The Andhra Agric. J 61(3): 520-525, 2014

Selection Strategy for Improvement of Yield and Quality Through Genetic Variability Parameters and Trait Association Studies in Rice (*Oryza Sativa* L.)

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ABSTRACT

Thirty two genotypes of rice were evaluated for fourteen quantitative characters to assess the genetic variability and character association among themselves. Genotypic and phenotypic coefficients of variation were high for plant height and harvest index. High heritability accompanied by high genetic advance for days to 50 % flowering, days to maturity, number of effective tillers per plant, plant height, number of grains per panicle, harvest index, kernel L/B ratio, 1000-grain weight and grain yield per plant indicated the predominance of additive gene action for the expression of these characters. Grain yield per plant was found to be positively and significantly correlated with harvest index, number of grains per panicle, panicle length, days to maturity, days to 50 % flowering and plant height. Path analysis revealed high positive direct effects of days to maturity and harvest index on the grain yield per plant, indicating the possibility of yield improvement through direct selection of these traits.

Key words : Correlation, Path analysis, Rice, Variability.

Rice is the most important cereal food crop of India and more than 90 per cent of rice is produced and consumed in Asia. Improvement of rice grain yield is the main target of breeding program to develop rice varieties for diverse ecological conditions. Knowledge on the genetic architecture of genotypes is necessary to formulate efficient breeding methodology.

The systematic breeding programme involves the steps like creating genetic variability, practicing selection and utilization of selected genotypes to evolve promising varieties. Direct selection based on crop yields is often a paradox in breeding programmes because yield is a complex polygenically inherited character. Grain yield being a complex character is governed by the interaction of many variables. Knowledge of the association between yield and its component characters themselves can prove the efficiency of selection and studies on character association prove to be an effective tool for partitioning the correlation coefficient into direct and indirect effects of component characters. Information on direct and indirect effects contributed by each character towards yield will be an added advantage in aiding the selection process. Hence, the present investigation was carried out to determine the interrelationship between yield and its contributing characters as well as to identify the characters to be considered for selecting better genotypes for the development of high yielding varieties.

MATERIAL AND METHODS

The experimental material comprising of thirty two diverse rice genotypes were evaluated during late *rabi* 2011 at wetland farm of S.V. Agricultural College, Tirupati. The experiment was conducted in randomized block design with three replications following a spacing of 20 x 15 cm. Observations on twelve quantitative traits viz., number of effective tillers per plant, plant height, panicle length, number of grains per panicle, 1000-grain weight, harvest index, kernel length, kernel breadth, kernel L/B ratio, kernel length after cooking and kernel elongation ratio were recorded on five randomly selected plants in each genotype in each replication except days to 50 % flowering and days to maturity for which the data were recorded on plot basis. All the recommended agronomic practices were followed. The mean values were subjected to analysis of variance and covariance (Panse and Sukhatme, 1961). The genetic parameters were calculated according to Burton (1952). Genotypic and phenotypic correlation coefficients were estimated following the method of Johnson *et al*. (1955). Similarly, path coefficient analysis as suggested by Dewey and Lu (1959) was used to partition the phenotypic correlation coefficients of characters that correlated significantly with grain yield into components of direct and indirect effects.

RESULTS AND DISCUSSION

The analysis of variance carried out in respect of fourteen quantitative characters revealed highly significant differences among the genotypes for all the characters, indicating the presence of considerable amount of genetic variation for different traits in the present material. The development of an effective plant breeding programme depends on the existence of genetic variability. The higher magnitude of genotypic (GCV) and phenotypic coefficients of variation (PCV) were recorded for traits like plant height and harvest index (Table 1). This suggests that the direct selection for these traits would offer desirable results in further improvement of yield in the present material. However, moderate estimates were observed for number of effective tillers per plant, number of grains per panicle, grain yield per plant, 1000-grain weight, days to 50 % flowering, kernel L/B ratio and days to maturity and rest of the characters showed low estimates of GCV and PCV. Heritability estimates (broad sense) ranged from 76.9 % (grain yield per plant) to 99.9 % (days to maturity). All the characters under study showed high heritability indicating high component of heritable portion of variation that could be exploited in the selection of superior genotypes on the basis of phenotypic performance. High heritability coupled with high genetic advance as per cent of mean was recorded for days to 50 % flowering, days to maturity, number of effective tillers per plant, plant height, number of grains per panicle, harvest index, kernel L/B ratio, 1000-grain weight and grain yield per plant suggesting preponderance of additive gene action in the expression of these characters. Hence, these traits could be considered as favourable attributes for rice improvement through selection. Breeding methods based on progeny testing and mass selection could be useful in improving these traits. Similar findings were also reported by Sankar *et al*. (2006) and Nair and Rosamma (2007).

