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# Study correlation coefficients and Path Analysis for Yield and its Component characters in Rice (*Oryza sativa* L.)

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**Abstract**

Twenty seven diverse germplasm accessions of Rice were evaluated for seed yield and its components for eighteen characters under irrigated condition during *Kharif* 2017 at Research farm, NDUA&T, Kumarganj, Faizabad. Tillers per plant exhibited highly significant and positive phenotypic correlation with panicle bearing tillers per plant, seedling length exhibited highly significant and positive phenotypic correlation with seedling vigour index, root length shows highly significant and positive phenotypic correlation with seedling vigour index, root length shows highly significant and positive phenotypic correlation with seedling length and harvest index shows highly significant and positive phenotypic correlation with economic yield components suggested that selection would be highly effective and efficient in improving these traits due to possibility of correlation response. Path coefficient analysis identified highest positive direct effect on economic yield was exerted by harvest index followed by biological yield, root length, the highest negative direct effect on economic yield was exerted by seedling length followed by seed germination, substantial positive indirect effects was exerted by seedling length via seedling vigour index, seedling vigour index via harvest index, the negative indirect effects was exerted by seedling length via seedling vigour index and shoot length via seedling length as important components having high order of indirect effect on economic yield. The characters identified above as important direct and indirect yield components merit due to consideration in formulating effective selection strategy for developing high yielding rice varieties.

**Keywords:** Rice, correlation coefficients, path analysis and yield

## Introduction

Rice **(***Oryza sativa* L.**)** belongs to Poaceae family. It has been cultivated as a major crop from ~11,500 years and [it] currently sustains one half of the world population (Wu *et al*., 2004) and its native is in tropical and subtropical south-eastern Asia and Africa. Rice is the principal source of food for more than one third of the world's population.

Rice is one of the most important staple food crops in the world. In Asia, more than 2 billion people are getting 60-70% of their energy requirement from rice, occupies an area of 44 million hectare with productivity of 2.0 tones/hectare. More than 90% of the world's rice is grown and consumed in Asia where 60% of the earth's people and about two-third of the world's poor live. (Khush and Virk, 2000). Demand for rice is growing every year and it is estimated that in 2010 and 2025 AD the requirement was 100 and would be 140 million tons respectively. To sustain present food self-sufficiency and to meet future food requirement, India has to increase its rice productivity by 3% per annum (Thiyagarjan and Selvaraju, 2001).

India has the largest area 43.39 million hectare constituting 28.01% of the land under rice in the world and rank second in total production 108.50 million tonnes next to china (185.490 million tons) with an average productivity of 2604 kg/hectare (Anonymous 2016-17) [2]. Asia has an area of only 140.036 million hectare and productivity as 4.21 tones/hectare. More than 80% of people of our country depend fully or partially on rice as their main food and staple diet. Uttar Pradesh is one of the important rice growing state of country.

The area and production of rice in this state is about 5.34 million hectare and 16.51 million tonnes respectively with the productivity of 3.75 tonnes/hectare (Uttar Pradesh Directorate of Agricultural Ministry, 2016 - 17).

The concept of path analysis was developed by Wright (1921) but the technique was first used for plant selection by Dewey and Lu (1959). Path-coefficient is simply a standardized partial regression coefficient, which splits the correlation coefficient into the measures of direct and indirect effects. In other words, it measures the direct and indirect contribution of various independent characters on a dependent character. It also estimates residual effects. Path analysis reveals relative importance of yield-contributing characters thus, is useful in indirect selection. Several literatures in respect of genetic variability, correlation and path analysis in rice is available. However, the result of the earlier studies on such aspect are relevant only for materials and environment involved in the particular study due to their non-consistent nature and can't be generalized. Therefore, studies on above aspect on the available germplasm is essential for successful utilization of germplasm resources for the development of superior rice variety.

