Agro-morphologic Traits as Selection Parameters for Improvement of Upland Rice

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Fifty-seven upland rice genotypes were studied to estimate the degree of character association by correlation and path analysis on basis of 14 agro-morphological characters. Genotypic correlation coefficients were higher as compared to the phenotypic correlation coefficients. The grain yield was significantly and positively correlated with flag leaf length and area, grain number/panicle, spikelet fertility, 1000-grain weight, biological yield and harvest index. In addition to high correlation to grain yield, the characters having positive direct effect on grain yield were grain number/panicle, harvest index, 1000-grain weight biological yield and flag leaf length, thus utilization of these traits as selection parameters and strengthening the predictive value of phenotypic selection for yield improvement in upland rice.

Key words: Rice, GCV, PCV, Biological yield, Harvest index

The knowledge about the extent and nature of association of plant characters among themselves and with yield would provide a better understanding in improving yield through selection. Grain yield in rice is a complex character being highly influenced by environmental changes. Therefore, direct selection for yield would not give expected results. The estimation of correlation coefficient among yield and its components has been useful to the breeders in selecting suitable plant types. However, this simple association does not provide the exact basis of simultaneous improvement of the different traits. Under such conditions, path coefficient analysis is a technique which facilitates the partitioning of the correlation coefficients into different components of direct and indirect effects. Further, the quantitative characters being more vulnerable to environmental changes are lively to exhibit differential relationship among themselves. It is for this reason the present study was undertaken in two *kharif* seasons i.e. *kharif* 2002 and 2003 to estimate the genotypic correlation among the 14 characters and to determine the direct and indirect effects of component traits on yield in 57 upland rice genotypes.

Materials and Methods

The experimental material consisted of 57 upland rice genotypes including 32 local rice germplasm collections from 8 hilly districts of Orissa (Table 1). The experiment was laid out in randomized block design with three replications at the Central Research Station, Orissa University of Agriculture & Technology (OUAT) Bhubaneswar, Orissa during *kharif* season in 2002 and 2003. The genotypes direct seeded in 5 rows of 3-m length with row-to-row 20 cm and plant-to-plant 10 cm spacing. Observations were recorded on 14 quantitative characters *viz.*, days to heading, plant height (cm), flag leaf Length (cm), flag leaf area (cm^2), panicle length (cm), panicles per meter square, no. of filled grain/panicle, spikelet fertility, 1000-grain weight (g), grain length (mm), Grain L/B ratio, grain yield (g) and harvest index (%). The data were subjected to statistical analysis. Correlation coefficient at genotypic and phenotypic level and path coefficient were worked out following the method suggested by Goulden (1952) and Dewey and Lu (1959), respectively.

Results and Discussion

The correlation coefficients at the phenotypic and genotypic levels for the characters are presented in Table 2. In respect of most of the character pairs, there was close correspondence between phenotypic and genotypic correlation coefficients, indicating less masking effect of environment on the character expression.

At the genotypic level, the correlation of grain yield with other characters reflected similar pattern of association as the phenotypic correlation. But the genotypic correlation coefficients were higher in magnitude (direction remaining same) as compared to phenotypic values in all the thirteen character pairs. Thus, higher correlation coefficient values at genotypic level having positive association and lower in case of negative association would reinforce selection based on phenotype. At phenotypic level, grain yield exhibited significant positive correlation with flag leaf length, flag leaf area, grain number, spikelet fertility, 1000-grain weight, biological yield and harvest index. Similar results have

