segregating population of rice cross ARC 10372 x IR 36 were worked out under different environments, viz. selected and tested in irrigated conditions, selected in upland and tested in irrigated conditions, selected in irrigated and tested in upland conditions and selected and tested in upland conditions. Substantial variability for yield and its components in F_2 gradually declined with the increase of mean values in subsequent generations of selection from F_2 base population and varied from method to method and selection in different environments. Heritability values gradually increased with the advancement of generation. Whenever heritability was high in the early generations, it continues to remain high even after subsequent cycles of selection. Bulk and SSD methods were superior in retaining and maintaining the high yielding lines in comparison to pedigree method of breeding. However, genotype x environment x method interaction had much bearing in changing the expression of yield and its components.

Key words: Breeding methods, pedigree, bulk, SSD, selection response, heritability, upland rice.

In segregating generation of rice, breeders tried to evaluate the genotypes suitable for upland (direct seeded) or transplanted (irrigated) conditions by either pedigree or bulk methods of breeding [1]. However, the information on effectiveness of different selection methods in segregating population of rice under different environments is lacking. Hence, present investigation was aimed to find out the practical utility of different breeding methods for the genetic improvement of rice. The study would, therefore, envisage the development of selection theory in relation to suitability of growing and testing environments of the selected populations derived through single cross.

MATERIALS AND METHODS

The two divergent rice varieties ARC 10372 (tall, early maturing, drought tolerant, fine grain and pigmented leaf) and IR 36 (dwarf, medium maturing, fine grain and drought recovery) were crossed. The segregating populations were advanced as described below.

The F_2 population was divided into two groups, e.g. (i) irrigated (transplanting) and (ii) upland (direct sowing). One thousand F_2 seeds were space planted in the field in both the environments at Agriculture College, Rewa, in kharif 1989. Based on the method of selection, the population has been broadly classified as pedigree selection, random bulk and single seed descent (SSD). The F_3 generation was advanced at CRRI, Cuttack in the year 1990 (off season).

Pedigree selection. Twenty five phenotypically superior plants (2.5% selection intensity) in F_2 were selected on visual basis in both the environments, viz. irrigated and upland. Observations were recorded on selected plants on yield and its components. Selected plants were planted as families in F_3 generation comprising 25 lines of 5 m length. Selections were made in both between and within families. Finally, 25 plants were selected on the basis of their yield and its components from the entire families in both the environments.

Random selection. Number of plants equal to pedigree selection method were selected at random to synthesise the random bulk from F_2 in both the environments. Selected plants were then bulked for further testing. Similar procedure was practiced in F_3 and 25 single plants were used to produce the bulk for testing in F_4 in both the environments.

Single seed descent. One seed per plant in F_2 was taken and bulked in both the environments. In F_3, the bulk seeds were planted and single seed per plant was taken and bulked in both the environments for further testing of F_4 generation.

Testing F_4 generation. Twenty five rows of 25 pedigree selected plants and 10 rows of bulks from random bulk and SSD from both the environments in F_4 generation along with parents, F_1, F_2 and F_3 were grown under irrigated and upland conditions in randomized complete block design with three replications during kharif 1990 at Agriculture College, Rewa. All the genotypes were tested in 4 sets of environments, viz. selected and tested in irrigated conditions, selected in upland tested in irrigated conditions, selected in irrigated and tested in upland conditions and selected and tested in upland conditions. The observations were recorded on five plant in each pedigree lines and on 10 plants in each bulk population in each replication. Genetical parameters of mean, GCV, heritability, expected response (GA as % of mean) and realised response (difference between the mean of base population and selected population) were worked out [2, 3].

RESULTS AND DISCUSSION

The estimates of yield and yield related components of cross ARC 10372 x IR 36 under different selection schemes showed increase in mean grain yield than F_2 in random bulk and SSD methods of breeding in the environments selected in irrigated and tested in upland conditions and selected and tested in upland conditions (Table 1). Yield contributing characters also exhibited higher mean values than F_2 in random bulk and SSD methods in above environments. GCV was high for yield and its components as compared to F_2 in pedigree method in the environments, viz. selected and tested in irrigated as well as selected in upland and tested in irrigated conditions. The mean and GCV of the F_2 base population and F_4 population selected through various selection scheme grown under different environments indicated substantial variability for yield and its components among material derived from hybridization programme. It is also observed that bulk and SSD exhibited high mean values coupled with low GCV; whereas pedigree method showed low mean values with high GCV in different environments of F_4 generation. It indicated that variability gradually declined with the increase of mean values due to subsequent generation of selection from the base population. However, the decrease in variability varied from method to method due to selection in different environments [4, 5].