The estimates of correlation coefficients revealed high genotypic correlations, in general, as compared to their phenotypic counterparts (Table 2). This indicated strong inherent associations between the characters, which might be due to masking or modifying effect of the environment (Johnson *et al*., 1955). The trend of both genotypic and phenotypic correlations was identical in almost all the character pairs. This would increase the efficiency of phenotypic selection. The trait grain yield per plant exhibited highly significant and positive association with harvest index, followed by number of grains per panicle, days to maturity, panicle length, days to 50 % flowering and plant height at both genetic and phenotypic levels, indicating that all these characters are important for exploiting yield improvement. These findings were also in close agreement with the earlier reports of Nandan *et al*. (2010) and Sharma and Sharma (2007). In contrast to this, grain yield per plant showed negative and significant association with number of effective tillers per plant at both levels. This might be due to coincidence of high temperatures with the seed setting in the later developed tillers. Similar results were also reported by Rao (2002).

Days to 50 % flowering exhibited significant positive correlation with days to maturity and number of grains per panicle at both genotypic and phenotypic levels, while significant negative correlation with number of effective tillers per plant at genetic level. On the other hand, days to maturity and plant height also showed significant negative association with number of effective tillers per plant. Whereas, plant height exhibited significant positive association with kernel length, kernel breadth and 1000-grain weight and significant negative association with kernel elongation ratio and kernel length after cooking.

Path coefficient analysis (Table 3) revealed that among the different yield components, days to

Table 1. Mean, Range, Co-efficient of variation, Heritability (broad sense), Genetic advance and Genetic advance as per cent of mean for 14 characters in rice under conventional fertilizer management

S. No.	Character	Mean	Range	Variance		PCV	GCV	Heritability in broad sense (h^2b)	Genetic advance	Genetic advance as % of mean
				Genotypic (V_g)	Phenotypic (V_p)					
1	DF	90.70	59.00 - 107.67	124.41	124.94	12.32	12.30	99.60	22.93	25.28
2	DM	121.92	82.67 - 144.33	152.20	152.41	10.13	10.12	99.90	25.40	20.83
3	ETPP	9.48	7.27 - 15.07	3.17	3.99	21.07	18.79	79.50	3.27	34.52
4	PH	66.89	46.10 - 108.57	245.87	252.91	23.78	23.44	97.20	31.85	47.62
5	PL	23.02	17.67 - 28.57	5.19	6.15	10.77	9.89	84.40	4.31	18.72
6	GPP	161.93	55.27 - 214.60	1018.13	1090.36	20.39	19.71	93.40	63.52	39.23
7	HI	36.96	16.72 - 50.35	55.76	64.56	21.74	20.20	86.40	14.30	38.68
8	KL	5.75	4.81 - 6.56	0.20	0.21	7.88	7.87	99.80	0.93	16.19
9	KB	2.35	1.95 - 2.70	0.04	0.04	8.19	8.16	99.40	0.39	16.76
10	K L/B R	2.46	1.78 - 2.97	0.08	0.08	11.52	11.50	99.60	0.58	23.63
11	KLAC	8.55	7.36 - 9.98	0.31	0.32	6.64	6.56	97.60	1.14	13.34
12	KER	1.49	1.20 - 1.71	0.02	0.02	8.92	8.87	98.70	0.27	18.14
13	1000 GW	22.15	15.14 - 26.83	10.31	10.36	14.53	14.49	99.50	6.60	29.79
14	GYPP	19.06	8.75 - 26.40	12.14	15.80	20.86	18.28	76.90	6.29	33.02

DF : Days to 50% flowering; DM : Days to maturity; ETPP : No. of effective tillers per plant; PH : Plant height (cm);
PL : Panicle length (cm); GPP : No. of grains per panicle;
HI : Harvest index; KL : Kernel length (mm); KB : Kernel breadth (mm); K L/B R : Kernel L/B Ratio;
KLAC : Kernel length after cooking (mm); KER : Kernel elongation ratio;
1000 GW : 1000-grain weight (g); GYPP : Grain yield per plant (g)

Table 2. Phenotypic (r_p) and Genotypic (r_g) correlation coefficients among grain yield per plant and its components in rice under conventional fertilizer management.