## Materials and Methods

The experiments will be conducted to evaluate 30 exotic and indigenous paddy germplasms including three checks ***viz.*** Sarju 52, NDR 8002, and NDR 359 following Randomized Block design at Research Farm of NDUA&T, Kumarganj, Faizabad and seed quality parameters will be tested in Seed Testing Laboratory of N.D.U.A. & T. Kumarganj, Faizabad. The observations on following characters will be recorded as per guidelines. The seeds were sown on 11 June, 2017 in separate pots and 28 days (17-18 July, 2017) old seedlings were transplanted as single seedling per hill in single row plots of 3 m length following 20 cm inter-row and 15 cm intra-row spacing. All the recommended cultural practices were followed to raise a good crop. The fertilizers were applied @ 120 kg nitrogen, 60 kg phosphorus and 60 kg potash per hectare through urea, DAP and mutate of potash, respectively. The full dose of phosphorus and potash and half dose of the nitrogen were applied as basal and rest of nitrogen was applied in two split doses as top dressing at tillering and panicle initiation stage of the crop growth.

## Results and Discussion

### Correlation

Economic yield, in almost all the crops, is the complex character, which manifests from multiplicative interactions of several other characters that are termed as yield components. The genetic architecture of seed yield in rice as well as other crops is based on the balance or overall net effect produced by various yield components directly or indirectly by interacting with one another. Therefore, selection for yield alone would not matter much as such unless accompanied by the selection for various component characters responsible for conditioning it. Thus, identification of important yield components and their association with yield and with each other are very useful for developing efficient breeding strategy for evolving high yielding varieties. The correlation coefficient is the measure of degree of symmetrical association between two variables or characters, which helps us in understanding the nature and magnitude of association among yield and its components traits.

In the present investigation, simple correlation coefficients were computed among 18 characters (Table 4.4).

The Tillers per plant exhibited highly significant and positive association with panicle bearing tillers per plant at phenotypic as well as genotypic levels. Thus, seedling length exhibited highly significant and positive association with seedling vigour index in rice, root length shows highly significant and positive phenotypic correlation with seedling vigour index, root length shows highly significant and positive phenotypic correlation with seedling length and harvest index shows highly significant and positive phenotypic correlation with economic yield also been reported earlier findings of Prasad *et al.*(2013) [10], Shiva *et al.* (2000) [12], Madhavilatha *et al.* (2005) [6], Sarangi *et al.* (2009) [11], panwar (2006) [9], and Saravani and Sabesan (2000) [12]. The seed moisture content represented highly significant and negative phenotypic correlation with economic yield, seed germination shows highly significant and negative phenotypic correlation with shoot length, plant height exhibited highly significant and negative phenotypic correlation with L/B ratio, seed moisture content highly significant and negative phenotypic correlation with speed of germination and 1000 seed weight and seed moisture content had highly significant and negative correlation with root length.

The genotypic correlation coefficients between different characters were generally similar in nature to the corresponding phenotypic correlation coefficients this experimentation. However, the genotypic correlations were greater in magnitude than their corresponding phenotypic correlations. Similar results have been reported in rice by various workers (Shivani and Reddy (2000) [12]; Watto *et al.* (2010) [13] and Kumar *et al.* (2015).

### Path coefficient analysis

Path coefficient analysis is a tool to partition the observed correlation coefficient into direct and indirect effects of yield components on grain yield. Path analysis provides clear picture of character associations for formulating efficient selection strategy. The concept of Path coefficient analysis was developed which differs from simple correlation in that it points out the causes and their relative importance, whereas, the later measures simply the mutual association ignoring the causation.

The direct and indirect effects of different characters on economic yield at phenotypic level are presented in Table 4.6. The highest positive direct effect on economic yield was exerted by harvest index followed by biological yield, root length, seedling vigour index and shoot length. The low positive direct effect on economic yield was exerted by panicle bearing tillers/plant followed by speed of germination, grains/panicle and days to 50% flowering also been reported earlier findings of Madhavilatha *et al.* (2013), Naseer *et al.* (2013) [8], Babu *et al.* (2015) [3], Kishore *et al.* (2018) [4], Kumar *et al.* (2018) [5] and Manohora *et al.* (2015) [7].

