Variability and Character Association of Yield Components in Rainfed Lowland Rice

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Forty-two released lowland rice varieties including check were evaluated to obtain information on genetic variability, heritability, interrelationship of grain yield and its components. Highly significant differences were observed among the genotypes in all the characters. High PCV and GCV were observed in plant height, grains/panicle, EBT/hill and panicle weight. High heritability with high genetic advance was observed in plant height and grains/panicle. But high heritability with low genetic advance was recorded in days to fifty per cent flowering, 1000-grain weight and grain length. Plant height had significant positive correlation with panicle weight, grains/panicle, 1000-grain weight and negative correlation with single plant yield.

Key Words: Correlation, Genetic variability, Rainfed lowland rice, Yield components

Introduction

Rainfed lowlands are very predominant in India in general and eastern India in particular. Of the 45 million ha of harvested rice area in the country, about 28% are rainfed lowland. It is very fragile due to erratic climatic conditions. The production is very low in these areas and varies from 1.5-2.0 t/ha. In order to increase the productivity, development of good varieties with specific traits should be taken into consideration. In any rice breeding programme, attempts are always being made to break the yield barrier. Grain yield is a very complex character and it is the result of expression of several interrelated polygenic characters. It is therefore, imperative to obtain information from different genetic parameter influencing grain yield. Development of high yielding varieties require a thorough knowledge of existing genetic variation and also the extent of genetic association among the yield contributing characters. Knowledge of association of yield component with yield is of paramount importance to formulate an effective breeding programme. The interrelationships of component characters of yield provide the information about the improvement of desirable characters under selection. The variability and nature of association of different yield characters were studied in native land races of rice by Tomar *et al.* (2000) and in upland rice by Rao and Srivastava (1994).

Materials and Methods

Forty-two released lowland rice varieties including check were transplanted to evaluate their yield attributing characters and yield under rainfed lowland condition. The materials were sown in Randomized Block Design in three replications with Pooja as local check during *kharif* 2005 and 2006 at Central Rice Research Institute, Cuttack. The recommended doses of fertilizer were applied. Five competitive plants in each replication were selected randomly for recording observation on plant height (cm), EBT/hill, panicle length (cm), panicle weight (g), days to fifty per cent flowering (DFF),1000-grain weight (g), grains/panicle, sterile spikelets /panicle, grain length (mm), grain breadth (mm), L/B ratio, single plant yield (SPY) (g).The data were subjected to statistical analysis (Panse and Sukhatme, 1967).The phenotypic and genotypic coefficient of variability, broad sense of heritability and genetic advance at 5% selection intensity were computed by using the formulae suggested by Johnson *et al.* (1955). The phenotypic and genotypic correlation coefficient were calculated as per Al-Jibouri *et al.* (1958).

Results and Discussion

The analysis of variance (ANOVA) of this experiment revealed that the genotypes were significant for all the characters (Table 1). Mean values, range, coefficient of variation, PCV, GCV, heritability in broad sense and genetic advance as percentage of mean indicate significant variability in certain characters and there is enough scope for exploitation (Table 2).The values of mean performance of yield and yield attributing characters are presented (Table 4). The plant height varied from 81.8 cm (BPT 5204) to 175.5 cm (Hanseswari), EBT/hill 7.8 (Sudhir) to 20.2 (Swarna), panicle length 21.3 cm (BPT 5204) to Sonamani (31.3 cm), panicle weight 2.1g (Dhusura) to

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Table 1. Analysis of variance for 12 yield attributing characters

Characters	Sources of variation		
	Replication	Genotypes	Error
Plant height (cm)	13.30	2050.89**	8.44
EBT/hill	4.02	14.52**	2.43
Panicle length (cm)	0.49	11.96**	1.35
Panicle weight (g)	0.20	1.40**	0.10
Grains/panicle	19.95	2822.09**	218.56
Sterile spikelets/panicle	11.00	35.12**	9.12
DFF	1.88	158.09**	0.23
1000-grain weight (g)	1.48	69.88**	0.24
Grain length (mm)	0.25	2.75**	0.06
Grain breadth (mm)	0.02	0.42**	0.01
L/B ratio	0.001	1.09**	0.02
SPY (g)	25.29	23.65**	6.16

