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Pattern of Segregation and Performance of Selected F_5 Individuals of some Crosses in Rice (*Oryza sativa* L.)

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A B S T R A C T

Pattern of segregation and performance of selected F_5 individuals were studied in 21 different F_5 families which were derived from eight crosses in rice. Pattern of segregations in different F_5 populations revealed moderate to wide range of genetic variation with respect to grain yield and yield components as well as other quantitative characters. In the cross KS × IE2, recombinants with semi-dwarf plant height with greater panicle length, good percentage of filled grain, higher secondary branches and yield were selected where the semi dwarf plant height was inherited from IET 14142 genotype which was a true breeding mutant having short plant height. In the cross SNT × KS, segregants with long slender and bold grains, semi-dwarf to tall plant heights and sturdy culm were obtained. In the cross SNT × IE2, the long slender grain found in most of the recombinants is one of the important characteristics of Shantibhog and the semi-dwarf height of segregants was contributed by the true breeding mutant of Tulaipanji, IET 141. In the cross STB × IE3, three segregants from each of the two families and one from another family were selected as they showed considerable variation for plant height, grain number as well as yield. In the cross IE2 × SS, recombinants with good grain yield, medium grain number with intermediate grain dimensions were found. Awns with variable expressivity was noticed under field condition which was contributed by the IET14142 parent.

Introduction

Rice (*Oryza sativa* L.) is one of the most important cereal crops belonging to the tribe oryzae of the family Gramineae (Poaceae). The cultivated rice is diploid having 24 chromosomes (2n = 2x = 24). It ranks first among the three major cereals, followed by wheat and maize. *O. sativa* and *O. glaberrima* are believed to have evolved independently from a common ancestor *O. perennis*. In 2016, The global production of rice has been estimated to be at the 741 million tonnes, led by China and India with a combined 50% of the total.Rice provides 21% of global human per capita energy and 15% of per capita protein. In developing countries, rice accounts for 715 kcal/capita/day, 27 per cent of dietary energy supply, 20 per cent of dietary protein and 3 per cent of dietary fibre.In any plant breeding programme, availability of large genetic variability in the crop species is the first step to select better performing types among the divergent group.

If significant amount of variation is present among the genotypes, attempts can be made to improve the trait of interest in selecting the desirable ones. First attempts are made to utilize the variability present in the germplasm pool and when maximum utilization causes exhaustion of such variability, additional variability can be generated be means of conventional and non-conventional innovative approaches.

Materials and Methods

The field experiments were conducted at the Agricultural Farm, Institute of Agriculture, Visva-Bharati, Sriniketan, which islocated at sub-humid lateritic belt.The present investigation was carried out with 21 different F_5 families derived from eight different cross combinations during warm wet (*kharif*) season (July-December) in 2018. The seven parents involved in the 21 different families were Dudheswar (DS), Shantibhog (SNT), Shitabhog (STB), Kerala sundari (KS), IET14142 (IE2), IET14143 (IE3) and Subhasita (SS). Thirty-day old single seedling per hill was transplanted in randomized complete block design (RCBD) with three replications.

Each plot consists of 5 rows each with 20 plants with a spacing of 20 cm × 15 cm spacing. Observations were recorded on following twelve different quantitative characters *viz.* plant height, days to flowering, flag leaf area, panicle exertion, panicle length, panicle number, primary branches panicle^{-1}, secondary branches panicle^{-1}, grain number panicle^{-1}, 100-grain weight, straw yield and grain yield plant^{-1}.

Results and Discussion

Pattern of segregations in different F_5 populations revealed moderate to wide range of genetic variation with respect to grain yield and yield components as well as other quantitative characters. Several segregants (Table.1) were selected mainly on the basis on superior grain dimensions combined with short stature, sturdy stem, large number of filled grains, effective tiller and grain yield. Semi-tall and moderate yielding segregants were also selected due to their better grain dimensions, heavy panicle and sturdy stem.

