Association Studies for Yield and Its Traits in Rice (*Oryza sativa* L.) Genotypes

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**A B S T R A C T**

AssOCIATION studies among seven traits were studied in 40 genotypes during *kharif*, 2015 at Agricultural Research Station, Kunaram, Telangana State. In general, genotypic correlation coefficients were higher than the corresponding phenotypic correlation coefficients suggesting that strong genetic association among the yield and yield components of rice. Correlation coefficient analysis showed that number of productive tillers per m² and 1000-grain weight exhibited significant positive correlation with yield at both genotypic and phenotypic levels. Significant negative correlation was observed between number of filled grains per panicle and yield. Path coefficient analysis revealed that positive direct effect of number of productive tillers per m² and days to 50% flowering on grain yield at both genotypic and phenotypic levels.

**Keywords**

Correlation coefficient, Path coefficient, Genotype, Rice

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**Introduction**

Rice is the world’s most important food and second most widely cultivated cereal in the world and is a staple food for more than half of the world’s population. Rice grain yield being a complex trait, depends upon the various yield contributing traits like test weight, number of grains per panicle, panicle length, effective bearing tiller number etc. Character association derived by correlation coefficient which is one of the important biometrical tools for formulating a selection index as it reveals the strength of relationship among the group of traits. The type and extent of correlation between the yield and other characters helps in estimating the relative effect of the individual traits on yield improvement thereby enable the breeders to identify desirable traits that play a key role in yield improvement. Knowledge about the relationship between a trait with yield and other yield components would be helpful in selecting proper rice genotypes as parents in breeding programmes. Path analysis furnishes the information of influence of each contributing trait to yield directly as well as indirectly and also enables the breeders to rank the genetic attributes according to their contribution. The present study is aimed at
estimating the association between yield and its components for further improvement to derive high yielding rice genotypes with desirable agronomic traits to attain self sufficiency and meet the future demand resulting from population growth.

Materials and Methods

In the present research work study, material consisted of 40 rice genotypes (37 genotypes involving 11 diverse parental lines from ARS, Kunaram and three released promising varieties from APRRI, Maurteru; RARS, Jagtial and ARS, Bapatla) developed through pedigree method of breeding (Table 1). The seed was raised on nursery beds and 25 days old seedlings of each entry was transplanted under irrigated system with two replications in a RBD design during kharif, 2015 at Agricultural Research Station, Kunaram, Telangana. All the recommended package of practices and need based plant protection measures were followed to ensure healthy crop growth. The data was recorded at maturity on 5 random plants for plant height (cm), panicle length (cm), number of productive tillers per m² and number of grains per panicle. However, days to 50 % flowering and grain yield (kg) were recorded on whole plot basis, whereas, random sample was taken to estimate 1000 grain weight (g) for each entry in each replication. Number of productive tillers per plant values were converted into the number of productive tillers per m² and grain yield values recorded from the net plot (kg per plot) were converted in to hectare (kg per ha). The mean data after computing for each trait was subjected to analysis of variance and estimates of correlations and path coefficients were determined to estimate the type and degree of association among the yield and its characters. Genotypic and Phenotypic correlation coefficients for all the possible comparisons were computed.

Results and Discussion

Analysis of variance revealed highly significant differences among the genotypes for all the traits studied indicating the presence of considerable amount of variability among the genotypes (Table 2). Calculation of correlation between yield and its traits, and among the traits plays an important role in selection of desirable genotypes. Genotypic and phenotypic correlations were in perfect agreement with each other and relatively higher magnitude of genotypic correlations indicated the masking effect of the environment. Similar results were reported by Ravindra babu et al., (2012), Mohan et al., (2015), Ratna et al., (2015) and Kalyan et al., (2017). The grain yield (kg per ha) showed significantly positive correlation with number of productive tillers per m² and 1000-grain weight at both genotypic and phenotypic levels. These results clearly indicated that genotypes with more number of productive tillers per m² and bold grains contribute for more grain yield (kg per ha). These results are in agreement with Akinwale et al., (2011), Ravindra babu et al., (2012) and Ratna et al., (2015) for productive tillers per plant and, Mohan et al., (2015) and Islam et al., (2016) for test weight. Days to 50% flowering exhibited significant positive association with number of grains per panicle and number of productive tillers per m², whereas, it manifested significant negative correlation with 1000-grain weight. The trait, number of grains per panicle showed significant negative correlation with grain yield (kg per ha) and 1000-grain weight indicating the practice of selecting bold grain genotypes would enhance the yield levels (Table 3). Akinwale et al., (2011), Ruth Elizabeth Ekka et al., (2011), Ravindra babu et al., (2012), Gopikannan and Ganesh (2013) and Ratna et al., (2015) reported the positive association of grain yield (kg per ha) with filled grains per panicle which was contradictory with this study.
Table 1 List of genotypes studied along with the pedigree and grain type