** Significant at 1% level of probability
EBT/hill: Ear bearing tiller/hill, DFF: Days to fifty per cent flowering, L/B: Grain length/grain breadth ratio, SPY: Single plant yield

4.8 g (Varshadhan), and grains/panicle 41.6 (FR-13A) to 193.0 (Tulsi). 1000-grain weight is an important character and it ranged from 13.7 g (Dhusura) to 31.0 g (Sabita) indicating wide variability. The single plant yield varied from 9.9 (Ketekijoha) to 23.7 (Gayatri). In general, all the traits exhibited higher magnitude of PCV than GCV. Maximum GCV was observed in 1000-grain weight (21.7) followed by grains per panicle (20.3), panicle weight (19.5), plant height (19.09) and L/B ratio (18:5). This high value of GCV indicated that maximum variability exists in these traits and there is enough scope for further improvement. Similar observations were obtained by Rabindra Babu (1996) and Deb Choudhury and Das (1998).

The heritability values expressed high in DFF (99.5) followed by 1000-grain weight (98.9), plant height (98.7), grain length (93.1), L/B (93.3) and lowest in sterile spikelets/panicle (48.7) and single plant yield (48.8). The genetic advance recorded highest in grains/panicle (54.2) followed by plant height (53.4) and lowest in panicle weight (1.2), L/B ratio (1.2) and grain breadth (0.73) etc. High heritability with high genetic advance was observed in plant height and grains/panicle. This is most likely due to additive gene effects and direct selection may be very effective. High heritability with low genetic advance was observed in EBT/hill, panicle length, panicle weight, grain length, grain breadth etc. These characters are governed by non-additive gene action (epistasis/dominance) and GXE interaction. The high heritability being exhibited was due to favourable influence of the environment rather than genotypic. In these cases, simple selection might not be effective. As such progeny of family testing should be practised for improvement of these traits. High heritability with moderate genetic advance was observed in days to fifty per cent flowering. This trait could be included in the breeding systems as composite characters. The estimates of PCV were higher than GCV value except DFF which indicates the influence of environment but variation was very less, because of low influence of environment on these characters. Heritability estimates along with genetic advance are more helpful in predicting gain under selection than heritability estimate alone. (Sinha *et al*., 2004; Johnson *et al*., 1955).

The estimates of genotypic correlation coefficients are essential in evaluating the possibility of simultaneous improvement of many characters or improvement of a single complex trait on the assumption of correlated response to selection. In the present study, the correlation

Table 2. Range, mean and genetic parameter of 12 yield attributing characters in lowland rice varieties

Characters	Range	Mean ± SE	PCV	GCV	Heritability (%) broad sense	Genetic advance	Genetic advance (as % of mean)
Plant height (cm)	81.8-175.5	136.6 ± 1.6	19.2	19.09	98.7	53.42	39.08
EBT/hill	7.8-20.2	11.44 ± 0.9	22.21	17.53	62.29	3.2	28.5
Panicle length (cm)	21.3-31.3	25.18 ± 0.6	8.78	7.43	72.3	3.2	13.07
Panicle weight (g)	2.1-4.8	3.37 ± 0.1	21.7	19.5	80.7	1.2	36.14
Grain/panicle	41.6-193.0	145.5 ± 8.5	22.7	20.3	79.8	54.2	37.30
Sterile spikelet/panicle	10.3-29.0	18.12 ± 1.7	23.26	16.24	48.7	4.2	23.25
DFF (days)	122.3-151.6	132.9 ± 0.2	5.5	5.6	99.5	14.9	11.2
1000-grain weight (g)	13.7-31.0	22.2 ± 0.2	21.8	21.7	98.9	9.9	44.50
Grain length (mm)	6.7-10.9	8.3 ± 0.1	11.78	11.36	93.1	1.9	22.50
Grain breadth (mm)	1.9-3.3	2.57 ± 0.05	14.9	14.4	93.2	0.73	28.70
L/B ratio	2.2-4.3	3.3 ± 0.09	18.7	18.1	93.3	1.2	35.90
SPY(g)	9.9-23.7	15.3 ± 1.4	22.6	15.8	48.8	3.5	22.60

