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Character Association and Path Analysis of Yield Components in Rice (Oryza sativa L.)

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ABSTRACT

Seventy six rice genotypes were evaluated to find out the association of different characters and their contribution to yield. Character association studies indicated significant positive association of ear bearing tillers plant^{-1} and filled grains panicle^{-1} with grain yield plant^{-1}. Hence, selection for these traits would be more effective to bring improvement in grain yield and to evolve high yielding varieties in rice. Results of path coefficient analysis revealed that ear bearing tillers plant^{-1}, filled grains panicle^{-1}, milling percentage, hulling percentage, grain length, L/B ratio, and kernel length after cooking could serve as important criteria for a sound selection programme, since these traits posses a positive direct effect on grain yield plant^{-1}.

Key words : Analysis, Rice, Yield.

Rice is the most important crop of India Which occupies 23.3 per cent of gross cropped area of the country. It continues to play vital role in the national food grain supply. Yield of paddy is a complex quantitative character controlled by many genes interacting with the environment and is the product of many factors called yield components. Selection of parents based on yield alone is often misleading. Hence, the knowledge about relationship between yield and its contributing characters is needed for an efficient selection strategy for plant breeders to evolve an economic variety. The correlation coefficient is a measure of the degree of association between two traits worked at the same time. Based upon genotypic and phenotypic correlations, the breeder would be able to decide the breeding method to be used to exploit the desirable and break the undesirable associations. Path coefficient analysis is a standardized partial regression analysis which permits the separation of correlation coefficient into measures of direct and indirect effects. This helps in giving due weightage to a particular character during selection. An attempt was made to undesstand the association between yield and its component characters and the extent of nature of direct of indirect effects of yield components on yield.

MATERIAL AND METHODS

The material for study consisted of seventy six genotypes obtained from Rice Research Unit (RRU), Bapatla, Andhra Pradesh. The material was grown in a randomized block design with two replications during *kharif* 2010 at Agricultural College Farm, Bapatla. The observations were recorded on ten random plants from each genotype of each replication for days to 50% flowering, plant height (cm), No. of ear bearing tillers plant^{-1}, filled grains panicle^{-1}, panicle length (cm), test weight (g), grain yield plant^{-1}(g), milling percentage, hulling percentage, head rice recovery, grain length (mm), grain breadth (mm), L/B ratio, kernel length after cooking (mm), protein content, amylose content, and alkali digestion values. Correlation coefficients for yield and its components were worked out. The portioning of genotypic correlation coefficient of traits into direct and indirect effects was carried out using the procedure suggested by Dewey and Lu (1959).

RESULTS AND DISCUSSION

Character association studies (Table 1) indicated significant positive association of ear bearing tillers plant^{-1} and filled grains panicle^{-1} with grain yield plant^{-1} which is in conformity with the findings of Siva Prasad *et al*., 2009 and Pankaj Garg

Table1. Estimates of phenotypic and genotypic correlation coefficients in 76 genotypes of rice (*Oryza sativa* L.)

