# Correlation and path analysis of grain yield in rice

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***Abstract:*** *Twenty five released high yielding rice varieties collected from various research stations of Kerala Agricultural University constituted the materials for the experiment. Observations on morphological characters were recorded at the time of harvesting and were subjected to statistical analysis. Grain yield was found to be positively and significantly correlated both at genotypic and phenotypic levels with plant height, total number of tillers plant$^{-1}$, number of productive tillers plant$^{-}$ , panicle length, straw yield and harvest index. At genotypic level yield was positively and significantly correlated with days to flowering and number of spikelets panicle$^{-1}$. Path analysis was carried out using significant genotypic correlation of these eight characters. The highest positive direct effect was exhibited by plant height on yield. This was followed by number of productive tillers plant$^{-1}$, straw yield harvest index and total number of tillers plant$^{-1}$. The highest negative direct effect on yield was obtained for days to flowering. Among the varieties analyzed Aruna recorded the maximum grain yield of 6.64 tonnes. The straw yield was 11.17 tonnes per hectare. So it can be concluded that yield of rice can be improved by selecting medium tall genotypes having more number of productive tillers plant$^{-1}$, higher straw yield and an optimum duration.*

**Key words:** correlation, path analysis, yield, rice

## INTRODUCTION

Rice occupies the largest area among all the crops grown in India and is the staple food for 65 per cent of the total population of India, providing 43% caloric requirement for more than two third of Indian population. The yield potentiality of rice has been increased substantially during 1970's. But after that there was no substantial increase in productivity. This pattern of yield plateau exhibited by High Yielding Varieties (HYVs) is a great challenge to meet the present demand of rice production to sustain the population of our country. Hence an insight into the characters contributing to the grain yield of rice is very much essential. The present study has been designed under the above circumstances to find out the major yield contributing characters in rice.

## MATERIALS AND METHOD

The present study was carried out as a part of a doctoral research programme in the Department of Plant Breeding and Genetics, College of Horticulture, Kerala Agricultural University, Vellanikkara, Thrissur, Kerala, India during 2002-2005. Twenty five released high yielding rice varieties collected from Rice Research Station (RRS), Moncompu, Kerala; Regional Agricultural Research Station (RARS), Pattambi, Kerala and Agricultural Research Station (ARS), Mannuthy, Kerala constituted the materials for the experiment. 16-20 days old seedlings according to the maturity duration of 25 rice varieties selected were planted in Randomized Block Design (RBD) with two replications having plots consisting of 5 rows of 30 hills with a spacing of 15 cm between plants and 20 cm between rows. The package of practices recommendations of Kerala Agricultural University for HYVs was adopted. Observations on morphological characters were recorded on ten randomly selected plants in each replication for each treatment at the time of harvesting after leaving the border rows. Grain yields of varieties were then subjected to correlation studies and path analysis to find out the characters affecting grain yield of rice.

## RESULTS AND DISCUSSION

The genotypic and phenotypic correlation coefficients among different morphological characters were studied and the results are presented in tables 1a and 1b). Grain yield was found to be positively and significantly correlated both at genotypic and phenotypic levels with plant height (0.633, 0.601) total number of tillers plant$^{-1}$ (0.326, 0.309), number of productive tillers plant$^{-1}$ (0.700, 0.685), panicle length (0.372, 0.370), straw yield (0.727, 0.676) and harvest index (0.299, 0.289). At genotypic level yield was positively and significantly correlated with days to flowering (0.284) and number of spikelets panicle$^{-1}$ (0.272).

Correlation coefficient measures the intensity of linear relationship between variables. In genetic studies it is common to find the correlation between two or more characters. Genotypic correlation between two or more characters may result from pleiotropic effects of genes or linkage of genes governing the inheritance of the characters. Phenotypic correlation on the other hand is determined by genotypic and environmental effects.

Thus estimation of correlation coefficients among different characters is very much important to know the type of relationship existing between the variables. Among the various characters studied presently, the highest genotypic association with yield was recorded for straw yield followed by number productive tillers plant$^{-1}$, plant height, panicle length, total number of tillers plant$^{-1}$, harvest index ,days to flowering and total number of spikelets panicle$^{-1}$. This reveals that improvement in grain yield could be achieved by exercising selection simultaneously for increased straw yield, increased number of total and productive tillers plant$^{-1}$, medium tall plants with longer duration, longer panicles, increased harvest index and more number of spikelets panicle$^{-1}$.With respect to yield components, the highest degree of positive association both at phenotypic and genotypic levels was exhibited by straw yield, followed by number of productive tillers plant$^{-1}$, suggesting that straw yield and number of productive tillers plant$^{-1}$ are highly reliable components of yield and can be utilized as yield indicators in yield trials. Similar findings were previously recorded by Shriram and Muley (2003) for harvest index and Abhinav *et al.* (2004) for plant height, number of productive tillers per plant and total number of spikelets per panicle.

