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Cause and Effect Relationship between Yield, Quality and Yield Attributing Traits in Rice (*Oryza sativa*. L.)

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ABSTRACT

Correlation studies revealed positive and significant association of total biomass, harvest index, number of productive tillers per plant, plant height, panicle length, days to 50% flowering and number of filled grains per panicle with grain yield per plant. Selection based on total biomass, harvest index, productive tillers per plant and 1000 grain weight would be more useful for improvement of grain yield in rice, because of their high and positive direct effect on grain yield.

Key words : Correlation, *Oryza sativa* L., Path analysis, Rice.

Yield being a polygenic trait, is dependent on several component characters and the existing interrelationship among the component characters. Knowledge on association of characters among themselves and with grain yield is important for selection in breeding programme. Also in order to get developmental relations, the cause and effect relationship between yield *per se* and yield components path analysis is very important. In the presnt study, an effort has been made to unravel the association of characters and cause and effect relationship among the characters.

MATERIAL AND METHODS

The experimental material comprised of 36 F_1s were evolved by crossing nine parents in diallel mating design. They were raised in randomized complete block design with three replications at Regional Agricultural Station, Jagtial, Karimnagar district during *rabi* 2008-09. Each genotype consisting of 20 plants were raised in a 3.0 m row length with a spacing of 20 x 15 cm and all recommended package of practices were followed to raise a healthy crop. Biometrical observations *viz*., days to 50 per cent flowering, plant height, panicle length, number of productive tillers per plant, number of filled grains per panicle, panicle density, 1000 grain weight, total biomass, harvest index, grain yield per plant, hulling percent, kernel length, kernel breadth and L/B ratio were recorded on 5 randomly selected plants. The estimates of phenotypic and genotypic correlation coefficients were worked out according to Singh and Chaudhary (1985). The genotypic and phenotypic correlations were partitioned into path coefficient using the technique outlined by Dewey and Lu (1959).

RESULTS AND DISCUSSION

From the present investigation it was inferred that the variation exists among the 36 genotypes was found to be highly significant for the entire fourteen trait studied. The analysis of results, revealed there exists highly significant variations among the genotypes for all the 14 traits studied. In general the genotypic correlation coefficients were slightly higher than the phenotypic correlation coefficients. Seven character *viz.,* days to 50 per cent flowering, plant height, panicle length, productive tillers per plant, filled grains per panicle, total biomass and harvest index had significantly positive association with grain yield(Table 1). This is in conformity of the finding of Krishna *et al.,* (2008) and Yugandhar Reddy *et al.,* (2008). This implies to attain improvement in grain yield, selection of parents for hybridization based on above characters could be very much handy.

Considering the inter relationship among yield components, days to 50 per cent flowering was positive and significantly correlated with productive tillers per plant and total biomass.

Selection for increased days to 50% flowering indirectly increase the productive tillers per plant and total biomass which in turn increase the grain yield per plant (Panwar and Mashiat Ali, 2007) and negatively correlated with 1000 grain weight, which reveals selection for early duration genotype decreases the test weight as in case of Suman (2003). Plant height exhibited significantly positive correlation with panicle length, filled grains per panicle and 1000 grain weight

Significant negative genotypic and positive non significant phenotypic association of productive tillers per plant with grain yield was observed, which is similar to the findings of Panwar and Mashiat Ali, (2007) and Krishna *et al.,* (2008). The kernel length/breadth ratio was negatively associated with grain yield which was also reported by Krishnaveni and Shobha Rani (2006) and Krishna *et al.,* (2008).

Total biomass yield per plant showed positively significant association with grain yield, similar findings were also reported by Panwar and Mashiat Ali (2007) and Yugandhar Reddy *et al.,* (2008). Positive association of harvest index with grain yield per plant obtained in the present investigation was in conformity with the results of Chitra *et al.,* (2005) and Yugandhar Reddy (2008). The trait kernel length showed significant positive genotypic correlation with grain yield, as against the findings of Krishnaveni and Shobha Rani (2006) and Krishna *et al.* (2008) who have reported negative correlation. The other quality trait, kernel breadth had positive correlation with yield (Krishnaveni and Shobha Rani, 2006).