| S.No. | Genotype       | Pedigree                        | Grain type |
|-------|----------------|--------------------------------|------------|
| 1     | KNM 2108       | MTU 1001 X JGL 11470           | MS         |
| 2     | KNM 2211       | MTU 1001 X JGL 11727           | LS         |
| 3     | KNM 2230       | BPT 5204 X JGL 3828            | MS         |
| 4     | KNM 2231       | BPT 5204 X JGL 3828            | MS         |
| 5     | KNM 2237       | JGL 3855 X JGL 11470           | MS         |
| 6     | KNM 2242       | JGL 3855 X JGL 11470           | MS         |
| 7     | KNM 2246       | JGL 3855 X JGL 11470           | MS         |
| 8     | KNM 2249       | JGL 3855 X JGL 11470           | MS         |
| 9     | KNM 2250       | JGL 3855 X JGL 11470           | MS         |
| 10    | KNM 2251       | JGL 3855 X JGL 11470           | MS         |
| 11    | KNM 2254       | JGL 3855 X JGL 11470           | MS         |
| 12    | KNM 2266       | JGL 3828 X JGL 13595           | MS         |
| 13    | KNM 2275       | JGL 13571 X JGL 11727          | MS         |
| 14    | KNM 2283       | JGL 13571 X JGL 11727          | MS         |
| 15    | KNM 2285       | JGL 13571 X JGL 11727          | MS         |
| 16    | KNM 2287       | JGL 3828 X JGL 13595           | MS         |
| 17    | KNM 2289       | JGL 11118 X Himalaya 741       | MS         |
| 18    | KNM 2300       | JGL 11470 X Himalaya 741       | MS         |
| 19    | KNM 2301       | JGL 11470 X Himalaya 741       | MS         |
| 20    | KNM 2302       | JGL 11470 X Himalaya 741       | MS         |
| 21    | KNM 2303       | JGL 11470 X Himalaya 741       | LS         |
| 22    | KNM 2311       | JGL 11727 X JGL 17004          | MS         |
| 23    | KNM 2312       | JGL 11727 X Himalaya 741       | MS         |
| 24    | KNM 2314       | JGL 11470 X Himalaya 741       | MS         |
| 25    | JGL 3844       | Released variety from RARS, Jagtial. | MS         |
| 26    | BPT 5204       | Released variety from ARS, Bapatla. | MS         |
| 27    | KNM 2110       | MTU 1001 X JGL 11727           | LS         |
| 28    | KNM 2112       | MTU 1001 X JGL 11727           | LS         |
| 29    | KNM 2114       | MTU 1001 X JGL 11727           | LS         |
| 30    | KNM 2118       | MTU 1001 X JGL 11727           | LS         |
| 31    | KNM 2119       | MTU 1001 X JGL 11727           | LS         |
| 32    | KNM 2207       | MTU 1001 X JGL 11727           | LS         |
| 33    | KNM 2213       | MTU 1001 X JGL 11727           | LS         |
| 34    | KNM 2290       | JGL 11118 X Himalaya 741       | LS         |
| 35    | KNM 2305       | JGL 11470 X Himalaya 741       | LS         |
| 36    | KNM 2307       | JGL 11727 X JGL 17004          | LS         |
| 37    | KNM 2321       | JGL 11470 X Himalaya 741       | LS         |
| 38    | KNM 2326       | JGL 11118 X Himalaya 741       | LS         |
| 39    | KNM 2332       | JGL 11118 X Himalaya 741       | LS         |
| 40    | MTU 1010       | Released variety from APRRI, Maureru. | LS         |