EBT/hill: Ear bearing tiller/hill, DFF: Days to fifty per cent flowering, L/B: Grain length/grain breadth ratio, SPY: Single plant yield

Table 3. Correlation coefficient of yield and its attributes in lowland rice

Character		PH	EBT/H	PL	PW	G/P	SS/P	DFF	1000-GW	GL	GB	L/B	SPY
PH	P	**1.000**	-0.082	0.098	0.312**	0.194*	-0.110	0.089	0.262**	0.108	0.354**	-0.192**	-0.301**
	G		-0.111	0.112	0.353	0.212	-0.151	0.089	0262	0.119	0…374	-0.200	-0.405
EBT/H	P		**1.000**	-0.109	-0.067	0.120	-0.147	0.027	-0.215*	-0.129	-0.102	-0.019	0.020
	G			-0.071	-0.030	0.157	-0.342	0.038	-0.263	-0.158	-0.118	-0.030	0.051
PL	P			**1.000**	-0.105	0.048	0.050	0.046	-0069	0.030	-0.257**	0.213*	0.110
	G				-0.118	0.083	0.036	0.059	-0.076	0.032	-0.319	0.264	0.169
PW	P				**1.000**	0.385**	-0.213*	0.238**	0.479**	0.217*	0.479**	-0231**	0.076
	G					0.464	-0.257	0.268	0.536	0.225	0.576	-0.301	0.047
G/P	P					**1.000**	-0.275**	0.306**	-0.042	-0.048	-0.012	-0.045	0.070
	G						-0.427	0.336	-0.052	-0.035	0.014	-0.060	0.200
SS/P	P						**1.000**	-0.265**	-0.031	-0.008	-0.120	0.096	-0.083
	G							-0.372	-0.030	0.051	-0.140	0.147	-0.035
DFF	P							**1.000**	0.149	0.032	0.025	-0.014	0.112
	G								0.151	0.033	0.031	-0.018	0.157
1000-GW	P								**1.000**	0.551**	0.555**	-0.089	-0.022
	G									0.576	0.581	-0.096	-0.016
GL	P									**1.000**	-0.092	0.663**	-0.136
	G										-0.111	0.674	-0.252
GB	P										**1.000**	-0.796**	0.067
	G											-0.081	0.063
L/B	P											**1.000**	-0.138
	G												-0.183
SPY	P												**1.000**
	G												

* Significant at 5% level ** Significant at 1 % level

PH: Plant height, EBT/H: Ear bearing tiller/hill, PL: Panicle length, PW: Panicle weight, G/P: Grains/panicle, SS/P: Sterile spikelets/panicle, 1000-GW: 1000-Grain weight, DFF: Days to fifty per cent flowering, GL: Grain length, GB: Grain breadth, L/B: Grain length/grain breadth, SPY: Single plant yield.