Association analysis among yield component characters revealed that days to 50 per cent flowering showed significant negative association with panicle length, 1000 grain weight, harvest index, kernel length and kernel length/ breadth ratio, similar results of negative association was reported by Eradasappa *et al.,* (2007) for panicle length; Krishnaveni and Shobha Rani (2006) and Krishna *et al.,* (2008) for 1000 grain weight; Panwar and Mashiat Ali (2007) and Anbumalarmathi and Nadarajan (2008) for harvest index; Krishna *et al.,* (2008) for kernel length and Krishna Naik *et al.,* (2005) for kernel L/B ratio. Whereas, positive significant association of days to 50 per cent flowering with filled grains per panicle was in conformity with the results of Kavitha and Sree Rami Reddi (2001) and Krishna Naik *et al.,* (2005) and total biomass in accordance to Panwar and Mashiat Ali (2007).

Plant height recorded negative significant association with productive tillers per plant (Nayak *et al.,* 2001 and Anbumalarmathi and Nadarajan, 2008), Panicle density and kernel length/breadth ratio. Whereas, positive and significant association was reported with panicle length by Chitra *et al.,* (2005) and Krishna *et al.,* (2008), with 1000 grain weight by Panwar and Mashiat Ali (2007) and Krishna *et al.,* (2008), total biomass, hulling per cent and with kernel length and breadth (Krishna *et al.,* 2008).

The trait panicle length exhibited significant and positive association with 1000 grain weight (Sharma and Sharma 2007 and Krishna *et al.,* 2008), harvest index, kernel length and breadth (Krishna *et al.,* 2008) Number of productive tillers per plant showed significant negative correlation with filled grains per panicle (Tarasatyavathi *et al.,* 2001 and Krishna Naik *et al.,* 2005), panicle density, harvest index and positive association is reported with total biomass (Panwar and Mashiat Ali 2007). The character number of filled grains per panicle had significant positive association with panicle density, total biomass and hulling percentage, while significant negative association was recorded with 1000 grain weight (Krishna *et al.,* 2008), harvest index, kernel length (Krishnaveni and Shobha Rani 2006 and Krishna *et al.,* 2008), kernel breadth and kernel L/B ratio by Krishna *et al.,* (2008). Panicle density had significant negative association with the characters, 1000 grain weight, harvest index, kernel length, kernel breadth and kernel length/breadth ratio and with total biomass and hulling percentage the association was positive.

The character test weight observed the positive and significant association with harvest index (Panwar and Mashiat Ali, 2007 and Anbumalarmathi and Nadarajan, 2008), Kernel length and Kernel length/breadth ratio (Krishna *et al.,* 2008). The trait harvest index correlated positively and significant with kernel length and kernel length/breadth ratio. Kernel length had significant positive correlation with kernel breadth (Krishna *et al.,* 2008) and Kernel length/breadth ratio (Krishnaveni and Shobha Rani, 2006 and Krishna *et al.,* 2008) while, kernel breadth had significant negative association with kernel L/B ratio.

Table 1. Estimates of Phenotypic and Genotypic correlation coefficients among seed yield per plant and other characters of F_1 Progenies in rice.