Character	Days to 50% flowering	Plant height (cm)	Ear bearing tillers Plant^{-1}	Panicle length (cm)	Filled grains Panicle^{-1}	Test weight (g)	Milling%	Hulling%	Head rice recovery
	1	2	3	4	5	6	7	8	9
1	**1.0000**	0.1923*	-0.1265	-0.2247**	0.2246**	-0.0785	-0.0561	-0.2674	0.0161
2	0.2255**	**1.0000**	-0.2212**	0.5242**	0.2101**	0.1677*	-0.1198	-0.2147**	-0.2822**
3	-0.1780*	-0.3168**	**1.0000**	-0.2757**	-0.0676	-0.1246	0.1707*	0.1319	0.2205**
4	-0.2264*	0.5737**	-0.3105**	**1.0000**	0.1236	0.0790	-0.2307**	-0.1323	-0.0876
5	0.2338*	0.2513**	-0.0648	0.1310	**1.0000**	-0.1595*	0.0047	-0.0963	-0.1231
6	-0.1045	0.2949**	-0.1993	0.1140	-0.2380**	**1.0000**	-0.0569	-0.0616	-0.1762*
7	-0.0953	-0.1943*	0.2380**	-0.2810	0.0112	-0.1166	**1.0000**	0.4028**	0.4070**
8	-0.2706**	-0.2352**	0.1492	-0.1352	-0.1015	-0.1069	0.4513	**1.0000**	0.1619*
9	0.0100	-0.3012**	0.2838**	-0.0915	-0.1287	-0.2340**	0.4661	0.1709*	**1.0000**
10	-0.3135**	-0.0297	0.0768	0.0565	-0.0331	0.4469**	0.0557	0.0142	-0.0802
11	0.0514	0.4637***	-0.2613**	0.1112	-0.1013	0.5566**	-0.1065	-0.1955*	-0.3884**
12	-0.2151**	-0.3215**	0.2209**	-0.0454	0.0556	-0.1527	0.1043	0.1463	0.1991*
13	-0.3327**	-0.1926*	0.1579	0.0729	-0.0030	0.2249*	-0.0270	0.0675	-0.1848*
14	-0.1251	0.1510	-0.0395	0.0448	-0.0770	0.1209	0.0713	0.0259	-0.1578
15	-0.0251	-0.1368	-0.2113**	-0.1443	-0.2038*	-0.0612	-0.0560	-0.1734*	0.1546
16	-0.0654	-0.2112**	0.0835	-0.1809	-0.0142	-0.0024	0.1205	0.1044	0.0461
17	0.1051	0.0046	0.3036**	-0.0360	0.2613**	-0.1871*	0.1895*	0.1386	-0.0569

Table 1 Cont.....

Character	Grain length (mm)	Grain breadth (mm)	L/B ratio	Kernel length after cooking (mm)	Protein %	Amylose content	Alkali digestion values	YIELD (g)
	10	11	12	13	14	15	16	17
1	-0.3075**	0.0489	-0.2109**	-0.3263**	-0.1156	0.0021	-0.0695	0.0952
2	-0.0237	0.4052**	-0.2766**	-0.1689*	0.1327	-0.1354	-0.1780*	0.0106
3	0.0487	-0.2127**	0.1682*	0.1384	-0.0432	-0.1039	0.0787	0.2526**
4	0.0568	0.1097	-0.0435	0.0720	0.0422	-0.0974	-0.1729	-0.0282
5	-0.0282	-0.0984	0.0550	-0.0045	-0.0750	-0.1173	-0.0085	0.2562**
6	0.3207**	0.4177**	-0.1238	0.1635*	0.0912	-0.0243	-0.0056	-0.1271
7	0.0556	-0.0907	0.0936	-0.0261	0.0793	0.0513	0.0927	0.1502
8	0.0116	-0.1918*	0.1413	0.0648	0.0229	-0.1096	0.1012	0.1246
9	-0.0722	-0.3819**	0.2002*	-0.1800*	-0.1461	0.1113	0.0460	-0.0585
10	**1.0000**	-0.2263**	0.7302**	0.3590**	0.2069*	-0.0485	0.1589	0.0549
11	-0.2292**	**1.0000**	-0.8130	0.0256	0.0459	0.0539	-0.1318	-0.0558
12	0.7311**	-0.8151**	**1.0000**	0.1813*	0.0849	-0.0810	0.1742*	0.0861
13	0.3685**	0.0244	0.1869*	**1.0000**	0.1615*	-0.0897	0.2924**	0.0741
14	0.2068*	0.0460	0.0828	0.1662*	**1.0000**	0.0672	0.0389	-0.0735
15	-0.0646	0.1041	-0.1291	-0.1620*	0.0805	**1.0000**	0.0508	-0.1627*
16	0.1629*	-0.1354	0.1809*	0.2969**	0.0388	0.0582	**1.0000**	-0.0702
17	0.0584	-0.0620	0.0931	0.0759	-0.0809	-0.2301*	-0.0814	**1.0000**

*,** significant at 0.05 and 0.01 levels of probability respectively.