Table 4. Mean value of yield and yield attributes in 42 lowland rices

S. No.	Varieties	Parentage	PH	EBT/H	PL	PW	G/P	SS/P	DFF	1000-GW	GL	GB	L/B	SPY
1	Gayatri	Pankaj x Jagannath	93	11.3	23.1	3.5	113.3	16.3	136.3	22.6	6.8	3	2.2	23.7
2	Utkalprava	Waikyaku x CR1014	140.3	11.6	25	2.6	156	19	138.3	18	7.9	2.2	3.5	21.3
3	Varshadhan	IR31432-8-3-2	162.6	10.8	25.2	4.8	178.3	10.3	142	28.6	9.5	2.6	3.5	14.5
4	Durga	Pankaj x CR1014	121	12	23.6	3.4	137.6	18	150.6	22	7.9	2.3	3.4	16
5	Ketekijoha	Savitri x Badsabhog	136.3	13.3	26.6	2.2	80	16.6	129	17.6	8.1	2.1	3.8	9.9
6	Mahalaxmi	Pankaj x Mahsuri	155.4	13.2	23	4.1	186	16	130.3	20.3	8.3	2.7	3	12.2
7	Padmini	Mutant of CR1014	144.1	11.4	28	2.7	123.3	29	126.3	14	7.6	1.9	3.8	14.2
8	Purnendu	Patnei23 x Jaldhi2	163.6	14	26.6	4.1	178.3	17.3	142.6	21.6	8	2.5	3.1	13.6
9	Tulsi	CR151-79 x CR1014	132.7	14.7	26	3.4	193	18	151.6	22.6	8.6	2.4	3.5	14.7
10	Moti	CR151-79x CR 1014	114.3	10.3	26.1	3.6	152.6	16.3	125.3	24	9.1	2.3	3.9	14.9
11	Surendra	OR158-5 x Rasi	147.2	10.2	26	2.8	136.3	20.3	131	30.6	8	2.5	3.2	13.8
12	Dharitri	Pankaj x Jagannath	102.3	11	25.6	3.7	132	18.6	132.6	22.6	7	2.7	2.5	16.5
13	Mandyavijay	Sona x Mahsuri	139.6	11.1	26.2	2.8	160.3	18	123	16.6	7.8	2.2	3.5	12.8
14	Dubraj	Land race	143.5	9.5	22	2.7	150.6	16.6	126.6	17	8.1	2.3	3.4	12.7
15	Sarala	CR151 x CR1014	99	13	24.5	2.4	170.6	14.3	144	20.6	8.1	2.2	3.5	15.9
16	Kanchan	Jajati x Mahsuri	161.5	12.2	25.3	4.2	175.3	17	136.6	22	8.2	2.5	3.2	12.5

Table 4. Contd.

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S.No.	Varieties	Parentage	PH	EBT/H	PL	PW	G/P	SS/P	DFF	1000-GW	GL	GB	L/B	SPY
17	Sashi	IR 50 xPatnei-23	130.1	10.1	27.1	3	111.3	18	134.6	21.5	9.3	2.3	4	16
18	Sabita	Pure line of Boyan	148.5	11.7	23.8	3.8	137	16.3	130.6	31	10.9	2.5	4.3	16.9
19	Rajshree	Pure line sel	132.8	13.6	26.1	3	169.6	16	129	24.3	9.6	2.3	4.1	16
20	BPT5204	GEB 24 x TN-1 x Mahsuri	81.8	12.9	21.3	3.3	119.3	22.6	122.3	14.5	7.8	2.1	3.7	14.2
21	Salivanana	RP5-32 x Pankaj	109.5	9.9	24.2	3.4	142.6	17.3	134.3	22.3	7.9	2.9	2.7	15.2
22	FR 13A	Pure line sel.	153.5	13.1	24.3	2.4	41.6	27.6	131.6	25.6	8.5	3	2.7	11.6
23	Nalini	Pur line sel.	164.5	10	24.1	3.6	163	21	137.6	21	8	2.4	3.2	17.2
24	Dinesh	Laladhi-2 x Pankaj	159.7	9.4	24.1	3.8	143.3	16	136	23.3	7.9	3.3	2.3	17.8
25	Bhagirathi	Jingasali x Patnei-23	164.2	12.3	22.7	4.3	153	17	126.3	25.6	7.7	3.2	2.3	16.1
26	Panidhan	CR151-79 x CR 1014	135.8	12.8	25.9	4	159.6	16	143.3	19.3	8.9	2.4	3.7	17.2
27	Jogen	IR-20xSML 40-10-4	91.6	9.2	23	2.6	100.6	27.6	122.3	28.3	9.9	2.5	3.9	13.7
28	Swarna	Vasishtha x Mahsuri	96.1	20.2	24.2	3.3	157	15.3	123.6	19	7.7	2.5	3	18.9
29	Matangini	Pure line sel.	173.7	10.2	24.3	3.6	129.6	22.6	125.6	25.3	7.9	3	2.5	15.9
30	Hanseswari	Pure line sel.	175.5	11	23.6	4.3	139	16.3	125.3	24.3	8.1	3.2	2.5	10.3
31	Savitri	Pankaj x Jagannath	105.3	8.1	26.2	4	145	19.3	137.6	24.6	7	2.8	2.5	17.8
32	Sonamani	Velki x Mahsuri	160.6	13.3	31.3	3.9	155	17	131.3	27	8.3	3	2.7	18.6
33	Neerja	Pure line sel.	137.5	11	23	3.8	170.6	18.6	140	25.3	9.5	2.8	3.3	10.4
34	Golak	Jhingasali x CN544	158	8.3	24	3.4	162	18.3	134.3	25.6	7.7	3.2	2.3	14.8
35	Lunishree	Nonasali mutant	140.8	8.2	25.5	3.4	80.6	17.3	132.3	30.3	10.7	2.5	4.3	13.4
36	CR1014	T-90 x Uranga urangan	134.3	10.1	27.5	2.7	146.6	16	138	14	7.9	1.9	4.1	14.5
37	Mahasuri	Taichung 65 x Mayanga Ebos 60802	144.1	13.5	24.1	2.2	155	15	128	15.6	7.6	2.3	3.2	15.7
38	Dhusura	Land race	158.1	10.3	28.4	2.1	138.3	16	128.3	13.7	6.7	2.2	3	13.4
39	Saraswati	Pankaj x Patnei-23	176.3	12	23.2	3.9	176.6	15.6	136.6	26.3	7.9	3.2	2.4	13.8
40	Ranjeet	Pankaj xMahsuri	105.9	10.8	26.1	2.8	156.3	21.6	124.3	13.9	7.8	2.3	3.3	17.9
41	Sudhir	FR13A x CNM539	152.1	7.8	29.1	4.2	186.8	23.3	132	28.3	10.2	2.4	4.1	17.2
42	Pooja(Check)	Vijay x T-141	91.9	10.1	27.2	2.7	145.3	16	130.3	19.3	7.9	2.3	3.3	18.8
	Mean		136.6	11.4	25.1	3.3	145.4	18.1	132.9	22.1	8.3	2.5	3.3	15.3
	CV(%)		2.1	13.6	4.6	9.5	10.1	16.6	0.3	2.2	3.1	3.9	4.8	16.2
	SEM±		1.6	0.9	0.6	0.1	8.5	1.7	0.2	0.2	0.1	0.05	0.09	1.4
	CD(5%)		4.7	2.5	1.8	0.5	24	4.9	0.7	0.8	0.4	0.1	0.2	4

