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Selection Indices for Identification of Promising Hybrids in Hybrid Rice

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ABSTRACT

The present investigation was aimed at evaluating seventeen elite rice hybrids along with seven different checks to study the genetic basis of yield vigour in hybrids and identification of promising hybrids by selection indices in hybrid rice. Selection indices were constructed with grain yield as the economic criterion and nine different characters namely grain yield per plant, days to flowering, plant height, panicle length, panicle number, fertile grain number, fertility % , 100-grain weight and harvest index were selected for the construction of nine selection indices. The promising genotypes occupying better ranking in the nine character index were selected for their future use. The relative ranking of varieties selected on the basis of *per se* performance and index score differed indicating the importance of selection index over direct selection on grain yield. The higher productivity in those hybrids could be attributed to longer panicle length, increased panicle number, moderate to high grain number with improved spikelet fertility, desirable 100-grain weight and higher harvest index may serve as the basis of yield vigour in hybrid rice.

Keywords Non-additive gene action, Indirect selection, Correlated traits, Genetic advance.

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INTRODUCTION

Rice is the major food crop of the world and is the staple food for more than 60% of the global population. Adding 30-50% of agricultural income to the millions of farm house holds, it is a staple food for three fourths of Indian population (Babu et al. 2015). In terms of acreage, rice is grown in about 44.0 million hectares in India and it accounts for 40.5% of total food grain production and 43.4% of total cereal production thus continues to hold the key to sustain food sufficiency in the country. Being the staple for 65% of the population, at the current level of per capita availability rice production is required to go up by 40 and 70% -from 105 to145 and 190 million tonnes of milled rice respectively by 2030 and 2050 to meet the growing food demand. We would be, therefore, requiring to add annually not less than 3.0-3.5 million tonnes of milled rice to sustain the present level of self-sufficiency in rice. It is therefore, a challenging task to achieve this targeted production levels in the next few decades as increase in productivity has to come from the declining and degrading resource base in terms of land, water and other inputs and demand for environmentally sound rice production practices (Siddiq 2013). Although, the genetic gain in yield per day has been achieved but yield stagnation of the currently available varieties creates a serious problem. Therefore, there is a need to make concerted research efforts to step up rice production only through vertical yield growth. Out of the several efforts made in recent past to break the yield potential barrier, hybrid rice technology seems to be an alternative approach to meet this challenge. It has been experimentally verified that hybrid rice yield on an average of 1—1.5 t/ha more than semi dwarf rice varieties in the farmer's field (Virmani et al. 1993, Singh and Zaman 1996, Patra and Das 2018). Therefore, in the present investigation efforts were made to evaluate a set of elite hybrids to assess their yielding ability and to identify the promising hybrids by selection indices for their future use.

MATERIALS AND METHODS

The experiment was conducted at Rice Research Station, Orissa University of Agriculture and Technology, Bhubaneswar during 2012 *kharif,* using seventeen elite rice hybrids along with Annada and Udayagiri as early; IR 64 and Lalat as mid early; Jaya, Surendra and Pratikshya as medium checks. The test genotypes were evaluated under irrigated situations in medium lands. The experiment was laid out in Randomized Complete Block Design with three replications. The experimental materials were transplanted as nine row plots at 4.35 m length with a row to row distance of 20 cm and plant to plant spacing of 15 cm. A fertilizer dose of 100 : 50 : 50 kg NPK was applied as per scheduled management practices. Observations were recorded in eight metric traits on five competitive plants selected randomly from middle rows of each plot, whereas the characters like plot yield and days to 50% flowering were recorded on plot basis. During the course of investigation, observations were recorded on ten different characters like days to 50% flowering, plant height, panicle length, panicle number, fertile grain number, fertility percentage, 100-grain weight, harvest index, grain yield per plant and plot yield. Selection indices were constructed with grain yield as the economic criterion and nine different characters namely, grain yield per plant, days to 50% flowering, plant height, panicle length, panicle number, fertile grain number, fertility percentage, 100-grain weight, and harvest index were chosen for construction of nine selection indices. The nine character index including all the nine traits was used for the selection of genotypes. Those genotypes which occupied better rankings in the above selection index were selected for their future use. The expected genetic advance from selection indices was computed on the basis of model suggested by Smith (1936). The relative efficiency of an index was estimated as the ratio of the expected genetic advance from index selection to that from direct selection on the basis of yield and was expressed in percentage. On the basis of genetic advance values two selection indices including grain yield per plant as single character and combination of all the nine characters were used for the selection of genotypes from the present set of material. Those cultures which occupy better rankings in the complete nine character index were selected during the course of the present investigation for their future use.