Character	Days to 50% flowering	Plant height (cm)	Panicle length (cm)	No. of productive tillers/ hill	No. of filled grains/ panicle	Panicle Density	1000 grain weight (g)	Total biomass (g)	Harvest index (%)	Hulling recovery (%)	Kernel length (mm)	Kernel breadth (mm)	Kernel L/B ratio	Grain yield/ plant (g)
Days to 50% flowering	**1.0000**	-0.0840 (-0.1334)	-0.1212 (-0.2029*)	0.2334* (0.2925*)	0.1517 (0.1727)	0.1844 (0.2149*)	-0.2402* (-0.2496*)	0.2398* (0.2461*)	0.0189 (0.0042)	0.0203 (0.0542)	-0.3921** (-0.4125**)	0.0783 (0.0774)	-0.4561** (-0.4969**)	0.2096* (0.2087*)
Plant height (cm)		**1.0000**	0.5566** (0.8418**)	0.1882 (0.2348*)	0.2338* (02197*)	0.0501 (-0.0060)	0.3280** (0.3941**)	0.3052** (0.3511**)	0.2532** (0.3626**)	0.1689 (0.5153**)	0.3036** (0.3333**)	0.1433 (0.2054*)	0.1537 (0.1252)	0.3752** (0.4495**)
Panicle length (cm)			**1.0000**	0.2579** (0.4270**)	0.1542 (0.1886)	-0.1606 (-0.0591)	0.3354** (0.4428**)	0.3155** (0.4198**)	0.0932 (0.0865)	0.2238** (0.4142**)	0.2809** (0.4132**)	0.1546 (0.2358*)	0.1101 (0.1554)	0.3018** (0.3970**)
No. of productive tillers/ hill				**1.0000**	-0.0600 (-0.0499)	-0.1452 (-0.1602)	0.1316 (0.1426)	0.5503** (0.6639**)	-0.0938 (-0.1268)	0.1835 (0.6733**)	-0.0381 (-0.0603)	-0.0255 (-0.0521)	0.0073 (0.0189)	0.4487** (0.5304**)
No. of filled grains/ panicle					**1.0000**	0.9473** (0.9684**)	-0.4425** (-0.4746**)	0.1223 (0.1283)	0.2061* (0.2238*)	0.2014* (0.3396**)	-0.4060** (-0.436**)	-0.2588** (-0.2653**)	-0.0828 (-0.1194)	0.2080* (0.2135*)
Panicle density						**1.0000**	-0.5401** (-0.5850**)	0.0056 (0.0079)	0.1783 (0.2092*)	0.1311 (0.2213*)	-0.4915** (-0.5432**)	-0.3021** (-0.3277**)	-0.1192 (-0.1571)	0.1022 (0.1085)
1000 grain weight (g)							**1.0000**	0.0721 (0.0716)	-0.1592 (-0.1801)	-0.0088 (-0.0227)	0.8512** (0.8734**)	0.6999** (0.7395**)	0.0371 (0.0436)	-0.0029 (-0.0035)
Total biomass (g)								**1.0000**	0.1960* (0.2622v)	0.0995 (0.2392*)	-0.0290 (-0.0268)	0.0790 (0.0955)	-0.1006 (-0.1212)	0.8813** (0.9035**)
Harvest index (%)									**1.0000**	0.1169 (0.1848)	-0.1119 (-0.1186)	-0.1330 (-0.1623)	0.0363 (0.0605)	0.6004** (0.6252**)
Hulling recovery (%)										**1.0000**	0.0470 (0.1953*)	-0.0675 (-0.1748)	0.1162 (0.4033**)	0.1428 (0.3404**)
Kernel length (mm)											**1.0000**	0.5449** (0.5708**)	0.3323** (0.3415**)	-0.0790 (-0.0744)
Kernel breadth (mm)												**1.0000**	-0.6048** (-0.5728**)	-0.0074 (-0.0049)
Kernel L/B ratio													**1.0000**	-0.0564 (-0.0587)

* Significant at 5 per cent level; ** Significant at 1 per cent level; The values in the parenthesis are genotypic correlations

Table 2. Estimates of Phenotypic and Genotypic path coefficients of quality, yield and yield components of F_1 progenies in rice.

