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Genetic variability and selection indices for grain yield in upland rice

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ABSTRACT

Thirty two upland rice genotypes were assessed for study of genetic variability and construction of selection indices for enhancing selection efficiency. Observations on ten metric characters like days to 50% flowering, plant height, flag leaf area, panicle number, panicle length grain number, grain fertility %, 100 grain weight, harvest index and grain yield were recorded. The analysis of variance revealed the presence of considerable amount of variation among the test genotypes for all the characters. This was also supported by mean, range, GCV and PCV. Using grain yield as economic criterion, five selection indices were constructed. The relative efficiency of selection on the basis of selection indices is expected to increase upto 114.371%. On the basis of selection criteria, the promising genotypes selected were OR 1752-3, OR 1603-7, OR 2088-4, OR 2087-2, OR 1659-3, OR 2049-1, OR 2048-1, OR 2069-1, OR 2077-5 and OR 1920-7.

Key words: *Rice, selection index, genetic variability*

Upland rice is grown in around 5.5 million hectare as direct seeded crop in India, out of which 70% area is drought prone contributing low productivity of 0.6 to 1.5 t ha^{-1} in this ecosystem. This can be attributed mainly due to lack of suitable varieties and other factors like crop production and management practices. So there is an absolute need to identify high yielding varieties endowed with drought tolerance, very early to early duration, intermediate plant stature with weed suppressive ability and pest and disease tolerance. Large spectrum of genetic variability among the genotypes along with suitable selection criteria offer better scope for selection of appropriate genotypes. An attempt has been made in this regard in the present investigation.

The experimental material consisting of thirtytwo upland rice genotypes were evaluated in a field trial following Randomized Block Design with three replications at Rice Research Station, OUAT, Bhubaneswar during wet season 2005. Observations on ten quantitative characters viz. days to 50% flowering (DF), plant height (PH), flag leaf area (FLA), panicle number (PN), panicle length (PL), grain number (GN), grain fertility % (FT%), 100 grain weight (GW), harvest index (HI) and grain yield (GY) were recorded on five competitive plants except panicle number and grain yield which were recorded on one meter length and plot basis, respectively.

Analysis of variance was carried out separately for each character. The genotypic (GCV) and phenotypic (PCV) coefficient of variability were computed as per method given by Burton (1952). The five selection indices were constructed using the ten characters as suggested by Smith (1936) and Hazel (1943) and are as follows

Index -I Only grain yield was considered for selection of genotypes.

Index-II Three yield attributing characters such as panicle number, fertile grains/ panicle, and grain weight were taken for constructing this index.

Index-III All the nine metric characters excluding grain yield were taken for this index.

Index-IV This included the three characters as in index II and grain yield in addition.

Index-V This included all the ten metric characters.

The expected genetic advance from selection indices was computed on the basis of model suggested by Smith (1936).

Presence of genetic variability is a prime requirement in crop improvement programme. The analysis of variance revealed significant differences among test entries for all the ten characters under study, indicating the presence of considerable amount of variability in the material studied. This fact was also supported by estimates of mean, range, GCV and PCV (Table 1). The genotypic and phenotypic coefficient of variation was highest for panicle number followed by grain number and grain yield, indicating reliability of genetic improvement through selection for these characters. The findings were in agreement with Singh and Chaudhury (1996).

As grain yield is a complex trait, much influenced by environments and exhibits low heritability, direct selection for grain yield *per se* is often not reliable and effective. Therefore, several workers in different crop plants have emphasized the importance of indirect selection for yield through the use of component traits. It would, therefore, be rewarding and efficient in selecting single plants on the basis of panicle number, number of grains panicle^{-1} and 100 grain weight (Mahapatra and Mohanty, 1986). As no single trait could be taken as an adequate criterion for selection for yield, therefore selection indices provide an useful method by making use of several correlated traits for greater efficiency of selection for yield (Das *et al*., 2001).

During present investigation selection indices were constructed using grain yield as economic criterion and nine other component characters. Five selection indices (Table 1) were used for comparing the efficiency of selection criteria. The predicted genetic advance on the basis of different indices at 5% selection ranged from 0.471 t ha^{-1} in index I to 0.581 t ha^{-1} in index V (Table 2). In terms of relative efficiency it varied from 92.116% in index II to 114.371% in index V.