The magnitude of recombination potential depends mainly on the extent of genetic diversity of the parents. A population with high mean coupled with high variability is said to be superior. In the cross KS × IE2, recombinants with semi-dwarf plant height with greater panicle length, good percentage of filled grain, higher secondary branches and yield were selected. Recombinants with greater plant height were also selected in one family based upon high percentage of fertile grains and 100-grain weight. Some segregants with very low plant height (100cm) were also selected on the basis of the grain characteristics. Four segregants from one family and three segregants from another family of the cross KS × IE2 were selected and one family was rejected due to short grain size, low percentage of fertile grains and shorter panicle length. Awn was present in most of the segregants which was the characteristic features of both the parents Kerala Sundari and IET 14142.

In the cross SNT × KS, segregants with long slender and bold grains, semi-dwarf to tall plant heights and sturdy culm were obtained.

The segregants with greater number of filled grain and improved spikelet fertility were found. Test weight was good. Segregants were also good yielder. Incidence of major diseases like blast, leaf spot and BLB were very low. Total ten plants were selected based on secondary branches panicle^{-1}, panicle length, percentage of fertile grain and 100-grain weight which included two semi-dwarf segregants. The long bold grain and sturdy stem of the selects are the characteristic features of the female parent Shantibhog.

In the cross SNT × IE2, recombinants with good grain dimensions like long slender and bold grains were selected. Considerable variability was found for grain characteristics. Segregants with slender grains with short to medium plant height were selected. Recombinants were having very good percentage of filled grains and were good yielder. Twelve recombinants from all the three families were selected which were uniform with respect to panicle length while considerable variation was present for most of the valuable traits.

One of the segregant with the filled grain number of up to 165, 87% of spikelet fertility and 100-grain weight of 2.5g was selected for the next generation. Low to moderate infestation of stem borer was found among the segregants. The long slender grain found in most of the recombinants is one of the important characteristics of Shantibhog and the semi-dwarf height of segregants was contributed by the true breeding mutant of Tulaipanji, IET 14142.

In the cross STB × IE3, three segregants from each of the two families and one from another family were selected as they showed considerable variation for plant height, grain number as well as yield. In one family, STB × IE3(2), semi-dwarf plants with cluster type panicles with greater number of filled grain, better spikelet fertility and moderate grain yield were selected. In the family STB × IE3(3), high infestation of gundhi bug, stem borer and high percentage of chaffy grains were observed in the field condition. As a result, a single individual was selected based upon its short plant stature.

In the cross IE2 × SS, recombinants with good grain yield, medium grain number with intermediate grain dimensions were found. Some plants were found to be very sturdy and short height, which were selected. Short height plants resembling the features of IET 14142 were obtained. Awns with variable expressivity was noticed under field condition which was contributed by the IET14142 parent. In the family IE2 × SS (1) considerable infestation of false smut was noticed. The plants in this cross were infested by stem borer and gundhi bug to a considerable degree which accounted for the restricted number of selected individuals of this cross.

In the cross KS × IE3, nine recombinants with uniform panicle length, number of primary branches, percentage of filled grain and 100-grain weight were selected. Some segregant showed considerable variation in grain dimensions and plant height Grain number and 100-grain weight among the segregants were intermediate. Some individual segregants were good yielder. Reduced height is contributed by the parent IET14143. The recombinants having the desirable parental traits were selected for the next generation. Major diseases like blast, leaf spot and BLB were found in very lower intensity.

In the cross IE2 × DS, a single plant with semi-dwarf plant height, higher panicle number and good yield was selected.

Table.1 Mean performance of some promising selected plants in F_5 families of rice