Values above diagonal indicate phenotypic correlations and values below diagonal indicate genotypic correlation coefficients.

Table 2. Direct and indirect effects (Genotypic) of yield components in 76 genotypes of rice (*Oryza sativa* L.).

Character	Days to 50% flowering	Plant height (cm)	Ear bearing tillers Plant^{-1}	Panicle length (cm)	Filled grains Panicle^{-1}	Test weight (g)	Milling%	Hulling%
	1	2	3	4	5	6	7	8
1	**0.2211**	0.0425	-0.0280	-0.0497	0.0497	-0.0174	-0.0124	-0.0591
2	-0.0227	**-0.1181**	0.0261	-0.0619	-0.0248	-0.0198	0.0141	0.0253
3	-0.0369	-0.0645	**0.2916**	-0.0804	-0.0197	-0.0363	0.0498	0.0385
4	-0.0320	0.0746	-0.0392	**0.1422**	0.0176	0.0112	-0.0328	-0.0188
5	0.0459	0.0430	-0.0138	0.0253	**0.2045**	-0.0326	0.0010	-0.0197
6	0.0106	-0.0227	0.0168	-0.0107	0.0216	**-0.1352**	0.0077	0.0083
7	-0.0087	-0.0186	0.0265	-0.0358	0.0007	-0.0088	**0.1550**	0.0624
8	-0.0357	-0.0287	0.0176	-0.0177	-0.0129	-0.0082	0.0538	**0.1337**
9	-0.0025	0.0445	-0.0348	0.0138	0.0194	0.0278	-0.0643	-0.0256
10	0.0261	0.0020	-0.0041	-0.0048	0.0024	-0.0272	-0.0047	-0.0010
11	0.0199	0.1648	-0.0865	0.0446	-0.0400	0.1699	-0.0369	-0.0780
12	-0.0910	-0.1194	0.0726	-0.0188	0.0238	-0.0534	0.0404	0.0610
13	-0.0147	-0.0076	0.0062	0.0032	-0.0002	0.0074	-0.0012	0.0029
14	0.0084	-0.0097	0.0031	-0.0031	0.0055	-0.0066	-0.0058	-0.0017
15	-0.0001	0.0090	0.0069	0.0065	0.0078	0.0016	-0.0034	0.0073
16	0.0076	0.0194	-0.0086	0.0188	0.0009	0.0006	-0.0101	-0.0110
Yield (g)	**0.0952**	**0.0106**	**0.2526****	**-0.0282**	**0.2562****	**-0.1271**	**0.1502**	**0.1246**
Partial R2	0.0210	-0.0013	0.0737	-0.0040	0.0524	0.0172	0.0233	0.0167

Table 2 Cont.....