The highest negative direct effect on economic yield was exerted by seedling length followed by seed germination, seedling dry weight, and plant height, seed moisture content. The low negative direct effect on economic yield was exerted by L/B ratio followed by tillers/plant, 1000 seed weight.

Substantial positive indirect effects was exerted by seedling length via seedling vigour index, seedling vigour index via harvest index, seedling vigour index via root length, root length via seedling vigour index and seedling length via root length, exerted on economic yield.

Substantial negative indirect effects was exerted by seedling vigour index via seedling length, shoot length via seedling length, harvest index via biological yield, seed moisture content via harvest index and harvest index via seedling length, exerted on economic yield. The direct and indirect effect of different characters on economic yield at genotypic level is presented in Table 4.7. In the path analysis at genotypic level, the seedling vigour index, followed by panicle bearing tillers/plant, root length, shoot length and harvest index exerted highest positive direct effect on economic yield. The seedling length, followed by seed germination, tillers/plant, and L/B ratio and plant height exerted highest negative direct effect on economic yield.

Substantial positive indirect effect was exerted by seedling length via vigour index, root length via seedling vigour index, shoot length via seedling vigour index, seed germination via seedling vigour index and seed moisture content via seedling vigour index respectively on economic yield.

Substantial negative indirect effects was exerted by seedling vigour index via seedling length, root length via seedling length, shoot length via seedling length, seed moisture content via seedling length and harvest index seedling length exerted on economic yield.

**Table 4.4:** Estimate of phenotypic correlation coefficients among 18 different characters in rice germplasm

| Characters | Plant Height (cm) | Tillers/ Plant | Panicle Bearing Tillers/ Plant | Grains/ Panicle | Biological Yield (g) | Harvest Index | 1000 Seed Weight (g) | L/B Ratio | Seed Moisture Content (%) | Seed Germination (%) | Speed of Germination | Shoot Length (cm) | Root Length (cm) | Seedling Length (cm) | Seedling Dry Weight (g) | Vigour Index-I | Economic Yield (g) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
| Days to 50% Flowering | 0.23$^{*}$ | -0.03 | -0.01 | 0.44$^{**}$ | 0.03 | 0.09 | -0.29$^{**}$ | 0.14 | -0.09 | 0.22$^{*}$ | 0.10 | -0.06 | -0.03 | -0.05 | -0.08 | 0.05 | 0.15 |
| Plant Height (cm) | | -0.12 | -0.13 | 0.19 | 0.35$^{**}$ | -0.19 | -0.17 | -0.23$^{*}$ | -0.14 | -0.12 | 0.12 | -0.07 | 0.13 | 0.05 | 0.06 | -0.01 | 0.01 |
| Tillers/ Plant | | | 0.94$^{**}$ | 0.12 | 0.07 | 0.05 | 0.13 | 0.19 | 0.03 | 0.08 | -0.05 | -0.04 | 0.01 | -0.03 | -0.35$^{**}$ | 0.01 | 0.17 |
| Panicle Bearing Tillers/ Plant | | | | 0.15 | 0.04 | 0.09 | 0.08 | 0.25$^{*}$ | 0.07 | 0.06 | -0.08 | -0.02 | 0.05 | 0.03 | -0.36$^{**}$ | 0.04 | 0.19 |
| Grains/ Panicle | | | | | 0.18 | 0.18 | -0.07 | 0.19 | -0.18 | 0.23$^{*}$ | 0.08 | 0.04 | 0.04 | 0.05 | -0.03 | 0.15 | 0.34$^{**}$ |
| Biological Yield (g) | | | | | | -0.46$^{**}$ | -0.03 | -0.06 | -0.09 | -0.07 | -0.10 | 0.09 | -0.11 | -0.03 | -0.10 | -0.05 | 0.15 |
| Harvest Index | | | | | | | -0.04 | 0.05 | -0.17 | 0.13 | 0.13 | 0.13 | 0.15 | 0.23$^{*}$ | -0.13 | 0.26$^{*}$ | 0.71$^{**}$ |
| 1000 Seed Weight (g) | | | | | | | | 0.31$^{**}$ | 0.24$^{*}$ | 0.02 | -0.03 | -0.09 | 0.21$^{*}$ | 0.08 | 0.19 | 0.09 | -0.09 |
| L/B Ratio | | | | | | | | | 0.14 | 0.02 | 0.01 | 0.07 | 0.01 | 0.04 | -0.02 | 0.05 | 0.02 |
| Seed Moisture Content (%) | | | | | | | | | | -0.13 | -0.23$^{*}$ | 0.03 | 0.21$^{*}$ | 0.16 | -0.19 | 0.09 | -0.25$^{*}$ |
| Seed Germination (%) | | | | | | | | | | | 0.20 | -0.24$^{*}$ | 0.15 | -0.05 | 0.06 | 0.39$^{**}$ | 0.07 |
| Speed of Germination | | | | | | | | | | | | 0.06 | 0.09 | 0.12 | 0.01 | 0.19 | 0.14 |
| Shoot Length (cm) | | | | | | | | | | | | | 0.06 | 0.69$^{**}$ | -0.03 | 0.54$^{**}$ | 0.18 |
| Root Length (cm) | | | | | | | | | | | | | | 0.74$^{**}$ | 0.07 | 0.75$^{**}$ | 0.12 |
| Seedling Length (cm) | | | | | | | | | | | | | | | 0.03 | 0.89$^{**}$ | 0.22$^{*}$ |
| Seedling Dry Weight (g) | | | | | | | | | | | | | | | | 0.06 | -0.29$^{**}$ |
| Vigour Index-I | | | | | | | | | | | | | | | | | 0.24$^{*}$ |