Selected individuals	plant height(cm)	Flag leaf length(cm)	Flag leaf width(cm)	Flag leaf area(cm^2)	panicle length(cm)	Panicle number	Number of primary branches	Number of secondary branches	Spikelet fertility (%)	spikelet number	grain number	Test weight(g)	grain yield(g)
IE2× DS	132.50	18.50	1.40	18.13	24.50	16.00	14.00	58.00	60.32	247.00	149.00	2.16	54.38
KS × IE2	134.50	23.50	1.50	24.68	27.50	23.00	12.33	24.66	79.41	158.66	126.00	1.96	53.35
B	144.50	44.00	1.50	46.20	31.00	7.00	13.00	62.33	84.20	296.88	250.00	2.33	40.23
C	125.50	28.00	1.40	27.44	24.00	6.00	11.66	47.33	79.62	162.00	129.00	1.79	12.52
D	127.00	26.50	1.00	18.55	25.00	13.00	13.00	14.66	74.93	114.33	85.67	1.72	21.27
KS ×	140.00	29.00	1.50	30.45	27.50	8.00	14.00	32.66	87.58	198.33	173.67	1.63	22.07
B	117.50	25.00	1.90	33.25	22.50	14.00	13.00	22.33	88.85	110.66	98.33	1.82	29.18
C	100.00	31.00	1.10	23.87	24.50	7.00	10.33	26.33	76.92	104.00	80.00	1.5	5.18
D	116.00	29.00	1.80	36.54	25.50	10.00	11.33	34.66	79.23	139.66	110.66	1.62	19.12
KS ×	133.00	19.00	1.70	22.61	25.00	13.00	12.33	65.66	82.93	222.66	184.66	2.36	54.73
B	177.00	22.50	1.40	22.05	27.40	9.00	14.00	50.33	86.62	271.66	235.33	2.32	49.00
C	155.50	37.80	1.60	42.34	25.00	7.00	12.00	32.00	84.39	155.66	131.33	2.52	19.32
SNT ×	135.00	31.50	1.60	35.28	25.00	16.00	10.00	17.00	91.21	159.33	145.33	2.42	52.66
B	128.50	32.50	1.40	31.85	25.00	14.00	8.66	21.66	89.85	118.33	106.33	2.39	34.93
C	146.50	20.00	1.50	21.00	23.00	9.00	11.00	27.00	89.93	152.33	137.00	2.38	25.34
D	136.50	36.50	1.80	45.99	25.00	11.00	10.00	14.00	77.27	110.00	85.00	2.29	24.01
E	123.50	28.00	1.80	35.28	20.50	12.00	10.33	12.33	78.49	93.00	73.00	2.38	16.95
SNT ×	162.30	23.80	1.90	31.65	25.00	8.00	13.00	28.66	93.39	171.66	160.33	2.56	34.36
B	167.70	34.30	2.00	48.02	26.00	8.00	12.00	28.00	77.47	198.33	153.66	2.50	30.63
C	117.50	35.50	2.30	57.16	26.00	9.00	14.00	35.00	91.21	188.33	171.79	2.23	29.86
D	149.00	36.00	1.90	47.88	27.00	9.00	14.00	34.00	92.48	173.00	160.00	2.45	31.14
E	134.00	40.50	1.80	51.03	28.00	18.00	13.00	34.00	91.50	192.33	176.00	2.35	75.12
SNT ×	146.00	11.50	1.00	8.05	20.00	18.00	13.00	25.66	81.12	148.33	120.33	2.86	59.30
B	109.00	16.50	1.60	18.48	24.50	11.00	10.33	26.33	80.72	157.33	127.00	2.68	34.22
C	96.00	36.50	1.60	40.88	24.00	9.00	11.66	36.00	87.14	189.33	165.00	2.43	35.02
D	76.00	20.00	1.50	21.00	20.50	18.00	9.66	18.33	82.68	84.66	70.00	2.06	28.93
E	110.00	24.00	1.40	23.52	23.50	7.00	10.00	16.00	81.50	133.33	108.67	2.07	12.16