Among the component characters, straw yield was positively correlated with productive tillers plant$^{-1}$ and productive tillers plant$^{-1}$ was positively correlated with total number of tillers plant$^{-1}$. The results were in agreement with the findings of Verma and Srivastava (2004). Panicle length showed positive association with total number of spikelets panicle$^{-1}$ and number of filled grains panicle$^{-1}$, indicating that longer panicles will be having more number of spikelets and filled grains. In the present study medium tall plants were found to be high yielders because of the positive correlation of plant height with number of productive tillers plant$^{-1}$ and harvest index.

Sometimes correlation may not be due to the direct effect of the characters, but due to the indirect effects through other characters. Hence in order to identify the direct and indirect effects of the variables path analysis is conducted. Plant breeder has to deal with correlated characters during improvement programmes. It was observed that there may not be genes for yield *per se* rather there could be genes which govern the inheritance of component characters. Therefore rapid improvement in yield is expected to result if selection is practiced for component characters. Rate of improvement is expected to be rapid if differential emphasis is laid on the component characters during selection. The basis of differential emphasis could be the degree of influence of component characters on the economic characters of interest. The degree of influence of one variable on the other can be expressed in quantitative terms by the method of path coefficient analysis. This helps to disentangle the direct and indirect influences of component characters on yield.

Path analysis was carried out using significant genotypic correlation of eight pollinator parent characters *viz.* plant height, total number of tillers plant$^{-1}$, number of productive tillers plant$^{-1}$, days to flowering, panicle length, total number of spikelets panicle$^{-1}$, straw yield and harvest index (Table 2). The residual effect was found to be 0.12. The highest positive direct effect was exhibited by plant height (0.438) on yield. This was followed by number of productive tillers plant$^{-1}$ (0.273), straw yield (0.257), harvest index (0.227) and total number of tillers plant$^{-1}$ (0.221). The highest negative direct effect on yield was obtained for days to flowering (-0.112). Total number of spikelets panicle$^{-1}$ exhibited the lowest direct effect and indirect effect of other characters through this trait was also found to be negligible.

The low residual effect of 0.12 obtained in the analysis indicates that the characters included in the study are enough to explain the variability in the yield of pollinator parents. Eighty eight per cent of the variation in yield was contributed genotypically by the eight components included in the study. The highest positive direct effect on yield was observed for plant height. This character was having high positive indirect effect through productive tillers plant$^{-1}$. High positive direct effects were also recorded by number of productive tillers plant$^{-1}$ and straw yield. These characters had high and positive correlation coefficients with yield. For number of productive tillers plant$^{-1}$ and straw yield correlation coefficients were greater than their corresponding direct effects on
yield. This can be explained by the positive indirect effect of productive tillers through plant height and straw yield. For straw yield the indirect effects through plant height and productive tillers plant$^{-1}$ contributed towards the higher correlation coefficient. The results are in agreement with the earlier reports Chaudhary and Motiramani (2003) for effective tillers per plant and biological yield per plant and Surek and Beser (2003) for biological yield and number of productive tillers /m$^2$.

Even though days to flowering was having positive correlation with yield, it recorded negative direct effect. This was in agreement with the reports of Shanthala *et al.* (2004). Indirect effect of this character

through plant height, straw yield, productive tillers plant$^{-1}$ and total number of spikelets panicle$^{-1}$ were positive explaining the positive correlation coefficient.

High negative direct effect exhibited by days to flowering and at the same time and positive significant correlation with yield indicates that there should be an optimum number of days to flowering and harvesting for maximizing the yield. So we can conclude that yield of rice can be improved by selecting medium tall genotypes having more number of productive tillers plant$^{-1}$, higher straw yield and an optimum duration.