LS: Long slender; MS: Medium slender

Table 2 Mean squares corresponding to various sources of variation for seven traits in rice

| Source of variation | Degrees of freedom | Days to 50% flowering | Plant height (cm) | Number of productive tillers per m² | Panicle length (cm) | Number of grains per panicle | 1000-grain weight (g) | Grain yield (kg/ha) |
|---------------------|--------------------|-----------------------|------------------|--------------------------------------|--------------------|-------------------------------|----------------------|-------------------|
| Replications        | 1                  | 0.01                  | 0.92             | 1119.01                              | 1.13               | 5126.40                       | 0.02                 | 1108263.00       |
| Treatments          | 39                 | 262.64**              | 211.16**         | 2082.54*                             | 5.47***            | 7004.89**                     | 47.61**              | 4718577.99**     |
| Error               | 39                 | 0.75                  | 5.42             | 1208.36                              | 0.72               | 1468.17                       | 0.23                 | 315815.28        |

*, ** significant at 5 and 1 per cent level
### Table 3 Phenotypic (P) and genotypic (G) correlation coefficients among yield and other parameters in rice genotypes

| Character                          | Days to 50% flowering | Plant height (cm) | Panicle length (cm) | Number of productive tillers per m² | Number of grains per panicle | 1000 grain weight (g) | Grain yield (kg/ha) |
|-----------------------------------|------------------------|-------------------|---------------------|------------------------------------|-----------------------------|----------------------|--------------------|
| Days to 50% flowering             | P: 1.0000              | 0.0565            | -0.0077             | 0.1148                             | 0.3638**                    | -0.3000**           | 0.0884             |
|                                   | G: 1.0000              | 0.0639            | 0.0058              | 0.2252**                           | 0.4544**                    | -0.3003**           | 0.0935             |
| Plant height (cm)                 | P: 1.0000              | 0.2843*           | 0.1961              | 0.0101                             | -0.1217                     | -0.0287             |                    |
|                                   | G: 1.0000              | 0.2940*           | 0.3687**            | -0.0153                            | -0.1267                     | -0.0420             |                    |
| Panicle length (cm)               | P: 1.0000              | 0.0100            | 0.1581              | -0.1518                            | 0.3297**                    | -0.0641             |                    |
|                                   | G: 1.0000              | 0.0058            | 0.2162              | -0.2452*                           | 0.3744**                    | -0.1532             |                    |
| Number of productive tillers per m²| P: 1.0000              | 1.0000            | -0.2251*            | 0.1649                             | 0.2422*                     |                    |                    |
|                                   | G: 1.0000              | 0.0987            | 0.3318**            | 0.4432**                           | 0.0338                      | 0.4432**            |                    |
| Number of grains per panicle      | P: 1.0000              | 0.0015            | -0.0225*            | 0.1649                             | 0.2422*                     |                    |                    |
|                                   | G: 1.0000              | -0.0987           | 0.3318**            | 0.4432**                           | 0.0338                      | 0.4432**            |                    |
| 1000 grain weight (g)             | P: 1.0000              | -0.0601           | -0.6287**           | -0.2511*                           | 0.2422*                     |                    |                    |
|                                   | G: 1.0000              | -0.7840**         | -0.3468**           | 0.2422*                            | 0.2422*                     |                    |                    |