Genotype	IC No	Parentage	Plant height (cm)	Place of origin/adaptation
KCM73	298382	Local collection	Tall	Dugudi, G.Udyagin. Kandhamal, Orissa
KCM 74	298383	Local collection	Tall	Dugudi, G.Udyagiri, Kandhamal, Orissa
KCM75	298384	Local collection	Tall	Dugudi, G.Udyagiri, Kandhamal, Orissa
KCM76	298385	Local collection	Tall	Gamuli, G.Udayagri, Kandhamal, Orissa
KCM93	298402	Local collection	Tall	Garnuli, G.Udayagri, Kandhamal, Orissa
KCM 104	298413	Local collection	Tall	Badabandha.Tumudibandha,Kandhamal, Orissa
KCM 105	298414	Local collection	Tall	Badabandha.Tumudibandha Kandhamal, Orissa
KCM 106	298415	Local collection	Tall	Badabandha.Tumudibandha, Kandhamal, Orissa
KCM 107	298416	Local collection	Tall	Badabandha, Tumudibandha.Kandhamal, Orissa
KCM 129	298438	Local collection	Tall	Sikharpadu, Rayagada. Rayagada, Orissa
KCM 130	298439	Local collection	Tall	Sikharpadu, Rayagada, Rayagada, Orissa
KCM 143	298452	Local collection	Tall	Madanpur, Kolhnara, Rayagada, Orissa
KCM 158	298467	Local collection	Tall	Rupakana. Rayagada. Rayagada, Orissa
KCM 170	298479	Local collection	Tall	Mahantaput, Baipariguda, Koraput, Orissa
KCM 176	298485	Local collection	Tall	Utakapadu, Rayagada, Rayagada, Orissa
KCM 186	298495	Local collection	Tall	Sunabahal, Malkanagiri, Malkanagiri, Orissa
KCM 187	298496	Local collection	Tall	Pandripani, Malkanagiri, Malkanagiri, Orissa
KCM 188	298497	Local collection	Tall	Pandnpani, Malkanagiri, Malkanagiri, Orissa
KCM 327	321742	Local collection	Tall	Biswanathpur, Lanjiguda, Kalahandi, Orissa
KCM 336	321753	Local collection	Tall	Phulajhari, Umarkot, Nawarangpur, Orissa
KCM 378	–	Local collection	Tall	Keshanbida, Umarkot, Nawarangpur, Orissa
KM 2	–	Mutant from Kalakeri	Tall	OUAT, Bhubaneswar, Orissa
KM 6	256528	Mutant from Kalakeri	Short	OUAT, Bhubaneswar, Orissa
PB16	256533	Local collection	Tall	Deogarh, Orissa
PB21	256537	Local collection	Tall	Deogarh, Orissa
PB25	256578	Local collection	Tall	Deogarh, Orissa
PB66	256585	Local collection	Tall	Sundargarh, Orissa
PB73	256614	Local collection	Tall	Sundargarh, Orissa
PB102	256650	Local collection	Tall	Sundargarh, Orissa
PB138	256652	Local collection	Tall	Sundargarh, Orissa
PB140	256653	Local collection	Tall	Sundargarh, Orissa
PB141	256660	Local collection	Tall	Sundargarh, Orissa
PB148	256672	Local collection	Tall	Sundargarh, Orissa
PB 160	–	Local collection	Tall	Sundargarh, Orissa
JD6	–	Mutant from (Dular x N 22)	Short	IARI, New Delhi
JD 13	–	Mutant from (Dular x N 22)	Short	IARI, New Delhi
N22	–	Pure line selection	Tall	Uttar pradesh
Blackgora	–	Pure line selection	Tall	Bihar
Kalakeri	–	Pure line selection	Tall	Orissa
Dular	–	Pure line selection	Tail	West Bengal
Annapurna	–	PTB 10/T(N) 1	Short	Kerala
Rudra	–	Parijat/IET3225	Short	OUAT. Bhubaneswar, Orissa
Shankar	–	Parijat/IET3225	Short	OUAT, Bhubaneswar, Orissa
Parijat	–	TKM6/T(N, 1	Short	OUAT. Bhubaneswar. Orissa
Subhadra	–	T(N)1/SR26B	Short	OUAT Bhubaneswar, Orissa
Pathara	–	COIfi/Hema	Short	OUAT, Bhubaneswar, Orissa
Ghanteswari	–	IR2G61-628/N 22	Short	OUAT, Bhubaneswar, Orissa
Lalitgiri	–	Badami/IR 1996-364	Short	OUAT, Bhubaneswar, Orissa
Udayagir	–	IRAT 138ATR 13543-66	Short	OUAT, Bhubaneswar, Orissa
Bhatta Sel. 2	–	Pureline selection	Tall	Orissa
Kalinga 3	–	AC 540/Ratna	Tall	CRRI, Cuttack Orissa
Annada	–	MTU 15/Yai Kyaku Kantoku	Short	CRRI, Cuttack, Orissa
Heera	–	CR 404-48/CR 289-1208	Short	CRRI, Cuttack, Orissa
Neela	–	CR 94-1512-6/Pusa 2-21	Short	CRRI, Cuttack, Orissa
Sneha	–	Annada/CR 143-2-2	Short	CRRI, Cuttack, Orissa
Vandana	–	C 22/Kalaken	Tall	CRRI, Cuttack, Orissa
Vanaprava	–	ARC 12422/ARC 12751	Tall	CRRI.Cuttack, Orissa

been reported in rice by Chauhan *et al.* (1986), Marimuthu *et al.* (1990), Shivani and Reddy (2000), Kavitha and Reddi (2001) and Shrirame and Muley (2003). Association of plant height and panicle length with grain yield was positive but not significant.