S. No	Character		DF	DM	ETPP	PH	PL	GPP	HI	KL	KB	K L/B R	KLAC	KER	1000 GW	GYPP
1	DF	r_p	1.0000	0.9625**	-0.3325	0.0451	0.1942	0.6268**	0.2631	0.0460	-0.3659*	0.2707	0.0854	0.0184	-0.1843	0.4065*
		r_g	1.0000	0.9655	-0.3762	0.0468	0.2124	0.6487	0.2851	0.0462	-0.3680	0.2722	0.0853	0.0175	-0.1838	0.4702
2	DM	r_p		1.0000	-0.3635*	0.0550	0.1635	0.6524**	0.2875	0.0696	-0.3691*	0.2868	0.0813	-0.0024	-0.2125	0.4613**
		r_g		1.0000	-0.4047	0.0554	0.1795	0.6766	0.3105	0.0699	-0.3699	0.2874	0.0820	-0.0030	-0.2136	0.5255
3	ETPP	r_p			1.0000	-0.5147**	-0.3427*	-0.3178	0.0364	-0.1678	-0.1220	-0.0164 -	0.3202	0.3642*	-0.2553	-0.3488*
		r_g			1.0000	-0.5686	-0.4360	-0.3598	0.0853	-0.1934	-0.1414	0.0199	0.3611	0.4140	-0.2824	-0.3933
4	PH	r_p				1.0000	0.2295	0.1812	-0.0217	0.3631*	0.5153**	-0.1098	-0.4868**	-0.6638**	0.4611*	0.3870*
		r_g				1.0000	0.2548	0.1882	-0.0319	0.3694	0.5243	-0.1112	-0.5158	-0.6887	0.4692	0.4280
5	PL	r_p					1.0000	0.2449	0.1773	0.3426*	-0.0119	0.2380	0.0287	-0.2731	0.2595	0.4143*
		r_g					1.0000	0.2732	0.2068	0.3727	-0.0060	0.2551	0.0407	-0.2912	0.2881	0.5132
6	GPP	r_p						1.0000	0.2628	0.0099	-0.1517	0.0991	-0.0357	-0.0393	-0.1883	0.5469**
		r_g						1.0000	0.2877	0.0086	-0.1569	0.1009	-0.0373	-0.0379	-0.1921	0.6030
7	HI	r_p							1.0000	-0.1453	-0.1273	0.0033	0.0434	0.1410	-0.0237	0.5696**
		r_g							1.0000	-0.1531	-0.1416	0.0106	0.0392	0.1422	-0.0275	0.6408
8	KL	r_p								1.0000	-0.1250	0.7377**	0.2107	-0.7129**	0.2057	0.0633
		r_g								1.0000	-0.1253	0.7386	0.2130	-0.7170	0.2069	0.0722
9	KB	r_p									1.0000	-0.7577**	-0.4406*	-0.2152	0.5479**	0.0596
		r_g									1.0000	-0.7581	-0.4477	-0.2178	0.5497	0.0638
10	K L/B R	r_p										1.0000	0.4452*	-0.3128	-0.2300	0.0067
		r_g										1.0000	0.4516	-0.3144	-0.2299	0.0082
11	KLAC	r_p											1.0000	0.5312**	-0.3783*	-0.0727
		r_g											1.0000	0.5244	-0.3829	-0.0917
12	KER	r_p												1.0000	-0.4813**	-0.1171
		r_g												1.0000	-0.4855	-0.1385
13	1000 GW	r_p													1.0000	0.2229
		r_g													1.0000	0.2521
14	GYPP	r_p														1.0000
		r_g														1.0000

*,** Significant at 5 % and 1 % level, respectively.