Character	Days to 50% flowering	Plant height (cm)	Panicle length (cm)	No. of productive tillers/ hill	No. of filled grains/ panicle	Panicle Density	1000 grain weight (g)	Total biomass (g)	Harvest index (%)	Hulling recovery (%)	Kernel length (mm)	Krneel breadth (mm)	Kernel L/ B ratio
Days to 50% flowering	**0.00709** **(-0.0038)**	-0.0006 (0.0005)	-0.0009 (0.0008)	0.0016 (-0.0011)	0.0011 (-0.0007)	0.0013 (-0.0008)	-0.0017 (0.0009)	0.0017 (-0.0009)	0.0001 (0.00000)	0.0001 (-0.0002)	-0.0028 (0.0016)	0.0006 (-0.0003)	-0.0032 (0.0019)
Plant height (cm)	-0.0014 (0.0087)	**0.0168** **(-0.0660)**	0.0093 (-0.0556)	0.0032 (-0.0155)	0.0039 (-0.0145)	0.0008 (0.0004)	0.0055 (-0.0260)	0.0051 (-0.0232)	0.0042 (-0.239)	0.0028 (-0.0340)	0.0051 (-0.0220)	0.0024 (-0.0136)	0.0026 (-0.0083)
Panicle length (cm)	-0.0112 (0.0166)	0.0512 (-0.0687)	**0.0920** **(-0.0816)**	0.0237 (-0.0349)	0.0142 (-0.0154)	-0.0148 (0.0048)	0.0309 (-0.0361)	0.0290 (-0.0343)	0.0086 (-0.0071)	0.0206 (-0.0338)	0.0259 (-0.0337)	0.0142 (-0.0192)	0.0101 (-0.0127)
No. of productive tillers/ hill	0.0170 (0.0400)	0.0137 (0.0322)	0.0187 (0.0586)	**0.0727** **(0.1369)**	-0.0044 (-0.0068)	-0.0106 (-0.0219)	0.0096 (0.0195)	0.0400 (0.0909)	-0.0068 (-0.0174)	0.0133 (0.0922)	-0.0028 (-0.0083)	-0.0018 (-0.0071)	0.0005 (0.0026)
No. of filled grains/ panicle	-0.0468 (0.0874)	-0.0721 (0.1112)	-0.0476 (0.0954)	0.0185 (-0.0253)	**-0.3084** **(0.5061)**	-0.2922 (0.4901)	0.1365 (-0.2402)	-0.0377 (0.0649)	-0.0636 (0.1133)	-0.0621 (0.1719)	0.1252 (-0.2207)	0.0798 (-0.1343)	0.0255 (-0.0604)
Panicle density	0.0646 (-0.0917)	0.0175 (0.0026)	-0.0563 (0.0253)	-0.0509 (0.0685)	0.3318 (-0.4139)	**0.3502** **(-0.4274)**	-0.1892 (0.2500)	0.0020 (-0.0034)	0.0624 (-0.0894)	0.0459 (-0.0946)	-0.1722 (0.2322)	-0.1058 (0.1401)	-0.0417 (0.0672)
1000 grain weight (g)	-0.0183 (-0.0285)	0.0251 (0.0450)	0.0256 (0.0506)	0.0100 (0.0163)	-0.0338 (-0.0870)	-0.0413 (-0.0668)	**0.0764** **(0.1142)**	0.0055 (0.0082)	-0.0122 (-0.0206)	-0.0007 (-0.0026)	0.0650 (0.0997)	0.0535 (0.0844)	0.0028 (0.0050)
Total biomass (g)	0.1803 (0.1668)	0.2294 (0.2380)	0.2372 (0.2846)	0.4137 (0.4501)	0.0920 (0.0870)	0.0042 (0.0054)	0.0542 (0.0485)	**0.7519** **(0.6779)**	0.1473 (0.1778)	0.0748 (0.1621)	-0.0218 (-0.0182)	0.0594 (0.0648)	-0.0757 (-0.0822)
Harvest index (%)	0.0085 (0.0020)	0.1144 (0.1761)	0.0421 (0.0420)	-0.0424 (-0.06160	0.0931 (0.1087)	0.0806 (0.1016)	-0.0719 (-0.0875)	0.0885 (0.1274)	**0.4518** **(0.4857)**	0.0528 (0.0898)	-0.0505 (-0.0576)	-0.0601 (-0.0788)	0.0164 (0.0294)
Hulling recovery (%)	-0.0001 (-0.0004)	-0.0010 (-0.0038)	-0.0014 (-0.0031)	-0.0011 (-0.0050)	-0.0012 (-0.0025)	-0.0008 (-0.0016)	0.0001 (0.0002)	-0.0006 (-0.0018)	-0.0007 (-0.0014)	**-0.0061** **(-0.0074)**	-0.0003 (-0.0014)	0.0004 (0.0013)	-0.0007 (-0.0030)
Kernel length (mm)	-0.0497 (-0.01280	0.0385 (0.0103)	0.0356 (0.0128)	-0.0048 (-0.0019)	-0.0515 (-0.0135)	-0.0623 (-0.0168)	0.1079 (0.0271)	-0.0037 (-0.0008)	-0.0142 (-0.0037)	0.0060 (0.0061)	**0.1268** **(0.0310)**	0.0691 (0.0177)	0.0421 (0.0106)
Kernel breadth (mm)	-0.0173 (-0.0075)	-0.0317 (-0.0198)	-0.0342 (-0.0227)	0.0056 (0.0050)	0.0572 (0.0256)	0.0668 (0.0316)	-0.1548 (-0.0713)	-0.0175 (-0.0092)	0.0294 (0.0157)	0.0149 (0.0169)	-0.1205 (-0.0551)	**-0.2211** **(-0.0965)**	0.1338 (0.0553)
Kernel L/B ratio	0.0771 (0.0318)	-0.0260 (-0.0080)	-0.0186 (-0.0099)	-0.0012 (-0.0012)	0.0140 (0.0076)	0.0201 (0.0100)	-0.0063 (-0.0028)	0.0170 (0.0078)	-0.0061 (-0.0039)	-0.0196 (-0.0258)	-0.0561 (-0.0218)	0.1022 (0.0366)	**-0.1689** **(-0.0640)**