High heritability was observed in F_2 for yield and its components except tillers/plant and harvest index, in upland condition. In F_3 and F_4 generations heritability was high in bulk and SSD methods for grain yield in upland condition irrespective of whether the selection was done in irrigated or upland condition. The heritability was also high for all the yield characters in all the environments in bulk and SSD methods (Table 1). The estimates of heritability for various characters in different selection schemes indicated that heritability gradually increased with the advancement of generation. Whether the heritability was high in the early generations, this continued to remain high in subsequent generation of selections. It would be conjectured the presence of additive component of genetic variance cannot be overruled because in most of the characters high heritability was observed. This is indicative of additive gene action. The presence of such gene action helps to retain the transgressive ability among selected genotypes in different environments. However, the genotype x environment x method interaction has much bearing in changing the expression of yield and its components in different situations [6–8].

Expected response of selection for grain yield in F_4 was higher than in F_2 in random bulk and SSD methods for breeding in irrigated and upland condition; while it was high for pedigree selection from and tested in upland conditions. High expected response was also observed for tillers/plant, grains/panicle and harvest index by bulk and SSD methods of breeding in different environments. However, grains/panicle and panicle weight exhibited high expected response in pedigree method in different environments (Table 1). Positive

Table 1. Genetic parameters of yield and its component characters in F_2, F_3 and F_4 of cross ARC 10372 x IR 36 under different selection schemes in 4 environments in rice

Generation	Breeding method	Environment	Grain yield					Tillers/plant					
			mean (g)	GCV	h^2	selection exp.	response obs.	mean	GCV	h^2	selection exp.	response obs.	mean
F_2		I	15.1	10.7	90.4	28.7	—	8.6	13.4	70.9	37.9	—	137.8
		II	20.0	54.4	98.0	127.2	—	11.8	6.0	42.7	19.9	—	124.0
F_3	Pedigree	I	10.0	11.5	31.5	13.3	-5.1	7.6	6.5	35.6	8.0	-0.9	108.4
		II	13.5	21.9	77.6	39.8	-1.7	8.6	13.5	68.8	23.1	0.0	112.5
		III	12.9	27.9	58.9	44.1	-7.1	10.9	19.3	74.6	34.4	-0.9	132.8
		IV	11.1	11.1	20.5	10.4	-8.9	8.9	8.2	35.8	10.2	-2.9	109.8
	Bulk	I	11.6	0.0	0.0	0.0	-3.5	7.9	7.7	49.6	21.8	-0.7	119.4
		II	13.7	0.0	0.0	0.0	-1.4	8.9	14.4	74.3	40.5	0.4	114.1
		III	16.4	0.0	0.0	0.0	-3.6	11.1	24.4	81.3	70.4	-0.7	107.2
		IV	22.7	28.2	95.1	70.2	2.7	14.1	30.5	89.6	81.9	2.3	116.0
	SSD	I	17.1	0.0	0.0	0.0	1.9	8.7	15.2	75.2	42.7	0.1	119.4
		II	11.4	0.1	1.0	0.1	-3.7	9.6	6.6	51.0	18.7	1.1	110.0
		III	16.8	18.4	86.2	50.9	-3.2	14.8	22.7	85.5	63.3	3.0	122.7
		IV	26.1	37.1	97.5	87.8	6.0	15.3	24.2	87.3	66.6	3.5	119.6
F_4	Pedigree	I	10.0	18.4	68.4	31.2	0.0	7.5	10.3	62.0	16.7	-0.1	96.1
		II	10.4	17.0	72.9	29.9	-3.0	8.2	10.6	61.0	17.0	-0.3	94.0
		III	14.8	22.2	48.8	31.9	1.9	10.8	15.2	51.8	22.5	-0.1	105.0
		IV	15.5	33.2	76.7	60.0	4.3	11.5	16.0	58.1	25.1	2.6	108.6
	Bulk	I	11.2	3.4	56.3	11.3	-0.4	7.8	13.5	68.5	38.4	-0.1	138.3
		II	13.2	8.3	83.9	23.7	-0.5	8.1	7.6	50.1	21.5	-0.8	107.2
		III	22.8	25.4	94.3	64.0	6.5	15.0	31.8	91.0	84.2	3.9	130.3
		IV	19.3	11.3	78.9	32.8	-3.4	15.0	23.4	86.4	64.8	0.9	121.7
	SSD	I	10.2	6.0	70.2	18.7	-6.8	7.9	12.7	66.9	36.2	-0.8	106.6
		II	13.7	10.0	88.0	27.6	2.2	8.4	15.5	74.4	43.4	-1.3	109.3
		III	16.0	78.0	98.4	179.7	-0.8	12.5	13.7	69.7	66.0	-2.2	130.1
		IV	17.1	0.0	0.0	0.0	-8.9	12.8	16.4	75.1	49.0	-2.5	155.7

(Contd.)

Table 1 (contd.)

