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Selection of High Yielding Rice Variety from a Cold Tolerant Three-Way Rice (*Oryza sativa* L.) Cross Involving *Indica, japonica* and Wide Compatible Variety

Sujoita Purohit and M.K. Majumder

Department of Genetics and Plant Breeding,
University College of Agriculture, University of Calcutta, Kolkata, India

Abstract: With a view to inducing high yielding characteristic of desirable rice strain suitable for boro culture in eastern India,selection of early heading indica genetic background from cold tolerant rice varieties seems to be reasonable approach. A three way rice cross namely, (Barkat X Dular) X IR-36 was made in boro season of 1999-2000.Ten selections have been made by employing discriminant function technique involving grain yield and other component traits like plant height,number of effective tillers, number of grains per panicle and hundred grain weight.

Key words: Three way rice cross · Cold tolerant · Discriminant function technique · High yield rice

INTRODUCTION

Early heading coupled with high yielding potentiality is a desired objective in rice breeding program for *boro* culture in Eastern India. Spikelet number per panicle is a major target trait for improving rice [*Oryza sativa*(L.)] yield [1]. Development of new plant types (NPTs) and hybrids are two major approaches for improving the yield potential of irrigated rice [*Oryza sativa*(L.)]. [2]. The cultivated rice [*Oryza sativa* (L.)] has two subspecies, *indica* and *japonica*. The *japonica* rice germplasm has a narrower genetic diversity compared to the *indica* subspecies. Rice breeders aim to develop new varieties with a higher yield potential, with enhanced resistances to biotic and abiotic stressesandimproved adaptation to environmental changes. Interesting traits such as low-temperature toleranceandwider climate adaptation could be introgressed into the *indica* subspecies. [3]. *Japonica* rice varieties have a higher level of tolerance to low temperature stress as compared to that of *indica* rice varieties particularly at the early growth phases [4].

Wide-compatibility varieties (WCVs) are a special class of rice germplasm that is able to produce fertile hybrids when crossed to both *indica* and *japonica* rice varieties. WCVs may differ greatly in their spectrum and level of compatibility. 'Dular', a landrace variety from India has demonstrated a high level of wide-compatibility in previous studies with a broad range of indica and japonica varieties. [5].The discovery of wide-compatibility varieties (WCVs) that are able to produce normal fertility hybrids when crossed both to indica and japonica rice has enabled the fertility barrier between indica and japonica subspecies to be broken and provided the possibility of developing inter-subspecific hybrids in rice breeding programs [6]However, the major problem in utilizing the *japonica* source of tolerance for developing improve cold tolerant *indica* rice cultivars is the high spikelet sterility in F_1 and succeeding generations . Although, the degree and the frequency of the partial sterility are overwhelming, rice breeding by means of wide crosses has been attempted and were successful in some cases [7-9].

With these background one three way rice cross(Barkat x Dular) x IR-36 was made in *boro* season of 1999-2000 involving *japonica* strain (Barkat); a high yielding *indica* strain (IR-36); and one *indica* wide compatible variety (WCV).

Ten desirable selections of the fourth generation isolated from the aforementioned cross have been evaluated employing appropriate biometrical techniques.

MATERIALS AND METHODS

The present investigation was carried out at the Agricultural Experimental Farm of Calcutta University at Baruipur, South 24-Parganas, West Bengal during *boro* season of 2001-2002 as well as in Department of Genetics and Plant Breeding, Department College of Agriculture, Calcutta University .

Corresponding Author: Sujoita Purohit, Department of Genetics and Plant Breeding,
University College of Agriculture, University of Calcutta, Kolkata, India

Table 1: Relevant particulars of the parent and cross

Genotypes	Parents Characteristic features	Ecogeographic type
IR-36	Short statured, high yielding and susceptible to low temperature stress	*Indica*
Barkat	Medium tall, tolerance to low temperature stress	*Japonica* (derived from *indica x japonica* crosses)
Dular	Tall,susceptible to low temperature stress, considered as wide compatible varieties (W.C.V.s)	*indica*(Aus)
Cross	(Barkat x Dular) x IR-36	

The fourth generation populations of ten desirable elites of a three way cross viz, (Barkat x Dular) x IR-36 was employed for the present investigation along with its respective parents (Table 1). A single cross viz., (Barkat x Dular) was made in *kharif* season of 1999. F_1 population from this single cross was grown and crossed with the third parent IR-36 in *boro* season of 1999-2000 to develop a three way cross . First generation population from this three-way cross was grown in *kharif* season of 2000. The second generation population of a three way cross was raised in *boro* season of 2000-2001 whereas the third generation was grown in *kharif* season of 2001 on which the present investigation was carried out.

The population of the three-way cross along with its parents was grown as a *boro* crop in a randomized block design with three replications. The cross in each replication was represented by four rows, consisting of ten plants in each row . Seeds derived from the third generation of the aforesaid cross was carefully collected in *kharif* 2001 . A representative sample of 300 seeds of each cross was used to raise the respective population of fourth generation in *boro* season 2001-2002 . The seeds of the cross along with parents were sown on December 14th, 2001 and seedlings were transplanted on January 31st, 2002 in lines with a single plant per hill. The seedlings were planted keeping a distance of 20x15 cm. All the cultural and field operations like irrigation weeding, basal and top dressing, were carried out according to the usuals practices followed in improved method of paddy cultivation.

RESULTS AND DISCUSSION

Among the yield attributes, the most important contributing characters in rice that are taken into consideration for drawing up an indication of grain yielding potentialities are number of effective tillers, number of grains per panicle and weight of 100 grains [10]. As IR-36 has been involved as a third parent in aforementioned a three-way cross and its plant stature is conducive to higher yielding potentiality this character was also taken into consideration for evaluating the different selections of the cross. Thus, grain yield and four component traits viz, plant height, number of effective tillers, number of grains per panicle and weight of 100 grains constitute the core group of characters for evaluating yielding ability of the segregates of the cross.