*,** significant at 5.0% and 1.0% probability level, respectively.

**Table 4.5:** Estimate of genotypic correlation coefficients between different characters in rice.

| Characters | Plant Height (cm) | Tillers/ Plant | Panicle Bearing Tillers/ Plant | Grains/ Panicle | Biological Yield (g) | Harvest Index | 1000 Seed Weight (g) | L/B Ratio | Seed Moisture Content (%) | Seed Germination (%) | Speed of Germination | Shoot Length (cm) | Root Length (cm) | Seedling Length (cm) | Seedling Dry Weight (g) | Vigour Index-I | Economic Yield (g) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Days to 50% Flowering | 0.31 | -0.06 | -0.02 | 0.53 | 0.09 | 0.12 | -0.29 | 0.16 | -0.12 | 0.35 | -0.35 | -0.07 | -0.06 | -0.08 | -0.10 | 0.06 | 0.20 |
| Plant Height (cm) | | -0.17 | -0.19 | 0.39 | 0.23 | -0.04 | -0.24 | -0.40 | -0.24 | -0.25 | -0.31 | -0.15 | 0.19 | 0.06 | 0.06 | -0.05 | 0.08 |
| Tillers/ Plant | | | 0.99 | 0.18 | 0.07 | 0.13 | 0.14 | 0.34 | 0.03 | 0.18 | -0.39 | -0.01 | -0.09 | -0.08 | -0.46 | -0.01 | 0.29 |
| Panicle Bearing Tillers/ Plant | | | | 0.19 | 0.03 | 0.17 | 0.09 | 0.38 | 0.03 | 0.21 | -0.34 | 0.02 | -0.02 | 0.01 | -0.45 | 0.08 | 0.30 |
| Grains/ Panicle | | | | | 0.15 | 0.33 | -0.08 | 0.26 | -0.14 | 0.46 | -0.38 | -0.14 | 0.02 | -0.07 | -0.06 | 0.11 | 0.39 |
| Biological Yield (g) | | | | | | -0.42 | -0.04 | -0.19 | -0.35 | -0.23 | -0.51 | 0.16 | -0.27 | -0.07 | -0.19 | -0.16 | 0.18 |
| Harvest Index | | | | | | | -0.08 | 0.11 | 0.02 | 0.18 | -0.13 | 0.18 | 0.26 | 0.28 | -0.12 | 0.33 | 0.86 |
| 1000 Seed Weight (g) | | | | | | | | 0.38 | 0.36 | 0.01 | 0.07 | -0.09 | 0.24 | 0.12 | 0.20 | 0.11 | -0.13 |
| L/B Ratio | | | | | | | | | 0.18 | 0.08 | 0.17 | 0.08 | 0.09 | 0.11 | -0.01 | 0.13 | 0.01 |