Generation	Breeding method	Environment	Grains/panicle				Panicle weight					Harvest index				
			GCV	h^2	selection exp.	response obs.	mean	GCV	h^2	selection exp.	response obs.	mean	GCV	h^2	selection exp.	response obs.
F_2		I	6.9	77.9	18.9	—	18.1	9.3	94.3	23.8	—	47.8	5.8	96.1	15.0	
		II	15.3	96.2	37.6	—	22.8	49.5	94.8	121.5	—	40.1	8.2	52.7	27.0	
F_3	Pedigree	I	11.6	42.4	15.5	-29.4	12.0	8.4	21.5	8.0	-6.0	45.9	7.3	50.2	10.9	-1.9
		II	11.5	48.2	16.5	-25.2	16.6	21.0	84.4	39.8	-1.4	48.8	6.3	35.3	8.2	1.0
		III	21.6	61.2	34.8	8.8	16.2	24.5	55.6	37.7	-6.6	38.5	7.4	25.2	7.8	-1.6
		IV	9.1	27.3	9.8	-14.2	14.5	8.8	11.9	6.3	-8.3	40.7	5.0	33.7	4.9	0.6
	Bulk	I	6.0	69.8	16.8	-18.4	13.9	0.0	0.0	0.0	-4.2	42.6	13.5	98.8	31.6	-5.2
		II	8.2	77.2	22.5	-23.7	15.7	0.0	0.0	0.0	-2.4	45.9	0.7	50.0	2.6	-1.9
		III	15.4	95.2	38.4	-16.8	19.3	0.0	0.0	0.0	-3.5	43.6	0.0	0.0	0.0	3.0
		IV	15.5	95.9	38.3	-8.0	27.3	25.5	89.3	66.6	4.5	45.5	0.0	0.0	0.0	5.4
	SSD	I	14.4	89.8	37.2	-18.4	20.2	0.0	0.0	0.0	2.1	52.1	0.0	0.0	0.0	4.3
		II	4.1	53.9	11.4	-27.8	13.8	0.0	0.0	0.0	-4.2	43.5	7.0	96.7	17.8	-4.3
		III	15.4	96.2	37.8	-1.3	20.7	10.3	59.0	29.6	-2.1	40.0	4.1	32.2	13.8	-0.1
		IV	9.0	91.0	23.9	-4.4	30.5	34.1	94.1	84.7	7.7	48.0	0.0	0.0	0.0	7.9
F_4	Pedigree	I	14.5	65.3	24.1	-12.3	11.7	17.3	65.7	29.0	-0.3	45.5	9.5	68.3	15.4	-0.4
		II	17.0	89.6	33.2	-18.5	12.3	17.3	75.1	30.9	-4.3	46.0	8.1	43.5	10.9	-2.8
		III	18.1	69.8	31.2	-27.8	17.8	21.7	44.4	29.7	1.6	41.9	8.9	34.5	11.9	3.4
		IV	13.2	73.3	23.3	-1.2	18.4	31.0	76.7	56.0	3.9	44.3	12.0	41.3	15.8	3.6
	Bulk	I	13.3	90.7	34.0	18.9	13.6	8.2	89.8	22.4	-0.2	43.5	10.4	98.3	25.1	0.9
		II	8.9	78.0	24.4	-6.9	15.2	7.5	90.1	20.4	-0.4	45.7	9.9	98.2	23.8	-0.2
		III	11.6	94.6	29.4	23.1	27.4	21.8	86.8	58.1	8.1	42.5	0.0	0.0	0.0	-1.1
		IV	7.4	88.5	20.2	5.7	23.4	5.8	42.5	15.9	-3.8	43.7	0.0	0.0	0.0	-1.8
	SSD	I	6.9	70.6	19.3	-13.0	12.4	4.8	78.0	14.5	-7.7	43.1	3.9	91.7	11.1	-9.0
		II	9.3	79.6	25.4	-0.6	16.2	10.1	94.0	25.9	2.3	46.3	3.6	91.7	10.2	2.9
		III	11.1	94.2	28.3	7.3	17.0	0.0	0.0	0.0	-3.7	61.7	185.8	91.7	403.8	21.7
		IV	14.4	97.1	34.7	36.1	21.8	0.0	0.0	0.0	-8.7	42.8	0.0	0.0	0.0	-5.2

and high realised response of selection was observed for grain yield in F_4 generation with bulk method, followed by pedigree and SSD methods in different environments. High realised selection response was noted for tillers/plant and grains/panicle in bulk and SSD methods of breeding (Table 1). This indicates superiority of random bulk [5, 9, 10] and SSD [4, 10–12] methods of breeding in retaining the high yielding lines in comparison to pedigree method. It could be attributed to high degree of dominance gene effects and dominance x dominance interactions in the expression of yield and its components [13, 14]. However, there was no match between the expected and realised responses, which may be due to genotype x environment x method interaction. As regards the choice of an appropriate environment for growing segregating population, upland condition proved to be best to obtain high yielding lines for upland condition. Similarly, for the development of lines suitable for irrigated condition, selection in the segregating material should be carried out under irrigated condition [15, 16].

Thus, the present findings confirm the superiority of random bulk and SSD methods in retaining and maintaining the lines with high yielding potential as compared to pedigree method of breeding.

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