P: Phenotypic correlation coefficients, G: Genotypic correlation coefficients

* *, ** significant at 5 and 1 per cent level

Gen: R² = 0.4855; Residual effect = 0.7173

Phe: R² = 0.1772; Residual effect = 0.9071

### Table 4 Phenotypic (P) and genotypic (G) path coefficients of yield and other parameters in rice genotypes

| Character                          | Days to 50% flowering | Plant height (cm) | Panicle length (cm) | Number of productive tillers per m² | Number of grains per panicle | 1000 grain Weight (g) | Grain yield (kg/ha) |
|-----------------------------------|------------------------|-------------------|---------------------|------------------------------------|-----------------------------|----------------------|--------------------|
| Days to 50% flowering             | P: 0.2002              | 0.0113            | -0.0015             | 0.0230                             | 0.0728                      | -0.0601              | 0.0884             |
|                                   | G: 0.1977              | 0.0126            | 0.0011              | 0.0445                             | 0.0898                      | -0.0594              | 0.0935             |
| Plant height (cm)                 | P: 0.0010              | 0.0183            | -0.0078             | -0.0983                            | 0.0041                      | 0.0338               | -0.0420            |
|                                   | G: -0.0178             | -0.2668           | 0.0052               | -0.0983                            | 0.0041                      | 0.0338               | -0.0420            |
| Panicle length (cm)               | P: 0.0016              | 0.0581            | -0.2045             | -0.0323                            | 0.0310                      | -0.0674              | -0.0641            |
|                                   | G: -0.0014             | -0.0718           | -0.2441             | -0.0528                            | 0.0599                      | -0.0914              | -0.1532            |
| Number of productive tillers per m²| P: 0.0196              | 0.0334            | 0.0269               | 0.1705                             | -0.0384                     | 0.0281               | 0.2422             |
|                                   | G: 0.1364              | 0.2232            | 0.1309               | 0.6055                             | -0.0598                     | 0.2009               | 0.4434             |
| Number of grains per panicle      | P: -0.0550             | 0.0015            | 0.0229               | 0.0340                             | -0.1511                     | 0.0950               | -0.2511            |
|                                   | G: 0.1364              | 0.0114            | 0.1829               | 0.0736                             | -0.7459                     | 0.5849               | -0.3468            |
| 1000 grain weight (g)             | P: -0.0791             | -0.0321           | 0.0869               | 0.0435                             | -0.1657                     | 0.2636               | 0.2570             |
|                                   | G: 0.1169              | 0.0493            | -0.1457              | 0.1291                             | 0.3052                      | -0.3892              | 0.2796             |

P: Phenotypic path coefficients, G: Genotypic path coefficients
The direct positive effect of number of productive tillers per m² on grain yield (kg per ha) and positive significant correlation between these two traits indicates that true relationship and direct selection through this trait would be more effective for the improvement. Positive direct effect of the trait, days to flowering on grain yield (kg per ha) was reported by Chandra et al., (2009) and Bhadru et al., (2011). Rice workers viz., Madhavilatha (2002), Khedikar et al., (2004), Ruth Elizabeth Ekka et al., (2011), Ravindra babu et al., (2012), Gopikannan and Ganesh (2013) and Ratna et al., (2015) found the positive direct effect and significant correlation between productive tillers per plant and grain yield (kg per ha) which supported the present finding. On the other hand, number of grains per panicle and panicle length exhibited negative direct effect on grain yield (kg per ha) suggesting the non reliability of these traits in selection process for improving the grain yield (kg per ha) using present experimental material. These results were in conformity with Ganesan et al., (1997), Nayak et al., (2001), Madhavilatha (2002), Nagaraju et al., (2013) and Rao et al., (2014) for number of filled grains per panicle; Basava raja et al., (2011), Padmina et al., (2011) and Mohanty et al., (2012) for panicle length. Number of grains per panicle and 1000-grain weight had direct negative and positive effects at phenotypic level on grain yield (kg per ha), respectively (Table 4). Simultaneous improvement of these both traits is not possible as they are negatively correlated with each other. Therefore, appropriate balance should be attained between them to get high yield.

It is concluded that number of productive tillers per m² and 1000-grain weight had strong genetic association with grain yield, and the traits number of productive tillers per m² and days to 50% flowering registered positive direct effect on grain yield (kg per ha) in studied genotypes. Thus, these plant traits deserve greater attention in further breeding programmes for developing high yielding rice varieties.

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