Character	Head rice recovery	Grain length (mm)	Grain breadth (mm)	L/B ratio	Kernel length after cooking (mm)	Protein %	Amylose content	Alkali digestion values
	9	10	11	12	13	14	15	16
1	0.0036	-0.0680	0.0108	-0.0466	-0.0722	-0.0256	0.0005	-0.0154
2	0.0333	0.0028	-0.0478	0.0327	0.0199	-0.0157	0.0160	0.0210
3	0.0643	0.0142	-0.0620	0.0491	0.0404	-0.0126	-0.0303	0.0230
4	-0.0125	0.0081	0.0156	-0.0062	0.0102	0.0060	-0.0139	-0.0246
5	-0.0252	-0.0058	-0.0201	0.0113	-0.0009	-0.0153	-0.0240	-0.0017
6	0.0238	-0.0434	-0.0565	0.0167	-0.0221	-0.0123	0.0033	0.0008
7	0.0631	0.0086	-0.0141	0.0145	-0.0040	0.0123	0.0080	0.0144
8	0.0216	0.0016	-0.0256	0.0189	0.0087	0.0031	-0.0146	0.0135
9	**-0.1579**	0.0114	0.0603	-0.0316	0.0284	0.0231	-0.0176	-0.0073
10	0.0061	**-0.0848**	0.0192	-0.0619	-0.0304	-0.0175	0.0041	-0.0135
11	-0.1554	-0.0921	**0.4068**	-0.3307	0.0104	0.0187	0.0219	-0.0536
12	0.0864	0.3152	-0.3509	**0.4316**	0.0783	0.0366	-0.0349	0.0752
13	-0.0081	0.0162	0.0012	0.0082	**0.0450**	0.0073	-0.0040	0.0132
14	0.0106	-0.0150	-0.0033	-0.0062	-0.0117	**-0.0727**	-0.0049	-0.0028
15	-0.0074	0.0032	-0.0036	0.0054	0.0060	-0.0045	**-0.0668**	-0.0034
16	-0.0050	-0.0173	0.0143	-0.0190	-0.0318	-0.0042	-0.0055	**-0.1089**
Yield (g)	**-0.0585**	**0.0549**	**-0.0558**	**0.0861**	**0.0741**	**-0.0735**	**-0.1627***	**-0.0702**
Partial R2	0.0092	-0.0047	-0.0227	0.0372	0.0033	0.0053	0.0109	0.0076

* = significant at 5% level, ** = significant at 1% level. Residual effect = 0.8688, Bold and diagonal values indicate direct effects

Table 3. Direct and indirect effects (Phenotypic) of yield components in 76 genotypes of rice (*Oryza sativa* L.).

Character	Days to 50% flowering	Plant height (cm)	Ear bearing tillers Plant^{-1}	Panicle length (cm)	Filled grains Panicle^{-1}	Test weight (g)	Milling%	Hulling%
	1	2	3	4	5	6	7	8
1	**0.3544**	0.0799	-0.0631	-0.0803	0.0829	-0.0370	-0.0338	-0.0959
2	-0.0481	**-0.2132**	0.0676	-0.1223	-0.0536	-0.0629	0.0414	0.0501
3	-0.0658	-0.1171	**0.3696**	-0.1147	-0.0239	-0.0736	0.0880	0.0551
4	-0.0619	0.1569	-0.0849	**0.2734**	0.0358	0.0312	-0.0768	-0.0370
5	0.0340	0.0366	-0.0094	0.0191	**0.1455**	-0.0346	0.0016	-0.0148
6	0.0400	-0.1129	0.0763	-0.0436	0.0912	**-0.3829**	0.0447	0.0409
7	-0.0179	-0.0365	0.0447	-0.0527	0.0021	-0.0219	**0.1876**	0.0847
8	-0.0440	-0.0382	0.0242	-0.0220	-0.0165	-0.0174	0.0733	**0.1625**
9	-0.0022	0.0654	-0.0616	0.0198	0.0279	0.0508	-0.1011	-0.0371
10	-0.1016	-0.0096	0.0249	0.0183	-0.0107	0.1448	0.0181	0.0046
11	0.0217	0.1961	-0.1105	0.0470	-0.0428	0.2354	-0.0450	-0.0827
12	-0.0201	-0.0300	0.0206	-0.0042	0.0052	-0.0143	0.0097	0.0137
13	-0.0033	-0.0019	0.0016	0.0007	0.0000	0.0022	-0.0003	0.0007
14	0.0104	-0.0126	0.0033	-0.0037	0.0064	-0.0101	-0.0059	-0.0022
15	0.0013	0.0068	0.0105	0.0072	0.0102	0.0031	0.0028	0.0087
16	0.0080	0.0258	-0.0102	0.0221	0.0017	0.0003	-0.0147	-0.0128
Yield (g)	**0.1051**	**-0.0046**	**0.3036****	**-0.0360**	**0.2613****	**-0.1871***	**0.1895***	**0.1386**
Partial R2	0.0372	0.0010	0.1122	-0.0098	0.0380	0.0716	0.0356	0.0225

Table 3 Cont.....