PH: Plant height, EBT/H: Ear bearing tiller/hill, PL: Panicle length, PW: Panicle weight, G/P: Grain/panicle, SS/P: Sterile spikelet/panicle, DFF: Days to fifty per cent flowering, GL: Grain length, GB: Grain breadth, L/B: Grain length/grain breadth, SPY: Single plant yield.

values for different characters are given in Table 3. In all these cases, genotypic correlation coefficients were higher in magnitude than phenotypic correlations. This indicated that there was strong inherent association among the traits and therefore, the selection based on phenotypic traits could be effective in achieving the genotypic gain for different attributes. Plant height was significantly positively correlated with panicle weight, grains/panicle, 1000-grain weight, and grain breadth. Panicle weight showed positive correlation with grains/panicle, days to fifty per cent flowering, 1000-grain weight, grain length and grain breadth. This indicates that panicle weight will increase with the increase of above-said characters. 1000-grain weight was positively correlated with grain length

and grain breadth suggested that increase of 1000-grain weight depended on the increase of grain breadth and grain length. L/B ratio was positively correlated with panicle length and grain length. Days to fifty per cent flowering showed positive correlation with grains/panicle. Grains/panicle will increase with increase of days to fifty per cent flowering. Plant height showed negative correlation with L/B ratio and yield. L/B ratio was negatively correlated with panicle weight and grain breadth and this may be due to the decrease of panicle weight and grain breadth. EBT/H and panicle length showed negative correlation with 1000-grain weight, grain breadth respectively. Yield expressed positive association with EBT/H, panicle length, panicle weight, grains/panicle and days to fifty per cent flowering but negatively correlated with sterile spikelets/panicle, 1000-grain weight and grain length. Hence, these characters should be given due consideration during formulation of selection criteria in the crop improvement programme. Similar studies were reported by Reddy *et al*. (1997) in lowland rice and Chauhan *et al.* (1993) in upland rice.

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