Mean performances of the selection along with the parent of the three-way cross with regard to five traits related to yielding ability, namely plant height number of effective tillers, number of grains per panicle,weight of hundred grains and grain yield per plant are presented in (Table 2). It is evident from this table that the selection as well as the parent exhibited significant differences among themselves in respect all these characters under study. A considerable variation was also observed with regard to co-efficient of variability . In the aforementioned cross, grain yield per plant exhibited the highest value, while the lowest value was recorded for plant height. High values were recorded for number of effective tillers and grains per panicle whereas lower values were found for 100 grain weight.

For isolation of promising selection from experimental materials, selection index was constructed employing discriminant function technique [9] involving grain yield and other four component traits. Respective variances and covariances were used for such construction (Table 3).

Assuming the selection efficiency for grain yield as hundred as 100 at 5% selection intensity, the results of the different selection indices (Table 4) revealed that selections were based on yield alone, the efficiency of selection of two or more traits . Among combinations involving grain yield and one component trait, maximum relative efficiency was observed in an index involving grain yield and number of effective tillers whereas the lowest relative efficiency was observed in combinations of grain yield and plant height.

Table 2: The mean performance of ten promising selections for five traits related to yielding ability in fourth generation of the cross

Crosses and parents	Plant height	No. of effective tillers	No.of grains / panicle	100 grain weight	Grain Yield /plant
S1	90	9	96.33	2.30	15.43
S2	97.67	12	92	2.73	27.2
S3	77.17	13.67	105.67	2.73	44.1
S4	78.17	17	118	2.73	47.67
S5	85.83	16	60.33	2.83	45.83
S6	84.167	13	59	2.80	11
S7	78.17	17.33	73	3.13	48.67
S8	78	18	42	3.13	13.83
S9	91.4	13	35.33	2.80	13.17
S10	78.83	19	58.67	2.63	40.4
Barkat	75.33	12.00	39.00	2.84	16.12
Dular	124.5	9	93	2.25	21.55
IR-36	73	14	96	2.15	30.4
Mean	85.56	14.08	74.4867	2.6962	28.874
CV	8.50145	21.34	37.4786	8.54878	52.4589
L.S.D 5%	3.06	2.463	3.181	0.367	2.98726

Table 3: Estimate of phenotypic, Genotypic and Error variances and covariances

A. Estimate of phenotypic variance and covariance for different character					
Characters	Plant height	No of effective tillers	No. of grain / panicle	100 grain weight	Grains yield / plant
Plant height	152.778	-48.418	-43.223	-2.033	-162.987
Number of effective tillers		(29.940)	-69.385	1.422	79.316
No. of grain / panicle			(2309.51)	-8.768	635.522
100 grain weight				(0.171)	1.7005
Grains yield / plant					(779.547)
B. Genotypic variances and covariances					
Plant height	(49.86)	-16.096	-14.382296	-0.70385	-54.5463
Number of effective tillers		(9.29233)	-23.35735	0.46346	26.0051
No. of grain / panicle			(768.69)	-2.93075	211.80091
100 grain weight				(0.0416)	0.5473
Grains yield / plant					(258.8382)
C. Error variances and covariances					
Plant height	(3.198)	-0.1289	-0.07611	0.07859	0.65216
Number of effective tillers		(2.063)	0.68705	0.0316	1.3007
No. of grain / panicle			(3.44)	0.02426	0.11927
100 grain weight				(0.046)	0.0586
Grains yield / plant					(3.0324)

Table 4: Expected genetic advance in grain yield and relative effectivity from the use of different indices in fourth generation of three-way crosses in rice

SL no.	Selection Index	Genetic Advance	Relative efficiency %
1.	Grain yield	19.0963	100.00
2.	Grain yield, Plant height	19.0537	99.77
3.	Grain yield, Number of effective tillers	19.0993	100.0158
4.	Grain yield, Number of grains / panicle	19.0978	100.0079
5.	Grain yield 100 grain weight,	19.0987	100.0126
6.	Grain yield, plant height, Number of effective tillers, Number of grains/ panicle 100 grain weight	19.0990	100.01451

Table: 5 Selection score values in fourth generation of three-way crosses along with parents for yielding ability in rice

Sl No.	Selection	Mean of characters x weigth Yield + Number of effective tillers	Selection score
1	S7	(48.67 x 0.3372) +(17.33x-0.0578)	15.40985
2	S4	(47.67 x 0.3372) +(17.00 x-0.0578)	15.091724
3	S5	(45.83 x 0.3372) +(16.00 x-0.057)	14.529076
4	S3	(44.1 x 0.3372) + (13.67 x-0.0578)	14.080394
5	S10	(40.4 x0.3372) + (19.00 x-0.0578)	12.52468
6	S2	(27.42 x 0.3372) + (12.00 x-0.0578)	8.552424
7	S1	(15.43 x0.3372) + (9.00x-0.0578)	4.4682796
8	S9	(13.17 x 0.3372) + (13.00 x-0.0578)	3.689524
9	S8	(13.83 x 0.3372) + (18.00 x-0.0578)	3.623076
10	S6	(11.00 x 0.3372) + (13.00 x-0.0578)	2.9578

Based on this best selection index, the selections score for different selections have also been evaluated (Table 5). Results revealed that, the highest score value was attained by selections, S7 followed by S4,S5,S3,S10,S2,S1,S9,S8 and S6.

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