RESULTS AND DISCUSSION

The mean performance of different varieties with respect to various characters including plot yield has been presented in Table 1. It was interesting to note that the increase or decrease in plot yield was not associated with the corresponding increase or decrease of related traits under study. This discrepancy might have resulted due to undetected sampling

Table 1. Mean performance of genotypes with respect to various traits.

Sl. No.	Variety	DF	PH (cm)	PL (cm)	PN	GN	F (%)	100-GW (g)	HI	GYP (g)	PY (q/ha)
1	DRRH-2	96	80.3	25.20	13.0	103.3	76.2	2.41	0.58	17.92	42.32 (3)
2	PA 6129	98	83.6	22.70	11.3	130.7	83.8	2.26	0.51	16.66	32.44
3	Sahyadri-2	97	86.6	27.07	12.7	112.0	74.5	2.27	0.58	18.22	40.44 (5)
4	Sahyadri-4	98	80.6	25.50	9.7	115.0	76.5	2.36	0.44	12.54	32.36
5	Pusa RH-10	97	87.1	26.03	9.7	107.3	69.9	2.48	0.41	11.61	26.31
6	Indira Sona	104	90.7	25.43	11.0	118.7	68.8	2.41	0.51	17.54	28.35
7	GK 5003	101	86.9	25.60	8.3	146.7	75.5	2.00	0.41	15.67	40.36 (6)
8	PSD-3	103	87.3	25.80	10.0	92.3	71.7	2.46	0.49	15.24	34.14
9	Sahyadri-3	113	90.9	25.83	10.7	111.3	65.4	2.61	0.48	17.10	32.27
10	HSD-1 (HKRH-1)	106	92.8	23.90	11.3	84.3	69.9	2.65	0.48	16.97	38.40 (7)
11	PA 6444	110	91.9	23.63	8.7	117.7	74.9	2.26	0.45	15.86	35.33
12	Suruchi(MPH 5401)	108	82.5	22.27	10.0	123.7	87.0	1.85	0.48	15.99	31.16
13	JKRH-2000	108	93.4	24.67	9.0	139.0	75.5	2.31	0.53	16.60	43.34 (2)
14	US-312	101	91.8	26.00	8.7	140.7	73.6	2.00	0.40	15.32	37.21
15	CORH-3	92	85.1	24.87	11.7	118.7	81.2	2.17	0.60	21.35	41.55 (4)
16	Annada (NVC-E)	94	74.5	23.33	10.0	112.7	82.1	2.03	0.46	8.52	14.77
17	Udayagiri (LC-E)	94	77.6	22.63	11.0	87.3	86.7	2.25	0.53	15.71	37.89 (8)
18	IR 64 (NVC-ME)	97	82.2	23.30	11.0	78.0	86.2	2.57	0.43	14.18	27.50
19	PA 6201 (NHC-ME)	99	88.3	23.67	9.3	126.3	68.8	1.97	0.43	14.08	30.23
20	Lalat (LC-ME)	98	94.1	25.33	11.0	105.3	81.4	2.51	0.62	18.19	44.02 (1)
21	Jaya (NVC-M)	99	83.6	23.73	8.7	110.7	83.1	2.47	0.44	13.25	21.96
22	KRH-2 (NHC-M)	98	100.3	25.77	10.7	114.3	70.5	2.16	0.50	17.12	37.80 (9)
23	Surendra (LC-M)	106	73.3	22.77	11.0	89.0	69.2	2.05	0.47	12.54	20.09
24	Pratikshya (LC-M)	110	89.1	23.00	10.7	137.7	70.5	2.08	0.48	16.17	37.55 (10)
	SED	1.8	2.7	0.97	1.1	14.7	5.3	0.09	0.06	2.59	4.48
	CD (5%)	3.7	5.4	1.95	2.2	29.6	10.7	0.19	0.13	5.23	9.05