Among the varieties analyzed Aruna recorded the maximum grain yield of 6.64 tonnes per ha followed by Karishma (6.37 tonnes per ha) and Krishnanjana (6.05 tonnes per ha). The straw yields were 11.17, 12.08 and 13.57 tonnes per hectare respectively for these varieties. Aruna exhibited a plant height of 103.70 cm, average six numbers of productive tillers per hill and 100-110 days duration. For Karishma and Krishnanjana the average plant heights were 99.75cm and 105.80 cm respectively. Both had mean six numbers productive tillers. Aruna (MO8), Karishma (MO 18) and Krishnanjana (MO 19) are high yielding varieties released from rice Research Station, Moncombu.

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Table 1a.Genotypic correlation coefficients between yield and yield component characters in rice

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | | | | | | | | | |
| 2 | -0.185 | | | | | | | | | | | | | | | | |
| 3 | 0.467** | 0.432** | | | | | | | | | | | | | | | |
| 4 | 0.455** | 0.049 | 0.198 | | | | | | | | | | | | | | |
| 5 | 0.440** | 0.068 | 0.189 | 0.961** | | | | | | | | | | | | | |
| 6 | 0.106 | 0.047 | -0.043 | 0.098 | 0.088 | | | | | | | | | | | | |
| 7 | 0.361* | 0.064 | -0.247 | 0.383** | 0.39** | 0.407** | | | | | | | | | | | |
| 8 | 0.075 | 0.326** | -0.182 | 0.345** | 0.333* | 0.466** | 0.597** | | | | | | | | | | |
| 9 | 0.315* | -0.347** | 0.043 | 0.013 | 0.057 | -0.226 | 0.322* | -0.474** | | | | | | | | | |
| 10 | -0.105 | 0.122 | 0.199 | 0.396** | 0.394** | 0.023 | -0.046 | -0.122 | 0.183 | | | | | | | | |
| 11 | 0.017 | 0.124 | 0.347** | 0.105 | 0.134 | -0.053 | -0.34* | -0.101 | -0.103 | 0.655** | | | | | | | |
| 12 | 0.367** | 0.46** | -0.112 | -0.056 | -0.104 | 0.134 | 0.196 | 0.008 | 0.093 | -0.61** | -0.621** | | | | | | |
| 13 | -0.121 | 0.281* | 0.295** | 0.113 | 0.151 | -0.059 | -0.311 | -0.063 | -0.135 | 0.717** | 0.977** | -0.830 | | | | | |
| 14 | 0.633** | 0.326* | 0.700** | 0.284** | 0.260 | 0.372** | 0.272* | 0.032 | 0.192 | 0.008 | -0.078 | 0.171 | -0.115 | | | | |
| 15 | 0.315* | 0.259 | 0.611** | 0.282** | 0.250 | 0.385** | 0.093 | 0.087 | -0.041 | 0.063 | 0.063 | 0.026 | 0.038 | 0.727** | | | |
| 16 | -0.204 | -0.166 | 0.512** | -0.175 | -0.138 | 0.412** | 0.090 | 0.060 | 0.206 | 0.046 | -0.095 | -0.083 | -0.044 | 0.299* | -0.942** | | |
| 17 | -0.091 | -0.108 | -0.027 | 0.132 | 0.159 | -0.204 | -0.353* | -0.123 | -0.220 | 0.602** | 0.315* | -0.289* | 0.333** | -0.088 | -0.128 | 0.171 | |

** significant at 1% level * significant at 5% level

1 Plant height 2 Total number of tillers /plant 3 Number of productive tillers/ plant 4 Days to flowering 5 Days to harvest
6 Panicle length 7 Total number of spikelets /panicle 8 Number of filled grains/ panicle 9 Chaff per cent 10 100 grain weight
11 Grain length 12 Grain breadth 13 L/B ratio of grains 14 Grain yield 15 Straw yield
16 Harvest index 17 Grain density

Table 1b.Phenotypic correlation coefficients between yield and yield component characters in rice