Character	Head rice recovery	Grain length (mm)	Grain breadth (mm)	L/B ratio	Kernel length after cooking (mm)	Protein %	Amylose content	Alkali digestion values
	9	10	11	12	13	14	15	16
1	0.0035	-0.1111	0.0182	-0.0762	-0.1179	-0.0443	-0.0089	-0.0232
2	0.0642	0.0063	-0.0989	0.0686	0.0411	-0.0322	0.0292	0.0450
3	0.1049	0.0284	-0.0966	0.0816	0.0584	-0.0146	-0.0781	0.0308
4	-0.0250	0.0154	0.0304	-0.0124	0.0199	0.0123	-0.0395	-0.0495
5	-0.0187	-0.0048	-0.0147	0.0081	-0.0004	-0.0112	-0.0297	-0.0021
6	0.0896	-0.1711	-0.2131	0.0585	-0.0861	-0.0463	0.0234	0.0009
7	0.0875	0.0105	-0.0200	0.0196	-0.0051	0.0134	-0.0105	0.0226
8	0.0278	0.0023	-0.0318	0.0238	0.0110	0.0042	-0.0282	0.0170
9	**-0.2170**	0.0174	0.0843	-0.0432	0.0401	0.0342	-0.0336	-0.0100
10	-0.0260	**0.3240**	-0.0743	0.2369	0.1194	0.0670	-0.0209	0.0528
11	-0.1642	-0.0969	**0.4228**	-0.3447	0.0103	0.0195	0.0440	-0.0573
12	0.0186	0.0683	-0.0761	**0.0934**	0.0175	0.0077	-0.0121	0.0169
13	-0.0018	0.0037	0.0002	0.0019	**0.0099**	0.0017	-0.0016	0.0030
14	0.0132	-0.0173	-0.0038	-0.0069	-0.0139	**-0.0834**	-0.0067	-0.0032
15	-0.0077	0.0032	-0.0052	0.0064	0.0081	-0.0040	**-0.0499**	-0.0029
16	-0.0056	-0.0199	0.0166	-0.0221	-0.0363	-0.0047	-0.0071	**-0.1223**
Yield (g)	**-0.0569**	**0.0584**	**-0.0620**	**0.0931**	**0.0759**	**-0.0809**	**-0.2301**	**-0.0814**
Partial R2	0.0123	0.0189	-0.0262	0.0087	0.0008	0.0068	0.0115	0.0099

* = significant at 5% level, ** = significant at 1% level. Residual effect = 0.8056, Bold and diagonal values indicate direct effects

et al., 2010 . Hence, selection for these traits would be more effective to bring improvement in grain yield and to evolve high yielding varieties in rice. Whereas amylose content showed a significant negative correlation with yield. A significant positive correlation was shown by 50 % flowering with plant height and filled grains panicle^{-1}, plant height with panicle length (Mohana Krishna *et al*. 2009), filled grains panicle^{-1} and test weight, no. of ear bearing tillers plant^{-1} with milling percentage, head rice recovery and L/B ratio, and test weight with grain length and grain breadth.

Partitioning the phenotypic and genotypic correlation coefficient into direct and indirect effects through path analysis (Table 2 & 3) revealed that ear bearing tillers plant^{-1} exhibited highest direct effect on yield. This was due to the positive indirect effects through plant height (Shashidhar *et al*., 2005), test weight, milling percentage, hulling percentage, L/B ratio, kernel length after cooking, protein content and amylose content. Since, the correlation between yield and this character is due to direct effect, it reveals true relationship between them and direct selection for this trait will be rewarding for yield improvement. These results are in conformity with those obtained by Satish Chandra *et al*. (2009) and Pankaj Garg *et al*.(2010). Characters like days to 50 % flowering, filled grains panicle^{-1}, milling percentage, hulling percentage, grain length, L/B ratio, and kernel length after cooking also showed positive direct effect on grain yield.

Hence, ear bearing tillers plant^{-1} and filled grains panicle^{-1} are the major yield contributing traits and should be given importance in selection process for improving the yield

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