Inter-relationship among the yield components at phenotypic level was significant in 42 out of 78 characters pairs. Days to heading showed significant positive correlation with plant height, panicle length and biological yield while significant negative correlation with spikelet

Table 2. Phenotypic (r_p) and genotypic (r_g) correlation among 14 characters pooled over years

Character		PH	FLL	FLA	PL	PN	GN	SF	GW	GL	GL/B	BY	HI	GY
DH	r_p	0.313*	0.067	0.267	0.530**	-0.098	0.212	-0.534**	-0.364**	0.072	0.159	0.282**	-0.481**	-0.119
	r_g	0.327	0.073	0.283	0.604	-0.198	0.240	-0.565	-0.377	0.073	0.164	0.304	-0.548	-0.122
PH	r_p		0.683**	0.720**	0.723**	-0.566**	0.660**	0.271*	0.170	-0.106	-0.080	0.699**	-0.037	0.342**
	r_g		0.75	0.762	0.821	-1.000	0.786	0.286	0.181	-0.116	-0.084	0.761	-0.040	0.363
FLL	r_p			0.821**	0.494**	-0.328**	0.579**	0.435**	0.307*	-0.030	-0.007	0.679**	-0.229	0.475**
	r_g			0.838	0.617	-0.776	0.711	0.495	0.337	-0.032	-0.008	0.771	-0.286	0.525
FLA	r_p				0.609**	-0.495**	0.791**	0.373**	0.153*	-0.185	-0.037	0.827**	-0.284*	0.589**
	r_g				0.728	-1.000	0.935	0.418	0.164	-0.213	-0.040	0.906	-0.330	0.628
PL	r_p					-0.559**	0.678**	0.001	-0.108	0.118	0.204	0.674**	-0.142	0.253
	r_g					-1.000	0.878	0.418	-0.121	0.136	0.233	0.798	0.174	0.294
PN	r_p						0.745**	0.212	0.157	0.021	-0.142	0.314*	-0.154	0.267*
	r_g						1.000	0.392	0.320	0.004	-0.307	-0.667	0.413	0.541
GN	r_p							0.484**	-0.204	0.137	0.307*	0.561**	0.228	0.402*
	r_g							0.559	-0.238	0.148	0.346	0.652	0.275	0.452
SF	r_p								0.411**	-0.228	-0.170	0.373**	0.520**	0.487**
	r_g								0.434	0.238	-0.175	0.410	0.599	0.515
GW	r_p									-0.154	-0.381**	0.577**	0.425**	0.532**
	r_g									-0.171	-0.394	0.613	0.476	0.547
GL	r_p										1.000**	-0.171	-0.022	-0.099
	r_g										1.000	-0.183	-0.029	-0.102
GL/B	r_p											-0.054	0.016	-0.038
	r_g											-0.057	0.011	-0.039
BY	r_p												0.859**	0.953**
	r_g												1.000	0.989
HI	r_p													0.914**
	r_g													1.000

* and ** significant at the levels of 5% and 1% respectively.

DH=Days to heading, PH=Plant height. FLL=Flag leaf length (cm). FLA=Flag leaf area, PL=Panicle length, PN=Panicle numbers/m². GN=Grain numbers/panicle, SF=Spikdet fertility. GW=1000-grain weight, GL=Grain length. GL/B=Grain length/breadth ratio, BY=Biological yield/meter, HI=Harvest index. GY=Grain yield/meter

Table 3. Genotypic path indicating direct (diagonal) and indirect effects of component traits on grain yield pooled over years