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | | | | | | | | | |
| 2 | -0.187 | | | | | | | | | | | | | | | | |
| 3 | 0.447** | 0.387** | | | | | | | | | | | | | | | |
| 4 | .406** | 0.072 | 0.198 | | | | | | | | | | | | | | |
| 5 | .426** | 0.058 | 0.181 | 0.951** | | | | | | | | | | | | | |
| 6 | 0.067 | 0.061 | 0.041 | 0.099 | 0.050 | | | | | | | | | | | | |
| 7 | .356** | 0.053 | -0.243 | 0.342* | .0.386** | 0.301* | | | | | | | | | | | |
| 8 | 0.073 | .0298* | -0.182 | 0.317* | 0.329* | 0.342* | 0.594** | | | | | | | | | | |
| 9 | 0.310* | 0.302* | 0.046 | 0.013 | 0.055 | 0.147 | 0.317* | -0.471** | | | | | | | | | |
| 10 | -0.101 | 0.109 | 0.205 | 0.347* | 0.386** | 0.036 | -0.049 | 0.118 | 0.181 | | | | | | | | |
| 11 | 0.017 | 0.012 | 0.362** | 0.170 | 0.135 | 0.003 | -0.324* | -0.100 | -0.097 | 0.623** | | | | | | | |
| 12 | 0.293* | -0.331* | -0.070 | -0.021 | -0.052 | 0.075 | 0.158 | 0.025 | 0.085 | -0.472** | -0.432** | | | | | | |
| 13 | -0.099 | 0.216 | 0.274 | 0.113 | 0.138 | -0.029 | -0.283* | -0.071 | -0.137 | 0.647** | 0.898** | -0.738** | | | | | |
| 14 | 0.601** | 0.309* | 0.685** | 0.271 | 0.252 | 0.370** | 0.261 | 0.022 | 0.188 | 0.014 | -0.034 | 0.152 | -0.091 | | | | |
| 15 | 0.311* | 0.234 | 0.583** | 0.256 | 0.246 | 0.262 | 0.090 | 0.087 | -0.042 | 0.067 | 0.045 | 0.013 | 0.039 | 0.676** | | | |
| 16 | -0.181 | -0.108 | 0.429** | -0.142 | -0.137 | 0.173 | 0.089 | 0.068 | 0.195 | 0.037 | -0.032 | -0.065 | -0.009 | 0.289* | -0.899** | | |
| 17 | -0.080 | -0.001 | -0.053 | 0.171 | 0.109 | -0.232 | -0.225 | -0.081 | -0.149 | 0.306* | 0.221 | -0.185 | 0.246 | -0.048 | -0.091 | 0.125 | |

** significant at 1% level * significant at 5% level

1 Plant height 2 Total number of tillers /plant 3 Number of productive tillers/ plant 4 Days to flowering
5 Days to harvest 6 Panicle length 7 Total number of spikelets /panicle 8 Number of filled grains/ panicle
9 Chaff per cent 10 100 grain weight 11 Grain length 12 Grain breadth
13 L/B ratio of grains 14 Grain yield 15 Straw yield 16 Harvest index
17 Grain density

Table 2. Direct and indirect effects of yield components on grain yield of pollinator parents

| Characters | Plant height | Total number of tillers plant $^{-1}$ | Number of productive tillers plant$^{-1}$ | Days to flowering | Panicle length | Total number of spikelets panicle$^{-1}$ | Straw yield | Harvest index | Correlation coefficient with yield |
|---|---|---|---|---|---|---|---|---|---|
| Plant height | **0.438** | -0.041 | 0.122 | -0.046 | 0.014 | 0.048 | 0.080 | 0.018 | 0.633 |
| Total number of tillers plant$^{-1}$ | -0.082 | **0.221** | 0.106 | -0.008 | 0.012 | 0.007 | 0.060 | 0.010 | 0.326 |
| Number of productive tillers plant$^{-1}$ | 0.196 | 0.085 | **0.273** | -0.022 | 0.008 | -0.033 | 0.151 | 0.042 | 0.700 |
| Days to flowering | 0.178 | 0.016 | 0.054 | **-0.112** | 0.020 | 0.046 | 0.069 | 0.014 | 0.284 |
| Panicle length | 0.029 | 0.013 | 0.011 | -0.011 | **0.203** | 0.040 | 0.069 | 0.017 | 0.372 |
| Total number of spikelets panicle $^{-1}$ | 0.156 | 0.012 | -0.066 | -0.038 | 0.061 | **0.134** | 0.023 | -0.009 | 0.272 |
| Straw yield | 0.137 | 0.052 | 0.160 | -0.030 | 0.054 | 0.012 | **0.257** | 0.087 | 0.727 |
| Harvest index | -0.069 | -0.024 | 0.207 | 0.059 | 0.068 | 0.048 | -0.217 | **0.227** | 0.299 |

Bold figures indicate direct effects; Residual effect = 0.12