Bold values are direct effects; Phenotypic residual effect = 0.1621; Genotypic residual effect = 0.1158; The values in the parenthesis are genotypic path coefficients.

The positive association of plant height with grain yield per plant obtained in the present study is in conformity with the results of Madhavilatha (2002) and Krishna *et al.,* (2008). Positive association of test weight with yield observed in the present study is in agreement with the findings of Anbumalarmathi and Nadarajan (2008).

It is quite possible that a trait showing positive direct effect on yield may have a negative indirect effect via other component traits. Path analysis permits the estimation of direct effects of various characters on yield as well as their indirect effects via other component traits. Thus through the estimates of direct and indirect effects, it determines the yield components and provides basis for selection of superior genotypes from the diverse breeding populations.

Number of filled grains per panicle, was found to have maximum direct positive effect on grain yield per plant (Table 2). These results are in agreement with the earlier reports of Malini *et al.,* (2007) and Krishna *et al.,* (2008). Positive direct effect of plant height on yield in the present study is in conformity with the results of Krishnaveni and Shobha Rani (2005) and Krishna *et al.,* (2008), Positive direct effect of total biomass on grain yield was reported by Panwar and Mashiat Ali (2007) and Yugandhar Reddy *et al.,* (2008) which is in conformation with the present findings.

In the present study, number of filled grains per panicle exhibited positive indirect effect on grain yield via panicle density, hulling percentage, days to 50 per cent flowering (Anbumalarmathi and Nadarajan, 2008) and total biomass (Panwar and Mashiat Ali, 2007), whereas 1000 grain weight exhibited positive indirect effect on yield via panicle density, number of filled grains per panicle (Krishna Naik *et al.,* 2008), hulling percent (Madhavilatha 2002) and days to 50 per cent flowering (Krishna *et al.,* 2008).

The character total biomass recorded positive indirect effect on yield through days to 50 per cent flowering, productive tillers per plant, kernel breadth, panicle density, hulling percent, plant height, number of filled grains per panicle and 1000 grain weight (Madhavilatha, 2002 and Panwar and Mashiat Ali, 2007).

Harvest index had indirect positive effect through1000 grain weight, kernel length/breadth ratio (Vinothini and Ananda Kumar 2005). Kernel length (Reddy *et al.,* 1997) and panicle length (Yugandhar Reddy *et al.,* 2008). Among the grain quality characters kernel length/breadth ratio showed positive indirect effect on grain yield through days to 50 per cent flowering, Plant height, panicle length, filled grains per panicle, Panicle density, total biomass and kernel breadth (Nayak *et al.,* 2001 and Madhavilatha, 2002), productive tillers per plant (Krishna Naik *et al.,* 2005), .

Correlation studies revealed significant association in desired direction with yield was observed for the traits, plant height, 1000 grain weight, total biomass, harvest index, kernel length and kernel L/B ratio. Path matrix revealed that number of filled grains per panicle, total biomass, harvest index and kernel length were found to have maximum direct positive effect on grain yield per plant.

The lower residual effect indicated that different characters other than the characters considered in this study influence the grain yield considerably. It is evident from the study that selection for the improvement of grain yield can be efficient based on filled grains per panicle, total biomass and 1000 grain weight and harvest index

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