Table1. Mean, Range, CV, GCV and PCV estimates for various characters in rice genotypes

Character	Mean	Range	CV(%)	GCV(%)	PCV(%)
Days to 50 % flowering	72.23	60.67-84.00	2.93	7.30	7.50
Plant height (cm)	16.93	12.81-22.99	17.52	11.46	15.29
Flag leaf area (cm^2)	16.93	12.81-22.99	17.52	11.46	15.29
Panicle number	52.20	35.33-101.33	15.48	30.75	32.03
Panicle length (cm)	18.84	14.65-23.31	8.91	7.25	8.89
Grain number	51.52	29.67-97.78	25.63	24.14	28.31
Fertility percentage	71.89	32.91-85.34	14.36	11.91	14.52
Grain weight (gm)	2.50	1.96-3.18	8.48	8.52	9.83
Harvest Index	0.25	0.17-0.34	25.29	9.97	17.82
Grain yield (t ha^{-1})	1.59	0.87-2.42	22.5	18.86	22.91

Table 2. Expected genetic advance and relative efficiency of selection indices over direct selection for grain yield in rice genotypes

Index No I No of Characters	Characters	Expected genetic advance	Relative efficiency in Percent
I(One character index)	GY	0.508	100.00
II(Three character index)	PN+ GN +GW	0.471	92.716
III(Four character index)	GY + PN +GN+GW	0.528	103.937
IV(Nine character index)	PN + GN +GW + DF + PW+PH+ PL+ FT % +HI	0.873	112.795
V(Ten Character index)	GY+PN+GN+GW+DF+FLA+PH + PL + FT % + HI	0.581	114.371

Where

DF = Days to 50% flowering, PH = Plant height
PN= Panicle number FLA = Flag leaf area
GN = Grain number FT% = Fertility %
PL = Panicle number GW = Grain weight
HI = Harvest index GY = Grain yield

It was observed that selection only on three major yield attributing characters such as panicle number, grain number and grain weight was not efficient as compared to direct selection for yield *per se*. But the relative efficiency of selection increased with addition of grain yield as a character to these. It was also observed that indirect selection for yield on the basis of all the nine component characters of yield exhibited higher relative efficiency. The selection criteria based on combination of all the component characters and yield showed higher efficiency (114.371%) This was in general agreement with those of Sundaram and Palaniswamy (1994) and Chakrabarty and Hazarika (1996).

On the basis of each of the above five selection criteria, all the genotypes were ranked (Table 3) and promising genotypes (about 20%) occupying better ranking in five selection criteria were selected (Table 4). The seven genotypes selected on the basis of mean grain yield were OR 1752-3, OR 1603-7, OR 2088-4, OR 2087-2, OR 1659-3, OR 2049-1, OR 2048-1. These genotypes also had higher ranks under other four selection indices. The genotypes such as OR 2069-1, OR2077-5 and OR1920-7 were found to have higher ranks under other four selection indices. This indicated that indirect selection or combined selection for grain yield is more efficient in identifying better genotypes as compared to selection based on grain yield *per se*.

Table 3. Relative rankings of rice genotypes on the basis of different selection criteria