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Seed Moisture Content (%) | | | | | | | | | | -0.16 | 0.29 | 0.25 | 0.47 | 0.48 | -0.28 | 0.38 | -0.19 |
| Seed Germination (%) | | | | | | | | | | | -0.52 | -0.39 | 0.29 | -0.02 | 0.04 | 0.38 | 0.08 |
| Speed of Germination | | | | | | | | | | | | 0.05 | -0.25 | -0.13 | -0.07 | -0.33 | -0.38 |
| Shoot Length (cm) | | | | | | | | | | | | | 0.08 | 0.70 | -0.04 | 0.49 | 0.26 |
| Root Length (cm) | | | | | | | | | | | | | | 0.77 | 0.08 | 0.82 | 0.03 |
| Seedling Length (cm) | | | | | | | | | | | | | | | 0.04 | 0.92 | 0.19 |
| Seedling Dry Weight (g) | | | | | | | | | | | | | | | | 0.05 | -0.34 |
| Vigour Index-I | | | | | | | | | | | | | | | | | 0.21 |

*,** Significant at 5 (%)and 1 (%) probability levels, respectively

**Table 4.6:** Direct and indirect effects of different characters on seed yield per plant at phenotypic level in rice germplasm

| **Character** | **Days to 50% Flowering** | **Plant Height (cm)** | **Tillers/ Plant** | **Panicle Bearing Tillers/ Plant** | **Grains/ Panicle** | **Biological Yield (g)** | **Harvest Index** | **1000 Seed Weight (g)** | **L/B Ratio** | **Seed Moisture Content (%)** | **Seed Germination (%)** | **Speed of germination** | **Shoot Length (cm)** | **Root Length (cm)** | **Seedling Length (cm)** | **Seedling Dry Weight (g)** | **Vigour Index-I** | **Economic Yield (g)** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** | **16** | **17** | **18** |
| Days to 50% Flowering | 0.0425 | -0.0181 | 0.0008 | -0.0004 | 0.0302 | 0.0173 | 0.0872 | 0.0021 | -0.0061 | 0.0049 | -0.0437 | 0.0091 | -0.0119 | -0.0093 | 0.0291 | 0.0066 | 0.0126 | 0.1529 |
| Plant Height (cm) | 0.0099 | -0.0775 | 0.0037 | -0.0121 | 0.0133 | 0.2000 | -0.1710 | 0.0012 | 0.0103 | 0.0079 | 0.0237 | 0.0105 | -0.0136 | 0.0367 | -0.0272 | -0.0045 | -0.0033 | 0.0082 |
| Tillers/ Plant | -0.0011 | 0.0095 | -0.0302 | 0.0893 | 0.0083 | 0.0394 | 0.0436 | -0.0009 | -0.0089 | -0.0017 | -0.0151 | -0.0044 | -0.0072 | 0.0005 | 0.0163 | 0.0279 | 0.0003 | 0.1657 |
| Panicle Bearing Tillers/ Plant | -0.0002 | 0.0099 | -0.0286 | 0.0941 | 0.0100 | 0.0247 | 0.0863 | -0.0005 | -0.0115 | -0.0039 | -0.0124 | -0.0068 | -0.0028 | 0.0145 | -0.0146 | 0.0289 | 0.0124 | 0.1996 |
| Grains/ Panicle | 0.0188 | -0.0151 | -0.0037 | 0.0138 | 0.0682 | 0.1036 | 0.1629 | 0.0005 | -0.0088 | 0.0099 | -0.0447 | 0.0073 | 0.0069 | 0.0119 | -0.0308 | 0.0022 | 0.0415 | 0.3446 |