errors during recording of observations. As during the present investigation, the *per se* performance of the varieties is more meaningful, therefore, major emphasis was given to plot yield than other yield components estimated on per plant basis to identify the most promising cultures for their future use. Out of seventeen varieties evaluated during the present investigation, as many as ten cultures showing yield level of more than 37.00 q/ha could be sorted out to be promising. The yield performance of these promising entries along with other metric traits is presented in Table1for ease of better comprehension. The most promising hybrids were JKRH-2000, DRRH-2, CORH-3, Sahyadri-2, GK 5003, HSD-1 (HKRH-1), KRH-2 (NHC-M) and the check varieties like Udayagiri, Lalat and Pratikshya also exhibited superior performance. A perusal of data from the mean performance, it is observed that superior performance of all the characters was not expressed in promising genotypes and different genotypes were found to be superior for various characters. The higher productivity in those varieties is due to a combination of various morpho-physiological traits, which could be ascribed at the basis of potential productivity in rice. Similar results were also reported by Rajput et al. (2014), Pradhan et al. (2015), Kar et al. (2018), Kumari et al. (2019). It is therefore, interesting to mention that the above mentioned hybrids should be used for commercial planting and the check varieties should be successfully utilized in the future breeding programs for genetic improvement of yield in irrigated rice.

The performance of promising hybrids and check varieties are classified as early, mid-early and medium groups on the basis of their maturity duration (Table 2). Out of seventeen hybrids under study, three hybrids namely DRRH-2, CORH-3 and Sahyadri-2 in early group exhibited 11.69, 9.65 and 6.73% yield superiority over the early check Udayagiri respectively. Similarly two hybrids namely JKRH-2000 and HSD-1 in medium group expressed 15.42 and 2.26% yield superiority over the check Pratikshya respectively. However, none of the hybrids in mid early group excelled in performance over the check

Table 2. Performance of promising rice hybrids.

Sl. No.	Variety	DF	PH (cm)	PL (cm)	PN	GN	F (%)	100-GW (g)	` HI	GYP (g)	PY (q/ha)	% of yield increase over the best check
Early group												
1	DRRH-2	96	80.3	25.20	13.0	103.3	76.2	2.41	0.58	17.92	42.32	11.69
2	CORH-3	92	85.1	24.87	11.7	118.7	81.2	2.17	0.60	21.35	41.55	9.65
3	Sahyadri-2	97	86.6	27.07	12.7	112.0	74.5	2.27	0.58	18.22	40.44	6.73
4	Udayagiri	94	77.6	22.63	11.0	87.3	86.7	2.25	0.53	15.71	37.89	–
Mid-early group												
1	GK 5003	101	86.9	25.60	8.3	146.7	75.5	2.00	0.41	15.67	40.36	–
2	Lalat	98	94.1	25.33	1.0	105.3	81.4	2.51	0.62	18.19	44.02	
3	KRH-2	98	100.3	25.77	10.7	114.3	70.5	2.16	0.50	17.12	37.80	
Medium group												
1	JKRH-2000	108	93.4	24.67	9.0	139.0	75.5	2.31	0.53	16.60	43.34	15.42
2	HSD-1	106	92.8	23.90	11.3	84.3	69.9	2.65	0.48	16.97	38.40	2.26
3	Pratikshya	110	89.1	23.00	10.7	137.7	70.5	2.08	0.48	16.17	37.55	–

variety Lalat. The foregoing observation on superior yield performance of selected hybrids and their association with various quantitative traits, it is revealed that no definite trend of relationship is suggested. However, it is clearly observed that high yield of different promising entries could be attributed to longer panicle length, increased panicle number, moderate to high grain number with improved spikelet fertility, desirable 100-grain weight and higher harvest index may serve as the basis of yield vigour. It is believed that these traits could be utilized as important selection criteria for prediction and realization of potential yield in rice (Virmani et al. 1993, Singh and Zaman 1996, Nayak et al. 2004, Virk et al. 2004) reported similar findings, indicating that the higher yield level was due to total biomass, higher harvest index and best combination of factors for bigger sink size and better grain filling.

Direct and multiple criteria of selection for improvement of yield and selection indices

Since grain yield is a complex trait, controlled by non-additive gene action and is believed to have low heritability, hence direct selection for grain yield *per se* is often not reliable and effective. Further inter-genotypic competition and a large experimental error associated with yield measurements often bias the outcome of selection for higher yield. Therefore, several workers in different crop plants have emphasized the importance of indirect selection for yield through the use of component traits governed by genes with additive effect and with strong correlation on grain yield (Mohapatra and Mohanty 1986). As no single trait could be taken as an adequate criterion of selection for yield, therefore, selection indices provide a useful method by making use of several correlated traits for greater efficiency of selection in yield (Das et al. 2000, Mathur 2011, Kar et al. 2018).