Selected individuals	plant height(cm)	Flag leaf length(cm)	Flag leaf width(cm)	Flag leaf area(cm^2)	panicle length(cm)	Panicle number	primary branches $panicle^{-1}$	secondary branches $panicle^{-1}$	Spikelet fertility (%)	spikelet number	grain number	Test weight(g)	grain yield
SNT × IE2(2)A	129.50	28.00	1.40	27.44	24.50	24.00	8.33	18.66	92.73	110.00	102.00	3.01	74.54
B	110.00	29.00	1.50	30.45	23.50	14.00	10.33	36.00	89.70	126.66	113.66	2.12	29.00
C	98.50	27.00	1.60	30.24	22.50	12.00	10.33	25.66	91.50	137.33	125.66	2.66	37.02
D	102.00	23.00	1.50	24.15	21.00	10.00	10.00	23.33	85.14	101.00	86.00	2.08	14.32
SNT × IE2(3)A	112.00	19.50	1.20	16.38	22.00	17.00	12.00	16.66	81.28	119.33	97.00	1.98	32.59
B	119.50	19.00	1.30	17.29	21.00	12.00	11.33	25.66	89.76	123.66	111.00	2.22	27.89
C	100.00	26.00	1.50	27.30	20.50	5.00	10.44	25.66	88.10	137.33	121.00	2.08	9.06
D	103.00	23.00	1.50	24.15	21.00	8.00	11.00	39.33	90.47	125.66	113.66	2.10	15.00
STB × IE3(1)A	146.50	35.00	1.60	39.20	26.00	11.00	12.33	24.00	86.05	153.00	131.67	2.67	35.74
B	114.00	21.00	1.30	19.11	22.50	7.00	11.66	13.33	87.70	122.00	107.00	1.85	8.90
C	107.50	20.00	1.50	21.00	21.00	15.00	10.66	34.33	87.62	102.66	90.00	1.51	22.50
STB × IE3(2)A	132.50	35.00	1.30	31.85	16.50	12.00	12.00	26.00	89.34	169.00	151.00	2.03	33.59
B	128.00	19.00	1.30	17.29	20.50	7.00	10.00	18.00	75.29	114.66	86.33	1.86	12.25
C	91.00	21.00	1.70	24.99	20.00	8.00	11.00	40.00	84.76	225.33	191.00	1.76	23.34
STB × IE3(3)A	75.50	16.50	1.50	17.33	21.00	6.00	10.33	7.33	83.14	101.00	84.00	1.92	3.45
IE2 × SS(1) A	120.00	27.00	1.50	28.35	26.50	9.00	12.00	14.00	86.66	95.00	82.33	2.24	13.14
B	122.00	26.00	1.60	29.12	25.00	7.00	11.00	25.00	85.71	154.00	132.00	2.26	20.89
IE2 × SS(4) A	121.00	28.00	1.10	21.56	26.00	9.00	12.00	35.00	68.33	186.33	127.33	1.87	20.25
KS × IE3(1) A	138.40	20.00	1.40	19.60	22.00	8.00	11.00	32.33	78.80	151.00	119.00	1.82	21.81
B	160.00	22.50	1.70	26.78	26.00	14.00	12.00	31.00	90.78	115.66	105.00	1.77	25.44
C	87.00	22.00	1.40	21.56	22.50	17.00	9.66	23.66	94.11	119.00	112.00	1.76	33.35
D	132.50	28.00	1.70	33.32	21.00	8.00	12.00	24.00	92.10	131.00	120.66	2.16	20.30
KS × IE3(2) A	98.50	22.00	1.70	26.18	22.50	19.00	9.33	17.00	86.06	107.66	92.66	2.02	32.34
B	98.50	21.50	1.50	22.58	23.50	8.00	10.33	19.00	85.83	120.00	103.00	2.03	12.67
C	107.00	20.50	1.40	20.09	23.00	13.00	11.33	23.66	89.47	95.00	85.00	2.17	21.88
D	144.00	37.00	1.80	46.62	29.00	11.00	11.00	38.00	75.40	203.33	153.33	2.63	47.76
E	128.00	28.00	1.90	37.24	25.00	13.00	10.00	20.00	88.72	139.00	123.33	2.21	32.48

Considerable magnitude of variation was observed in the F_5 families in terms of yield, plant height and other yield contributing traits, which revealed that the selected segregants had possessed high grain yield with semi-dwarf to medium stature, high tillering behaviour with resistance to lodging. Therefore, seeds from the promising F_5 plants should be forwarded to next generation for further evaluation and extensive testing under different geographical locations with different agronomic management practices.

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