DF : Days to 50% flowering; DM : Days to maturity; ETPP : No. of effective tillers per plant; PH : Plant height (cm); PL : Panicle length (cm);
GPP : No. of grains per panicle;
HI : Harvest index; KL : Kernel length (mm); KB : Kernel breadth (mm); K L/B R : Kernel L/B Ratio; KLAC : Kernel length after cooking (mm);
KER : Kernel elongation ratio;
1000 GW : 1000-grain weight (g); GYPP : Grain yield per plant (g)

Table 3. Phenotypic (P) and genotypic (G) path co-efficient analysis for grain yield per plant and its components in rice under conventional fertilizer management.

S. No.	Character		Days to 50% flowering	Days to maturity	Number of effective tillers per plant	Plant height (cm)	Panicle length (cm)	Number of grains per panicle	Harvest index (%)	Correlation value with Grain yield per plant (g)
1	Days to 50% flowering	P	**-0.4928**	0.5724	0.0056	0.0129	0.0396	0.1545	0.1142	0.4065*
		G	**-0.5690**	0.7065	-0.0167	0.0160	0.0594	0.1423	0.1317	0.4702
2	Days to maturity	P	-0.4743	**0.5947**	0.0062	0.0157	0.0334	0.1609	0.1248	0.4613**
		G	-0.5493	**0.7318**	-0.0179	0.0189	0.0502	0.1484	0.1435	0.5255
3	Number of effective tillers per plant	P	0.1638	-0.2162	**-0.0170**	-0.1471	-0.0699	-0.0783	0.0158	-0.3488*
		G	0.2141	-0.2961	**0.0443**	-0.1942	-0.1219	-0.0789	0.0394	-0.3933
4	Plant height (cm)	P	-0.0222	0.0327	0.0087	**0.2858**	0.0468	0.0447	-0.0094	0.3870*
		G	-0.0266	0.0405	-0.0252	**0.3415**	0.0712	0.0413	-0.0148	0.4280
5	Panicle length (cm)	P	-0.0957	0.0973	0.0058	0.0656	**0.2040**	0.0604	0.0770	0.4143*
		G	-0.1208	0.1314	-0.0193	0.0870	**0.2795**	0.0599	0.0955	0.5132
6	Number of grains per panicle	P	-0.3089	0.3880	0.0054	0.0518	0.0500	**0.2466**	0.1141	0.5469**
		G	-0.3691	0.4951	-0.0160	0.0643	0.0764	**0.2193**	0.1329	0.6030
7	Harvest index (%)	P	-0.1296	0.1710	-0.0006	-0.0062	0.0362	0.0648	**0.4340**	0.5696**
		G	-0.1622	0.2272	0.0038	-0.0109	0.0578	0.0631	**0.4620**	0.6408

Residual Effect (Phenotypic): 0.586; Residual Effect (Genotypic): 0.427
Bold: Direct effects; Normal: Indirect effects
* Significant at P = 0.05 level; ** Significant at P = 0.01 level

maturity exerted maximum positive direct effect followed by harvest index which corroborates the findings of Reddy *et al*. (2008) and Khan *et al*. (2009). Though grain yield per plant showed significant positive association with days to 50 % flowering, its direct effect was high and negative. The significant positive correlation is due to their high positive indirect effect through days to maturity. Thus, for improvement of this trait selection efforts would be more effective *via* days to maturity instead of selection based on days to 50 % flowering alone. Highly significant association of plant height, number of grains per panicle and panicle length with grain yield per plant is due to their direct effect, indicating a true relationship among the traits. This suggests that direct selection for these traits would likely be effective in increasing grain yield per plant. The residual factors to grain yield per plant at phenotypic (0.586) and genotypic (0.427) levels were observed to be high indicating the role of other possible traits which were not included in the study.

By and large, from the present investigation, it could be concluded that to bring simultaneous improvement of yield and its attributes more emphasis should be given on days to maturity and harvest index as they showed high correlation in addition to maximum direct effects on yield. Hence these characters need to be considered while designing a selection strategy for yield improvement in rice using the present material.

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(Received on 02.09.2012 and revised on 25.02.2013)