	Index Score				
Genotype	Indcx-1	Index-II	Index-III	Index-IV	Index-V
OR 1603-7	2.390(2)	2.254(2)	2.089(2)	4.142(2)	3.648(2)
OR 1659-3	2.013(5)	1.932(10)	1.767(5)	3.835(6)	3.57 (5)
OR 1734-1	1.65 (9)	1.876(15)	1.578(10)	3.61](17)	3.090(16
OR 1737-4	1.387(25)	1.936(9)	1.474(20)	3.538(21)	2.987(23)
OR 1752-3	2.417(1)	1.98)·(7)	1.980(3)	3.728(10)	3.343(7)
OR 1770-1	1.540(17)	1.922(11)	1.543(16)	3.709(12)	3.135(l2)
OR 1774-4	1.710(8)	1.7 71(23)	1.557(12)	3.660(14)	3.162(11)
OR 1783-3	1.417(24)	1.774(22)	1.419(24)	3.640(15)	3.085(17)
OR 1849-1	1.140(30)	1.442(31)	1.14-8(30)	3.375(28)	2.817(28)
OR 1920-7	1.383(26)	2.043(5)	1.523(18)	3.451(26)	2.887(27)
OR 2042-2	1.627(11)	1.785(21)	1.527(17)	3.518(23)	3.030(21)
OR 2048-1	1.793(7)	1.884(18)	1.628(7)	3.896(5)	3.370(4)
OR 2049-1	1.807(6)	1.799(20)	1.617(8)	3.772(8)	3.289(8)
OR 2052-4	1.460(21)	1.679(28)	1.401(25)	3.527(22)	3.009(22)
OR 2060-9	1.503(19)	1.973(8)	1.548(14)	3.744(9)	3.174(9)
OR 2069-1	1.483(20)	1.990(6)	1.548(13)	3.981(3)	3.347(6)
OR 2069-10	1.557(15)	1.732(26)	1.469(21)	3.618(16)	3.108(13)
OR 2075-3	1.237(29)	1.765(24)	1.331(29)	3.111(32)	2.592(32)
OR 2077-5	1.570(14)	2.185(3)	1.674(6)	3.781(7)	3.172(10)
OR 2081-5	1.443(23)	1.666(20)	1.388(26)	3.703(27)	2.908(26)
OR 2084-2	1.277(28)	1.756(25)	1.348(28)	3.353(29)	2.810(29)
OR 2085-9	1.573(13)	1.887(14)	1.544(IS)	3.545(20)	3.032(20)
OR 2087-2	2.167(4)	2.089(4)	1.914(4)	3.947(4)	3.459(3)
OR 2088-4	2.347(3)	2.610(1)	2.223(1)	4.488(1)	3.898(l)
OR 2089-9	1.543(16)	1.698(27)	1.448(23)	3.451(25)	2.970(24)
OR 2090-7	0.873(32)	1.435(26)	1.019(32)	3.211(31)	2.637(31)
OR 2091-1	1.000(31)	1.49?(30)	1.102(31)	3.234(30)	2.689(30)
OR 2093-4	1.640(10)	1.918(13)	1.590(9)	3.590(19)	3.083(18)
Khandagiri	1.460(22)	1.846(16)	1.467(22)	3.664(13)	3.097(14)
Pathara	1.277(27)	1.826(19)	1.367(27)	3.719(11)	3.094(15)
Annada	1.573(18)	1.845 (17)	1.501(19)	3.477(24)	2.958(25)
Sidhant	1.587(12)	1.920(12)	1.559(11)	3.591(18)	3.053(19)

Figure in parentheses indicate relative ranking of genotypes.

Table 4. Promising rice genotypes selected on the basis of five different selection criteria

Genotype	SC I	SC II	SC III	SC IV	SC V
OR 1752 -3	2.417(1)	1.985(7)	3.728(10)	1.980(3)	3.348(7)
OR 1603 -7	2.390(2)	2.254(2)	4.142(2)	2.089(2)	3.648(2)
OR 2088	2.347(3)	2.610(1)	4.488(1)	2.223(1)	3.898(1)
OR 2087 -2	2.167(4)	2.089(4)	3.947(4)	1.914(4)	3.459(3)
OR 1659 -3	2.013(5)	1.932(10)	3.835(6)	1.767(5)	3.357(5)
OR 2049 -1	1.807(6)	1.799(20)	3.772(8)	1.617(8)	3.289(8)
OR 2048 -1	1.793(7)	1.844(18)	3.896(5)	1.628(7)	3.370(4)
OR 2069 -1	1.483(20)	1.990(6)	3.981(3)	1.548(13)	3.347(6)
OR 2077 -	1.570(14)	2.185(3)	3.781(7)	1.674(6)	3.172(10)
OR 1920 -7	1.383(26)	2.043(5)	3.451(26)	1.523(18)	2.887(27)

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