Character	DH	PH	FLL	FLA	PL	PN	GN	SF	GW	GL	GL/B	BY	HI	Correlation with yield
DH	-0.004	0.029	-0.004	0.026	-0.079	-0.003	0.006	0.015	-0.010	-0.004	0.014	0.149	-0.258	-0.122
PH	-0.001	0.090	-0.037	0.071	-0.107	-0.021	0.810	-0.008	0.005	0.006	-0.007	0.374	-0.019	0.363
FLL	0.000	0.067	-0.049	0.078	-0.081	-0.013	0.017	-0.013	0.009	-0.002	-0.00!	0.380	0.135	0.525
FLA	-0.001	0.068	-0.041	0.093	-0.095	-0.020	0.022	-0.011	0.004	0.011	-0.003	0.445	0.156	0.628
PL	-0.002	0.074	-0.030	0.067	-0.131	-0.024	0.002	0.000	-0.003	-0.007	0.020	0.393	-0.082	0.294
PN	0.001	-0.107	0.038	-0.104	0.184	0.017	-0.040	0.010	0.008	0.000	-0.027	-0.328	-0.195	-0.054
GN	-0.001	0.071	-0.035	0.087	-0.115	-0.030	0.023	-0.015	-0.006	-0.008	0.030	0.321	0.130	0.452
SF	0.002	0.026	-0.024	0.039	0.00 1	-0.007	0.013	-0.027	0.011	0.012	-0.015	0.202	0.282	0.515
GW	0.001	0.016	-0.017	0.015	0.016	0.006	-0.006	-0.012	0.025	0.009	-0.034	0.302	0.225	0.547
GL	0.000	-0.010	-0.002	-0.018	-0.018	0.000	0.003	0.006	-0.004	-0.051	0.098	-0.090	-0.014	-0.102
GL/B	-0.001	-0.008	0.000	-0.004	-0.030	-0.005	0.008	0.005	-0.010	-00.58	0.086	-0.028	0.005	-0.039
BY	-0.001	0.008	-0.038	0.084	-0.104	-0.012	0.015	-0.011	0.160	0.01	-0.005	0.492	0.475	0.989
III	0.002	-0.004	-0.014	0.031	0.023	-0.007	0.006	-0.016	0.012	00.02	0.001	0.496	0.471	1.003

Residual=00854

DH=Days to heading, PH=Plant height. FLL=Flag leaf length (cm). FLA=Flag leaf area, PL=Panicle length, PN=Panicle numbers/m². GN=Grain numbers/panicle, SF=Spikdet fertility. GW=1000-grain weight, GL=Grain length. GL/B=Grain length/breadth ratio, BY=Biological yield/meter, HI=Harvest index. GY=Grain yield/meter

fertility, 1000-grain weight and harvest index. Plant height had significant positive association with flag leaf length and area, panicle length, grain number, spikelet fertility and biological yield but it showed significant negative association with panicle number. Flag leaf length and area had significant positive association between them as well as with panicle length, grain number, spikelet fertility and biological yield while both had significant negative association with panicle number. Flag leaf length exhibited significant positive association with 1000-grain weight whereas flag leaf area showed positive association with 1000-grain weight although not significant statistically. Association of panicle length was significantly positive with grain number and biological

yield, indicating selection of this trait would be reliable accompanied by high number of grains/panicle and high biological yield. Panicle number showed significant negative association with grain number and biological yield. Grain number/panicle had significant positive correlation with spikelet fertility, grain L/B ratio and biological yield whereas negative association with 1000-grain weight. Besides, above-mentioned characters, spikelet fertility had significant positive association with 1000-grain weight, biological yield land harvest index. 1000-grain weight showed significant negative association with grain L/B ratio while with biological yield and harvest index was positive and significant, indicating its important role in selection for yield improvement. High significant positive association between biological yield and harvest index suggesting their contribution in yield improvement. Characters having strong correlation values on grain yield are useful as selection parameters. Besides high positive and significant association of these traits with other yield attributing traits may be useful for simultaneous selection of many characters while selecting these traits. The contribution of grain number/panicle, panicle length, flag leaf length, 1000-grain weight, biological yield and harvest index towards grain yield in the present study is well corroborated by the results obtained in rice by Paul and Nanda (1994), Yolanda and Das (1995), Biao *et al.* (2002) and Shanthala *et al.* (2004).

The estimates of direct and indirect effects at the genotypic level are presented in Table 3. From the table it is observed that a positive direct effect was highest for biological yield (0.492) followed by harvest index (0.471). The direct positive effect of flag leaf area, plant height, grain L/B ratio, 1000-grain weight, grain number and panicle number were of lower magnitude at genotypic level. All characters except panicle number, grain length and grain L/B ratio had substantial positive indirect effect via biological yield at genotypic level. Flag leaf length and area, grain number, spikelet fertility, 1000-grain weight and biological yield had positive indirect contribution through harvest index. Direct and indirect effects of yield component traits on grain yield have also been reported earlier by Shivani and Reddy (2000), Kavitha and Reddi (2001), Biao *et al.* (2002), Shanthala *et al.* (2004) and Shashidhar *et al.* (2005).

In the present study high genotypic correlation coefficients as compared with the phenotypic correlation coefficients were observed. Significant positive correlation of flag leaf length and area, grain number spikelet fertility, 1000-grain weight, biological yield and harvest index with grain yield in the present study suggest that the selection based on these characters would be effective and reliable. From path coefficient analysis, it could be inferred that biological yield, harvest index, grain number, panicle number and 1000-grain weight contributed substantially towards grain yield both at phenotypic as well as genotypic level, thus suggesting that selection based on these characters would be more effective for yield improvement of early rice varieties for rainfed upland ecosystem.

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