| Biological Yield (g) | 0.0013 | -0.0269 | -0.0021 | 0.0040 | 0.0123 | 0.5760 | -0.4223 | 0.0002 | 0.0028 | 0.0048 | 0.0143 | -0.0091 | 0.0168 | -0.0306 | 0.0176 | 0.0083 | -0.0148 | 0.1527 |
| Harvest Index | 0.0040 | 0.0144 | -0.0014 | 0.0088 | 0.0120 | -0.2636 | 0.9228 | 0.0003 | -0.0023 | 0.0094 | -0.0248 | 0.0117 | 0.0236 | 0.0432 | -0.1275 | 0.0107 | 0.0727 | 0.7141 |
| 1000 Seed Weight (g) | -0.0124 | 0.0135 | -0.0039 | 0.0073 | -0.0051 | -0.0198 | -0.0407 | -0.0070 | -0.0142 | -0.0133 | -0.0047 | -0.0026 | -0.0166 | 0.0589 | -0.0464 | -0.0160 | 0.0253 | -0.0978 |
| L/B Ratio | 0.0058 | 0.0176 | -0.0059 | 0.0239 | 0.0132 | -0.0352 | 0.0460 | -0.0022 | -0.0454 | -0.0077 | -0.0029 | 0.0009 | 0.0132 | 0.0042 | -0.0241 | 0.0014 | 0.0130 | 0.0158 |
| Seed Moisture Content (%) | -0.0038 | 0.0110 | -0.0009 | 0.0066 | -0.0122 | -0.0499 | -0.1577 | -0.0017 | -0.0063 | -0.0552 | 0.0259 | -0.0201 | 0.0049 | 0.0598 | -0.0892 | 0.0159 | 0.0253 | -0.2477 |
| Seed Germination (%) | 0.0095 | 0.0094 | -0.0023 | 0.0060 | 0.0156 | -0.0423 | 0.1175 | -0.0002 | -0.0007 | 0.0073 | -0.1951 | 0.0177 | -0.0449 | 0.0432 | 0.0272 | -0.0052 | 0.1118 | 0.0745 |
| Speed of germination | 0.0044 | -0.0093 | 0.0015 | -0.0073 | 0.0057 | -0.0602 | 0.1230 | 0.0002 | -0.0004 | 0.0127 | -0.0349 | 0.0874 | 0.0120 | 0.0246 | -0.0670 | -0.0001 | 0.0540 | 0.1419 |
| Shoot Length (cm) | -0.0027 | 0.0056 | 0.0012 | -0.0014 | 0.0025 | 0.0518 | 0.1165 | 0.0006 | -0.0032 | -0.0014 | 0.0469 | 0.0056 | 0.1870 | 0.0170 | -0.3964 | 0.0026 | 0.1506 | 0.1827 |
| Root Length (cm) | -0.0014 | -0.0100 | -0.0001 | 0.0048 | 0.0029 | -0.0622 | 0.1409 | -0.0015 | -0.0007 | -0.0117 | -0.0289 | 0.0076 | 0.0112 | 0.2831 | -0.4218 | -0.0056 | 0.2109 | 0.1168 |
| Seedling Length (cm) | -0.0022 | -0.0037 | 0.0009 | 0.0024 | 0.0037 | -0.0179 | 0.2076 | -0.0006 | -0.0019 | -0.0087 | 0.0094 | 0.0103 | 0.1308 | 0.2107 | -0.5668 | -0.0028 | 0.2518 | 0.2230 |
| Seedling Dry Weight (g) | -0.0035 | -0.0043 | 0.0104 | -0.0337 | -0.0019 | -0.0593 | -0.1226 | -0.0014 | 0.0008 | 0.0109 | -0.0126 | 0.0001 | -0.0059 | 0.0197 | -0.0195 | -0.0807 | 0.0165 | -0.2872 |
| Vigour Index-I | 0.0019 | 0.0009 | 0.0000 | 0.0042 | 0.0101 | -0.0303 | 0.2390 | -0.0006 | -0.0021 | -0.0050 | -0.0776 | 0.0168 | 0.1002 | 0.2126 | -0.5080 | -0.0047 | 0.2809 | 0.2382 |

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