During the present investigation selection indices were constructed with grain yield per plant as the economic criterion and eight different characters namely days to 50% flowering, plant height, panicle length, panicle number, fertile grain number, fertility percentage, 100-grain weight, harvest index and grain yield per plant were chosen for the construction of nine character indices. The nine character indices including all the nine traits were used for the selection of genotypes. Those genotypes which occupied better rankings in the above selection index were selected for their future use. The expected genetic advance in yield from selection and different selection indices

Table 3. Expected genetic advance and relative efficiencies of selection index over direct selection on grain yield. GYP : Grain yield per plant, DF : Days to flowering, PH : Plant height, PL : Panicle length, PN : Panicle number, GN : Grain number, F% : Fertility percent, GW : Grain weight, HI : Harvest index.

Index No.	No. of characters	Characters	Expected genetic advance	Relative efficiency (%)
1	One character index	GYP	2.806	100.00
2	Two character index	GYP + DF	2.810	100.14
3	Three character index	GYP + DF + PH	3.032	108.05
4	Four character index	GYP + DF + PH + PL	3.062	109.12
5	Five character index	GYP + DF + PH + PL + PN	3.115	111.01
6	Six character index	GYP + DF + PH + PL + PN + GN	3.120	111.19
7	Seven character index	GYP + DF + PH + PL+ GN + F%	3.254	115.96
8	Eight character index	GYP + DF + PH + PL + PN + GN + F% + GW	3.336	118.88
9	Nine character index	GYP + DF + PH + PL + PN + GN + F% + GW + HI	3.517	125.33

over direct selection on yield is presented in Table 3. The predicted genetic advance from different indices at 5% selection intensity ranged from 2.806 g in index 1 to 3.517 g in index 9. Thus in terms of predicted genetic advance, the results of the present study brought out superiority of nine character index over direct selection on yield *per se*. This is in general agreement with those of Bastia et al. (2008), Sabouri et al. (2010), Alam et al. (2014), Souleymane et al. (2016), Kar et al. (2018), Kumari et al. (2019).

The promising genotypes occupying better ranking in the nine character index were selected for their future use. The index score, grain yield per plant and plot yield of promising genotypes namely KRH-2, Sahyadri-2, HSD 1 (HKRH-1), Lalat, Suruchi (MPH 5401), CORH-3, IR 64, US312, Indira Sona, Sahyadri-3, PA 6129 and PA 6444 are presented in Table 4. It was interesting to note that the relative rankings of varieties selected on the basis of *per se* performance and index score differed indicating the

Table 4. Selection of genotypes on the basis of nine character index.

Sl. No.	Genotypes	Days to flowering	Index score	Grain yield per plant (g)	Plot yield (q/ha)
1	KRH-2 (NHC-M)	98	49.56 (1)	17.12 (6)	37.80 (9)
2	Sahyadri-2	97	48.39 (2)	18.22 (2)	40.44 (5)
3	HSD-1 (HKRH-1)	106	48.11 (3)	16.97 (8)	38.40 (7)
4	Lalat (LC-ME)	98	48.11 (4)	18.19 (3)	44.02 (1)
5	Suruchi (MPH 5401)	108	47.90 (5)	15.99	31.16
6	CORH-3	92	47.82 (6)	21.35 (1)	41.55 (4)
7	IR 64 (NVC-ME)	97	47.70 (7)	14.18	27.50
8	US-312	101	47.46 (8)	15.32	37.20
9	Indira Sona	104	47.06 (9)	17.54 (5)	28.35
10	Sahyadri-3	113	46.96 (10)	17.10 (7)	32.27
11	PA 6129	98	46.96 (11)	16.66 (9)	32.44
12	PA 6444	110	46.88 (12)	15.86	35.33
			Checks		
13	Annada (NVC-E)	94		8.53	14.77
14	Udayagiri (LC-E)	94		15.70	37.90 (8)
15	IR 64 (NVC-ME)	97		14.18	27.50
16	Lalat (LC-ME)	98		18.19 (2)	44.02 (1)
17	Jaya (NVC-M)	99		13.25	21.96
18	Surendra (LC-M)	106		12.54	20.09
19	Pratikshya (LC-M)	110		16.17 (10)	37.55 (10)

imprortance of selection index over direct selection on grain yield.

Most of the published works on selection indices based on index scores reflect the genotypic worth of a particular culture and the relative efficiency has been assessed in terms of genetic advance. However, the validity of such expectations in selecting different genotypes on the basis of different selection indices is often questioned as it varies due to difference in the composition of material, selection of characters for the construction of indices and the experimental precision associated with yield measurement (Bastia et al. 2008, Mathur 2011, Kar et al. 2018). Therefore, it becomes imperative to study the relative efficiency of different selection criteria and to test the validity of expected superiority of selection indices over direct selection by testing the promising genotypes through appropriate field trials.

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