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# Correlation and path analysis of grain yield and its attributes of traditional rice (*Oryza sativa* L.) genotypes

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**Abstract**
The present study was carried out at the Bagusala farm, M. S. Swaminathan School of Agriculture, Centurion University of Technology and Management, Paralakhemundi, Odisha in Rabi, 2020 with twenty one genotypes comprising nineteen traditional rice varieties and two checks to examine the nature of associations between yield and yield attributing characters. The characters association at both the genotypic and phenotypic level for grain yield per hill and its component characters revealed that the grain yield per hill exhibited highly significant positive phenotypic association with traits number of filled spikelets per panicle (0.675**), number of spikelets per panicle (0.72**), percentage of filled grain per panicle (0.09**), days to 50% flowering (0.495**), 1000-grain weight (0.493**), straw yield per hill (0.412**) and starch content (0.375**). The characters like plant height, flag leaf area, number of tillers per hill and protein content showed significant to highly significant negative association with grain yield per hill. Path coefficient analysis at phenotypic level showed that the character 1000-grain weight (0.538) exhibited highest positive direct effect on grain yield per plant followed by number of filled spikelets per panicle (0.420), protein content (0.327), number of spikelet per panicle (0.317), number of panicles per hill (0.127), straw yield per hill (0.094), number of tillers per hill (0.02), and days to 50% flowering (0.057). Therefore direct selection for these characters will be rewarding.

**Keywords:** Genotypic, phenotypic, correlation, path coefficient, and traditional rice

## Introduction
Rice (*Oryza sativa* L.) is one of the world's most widely domesticated cereal crops. Rice is a staple food crop consumed by about half of the world's population. Rice is grown mostly in tropical, subtropical, and temperate climates around the world. There are twenty four different types of *Oryza* species, however only two major wild rice species are farmed in Asia and Africa, notably (*Oryza sativa* L.) and (*Oryza glaberrima*). Rice is a member of the Poaceae family, short-day, monocotyledon, self-pollinated plant that may thrive in a variety of agro-climatic situations. Nearly 90% of the world's rice crop is produced in Asian countries. Rice production of the world during 2019-2020 is 503.17 million metric tonnes (Agriculture at glance 2020). In the world, China is the leading country in production of rice with (148.5 million metric tonnes) and it was followed by India (118.43) and Indonesia (36.7). Rice is grown in around 162.06 million hectares in the world. India ranks first having highest area of cultivation of rice in the world (43.78 million hectares), followed by china. In India, West Bengal ranks first in total rice production of (15.57 million tonnes), second by Uttar Pradesh (15.52 million tons) and followed by Punjab (11.78 million tonnes), Andhra Pradesh, Tamil Nadu, Bihar, Chhattisgarh, Odisha. Rice contains 7-8% of proteins, 80% of Carbohydrates, 3% of Fiber, 3% of Fat. Traditional/Land races of rice are an important germplasm as they have valuable genes for adaptability and other traits and incorporation of those genes ensure optimum grain yield. Correlation studies provide information about inter-relationship between yield and its attributes and estimate the magnitude of association among traits. Path coefficient analyses evaluate the direct and indirect contribution of each trait to yield could be estimated picking up appropriate traits for indirect selection (Rasel *et al.*, 2018) [19]. Therefore, the keeping above point in consideration present investigation was taken up with an objective to studies inter-relationship and cause effect for grain yield and its attributes of Traditional rice (*Oryza sativa* L.) genotypes.

## Materials and Methods

The experimental material consists of twenty one rice genotypes (nineteen traditional rice and two checks). The experiment was conducted at Bagusala farm, M.S. Swaminathan School of Agriculture, Centurion University of Technology and Management (CUTM), Paralakhemundi, Odisha during late *Rabi* season, 2020. Twenty one rice genotypes were sown in Randomized Complete Block Design (RCBD) with three replications. Each plot size was 3 m x 1.45 m with the spacing of 20cm x 15 cm and recommended cultural practices were followed to grow the crop. Observations on fifteen quantitative traits like, plant height at harvest (cm), flag leaf area ($cm^2$), number of tillers per hill, number of panicles per hill, panicle length (cm), number of spikelets per panicle, number of filled spikelets per panicle, percentage of filled grains per panicle (%), 1000-grains weight (g), straw yield per hill (g), total soluble sugars (%), protein content (mg/g), starch content (%), grain yield per hill (g) were recorded from five randomly selected plants for each genotype in each replication. The observation on days to 50% flowering was recorded on plot basis. The genotypic and phenotypic correlation coefficients were computed by INDOSTAT-9.2 software following method suggested by Al-Jibouri *et al.,* (1958) [4]. Path coefficients are obtained by solving simultaneous equations which gives basic relationship between correlations given by Wright (1921) [26], Dewey and Lu (1959).

## Results and Discussion

The results of genotypic and phenotypic correlation coefficient of twenty one traditional rice genotypes including checks for all the quantitative characters under study are presented in table 1 and 2, respectively.

### Genotypic correlation coefficients

The estimates on genotypic correlation coefficients showed that the traits number of filled spikelets per panicle (0.723**), number of spikelets per panicle (0.627**), percentage of filled grains per panicle (0.609**), days to 50% flowering (0.525**), 1000-grain weight (0.456**), straw yield per hill (0.442**) and starch content (0.415**) exhibited highly significant positive association with grain yield per hill. These results are in agreement with Sahanabnath and Kole (2021) [21], Bhor *et al.,* (2020) [8], Dey *et al;* (2019) [17], Singh and singh (2015) [15], Hossain *et al.,* (2015) [22], Kole *et al;* (2008) [13]. Selvaraj and Nagaragjan (2011) [10] found same result for starch content in maize. The trait days to 50% flowering showed significant to highly significant positive association with the traits like panicle length (0.259*), number of spikelets per panicle (0.745**), number of filled spikelets per panicle (0.778**) and percentage of filled grains per panicle (0.528**) and straw yield per hill (0.530**) starch content (0.503**). The similar findings were obtained by Sahanabnath and Kole (2021) [21], Kamana *et al.,* (2019) [7] for all the characters except panicle length. Most of the characters under study exhibited the greater magnitude of genotypic correlation coefficient than corresponding phenotypic correlation coefficient indicating less effect of environment on genotypes.

### Phenotypic correlation coefficients

The estimate of phenotypic correlation coefficients highlighted that the trait grain yield per hill had highly significant positive association with the traits like number of filled spikelets per panicle (0.675**), number of spikelets per panicle (0.572**), percentage of filled grains per panicle (0.509**), days to 50% flowering (0.495**), 1000-grain weight (0.493**), straw yield (0.412**), and starch content (0.375**). These results are in accordance with earlier findings of Sahanabdnath and Kole (2021) [21], Bhor *et al.,* (2020) [8], Dey *et al;* (2019) [17], Singh and Singh (2015) [15], Hossain *et al.,* (2015) [22], and Kole *et al.,* (2008) [13] or all the characters under study except starch content. The trait days to 50% flowering showed significant to highly significant positive association with the traits number of spikelets per panicle (0.727**), number of filled spikelets per panicle (0.761**) and percentage of filled grains per panicle (0.462**) and straw yield per hill (0.486**) starch content (0.493**). These results are in accordance with earlier findings of Sahanabdnath and Kole (2021) [21] for the characters number of spikelets per panicle, number of filled spikelets per panicle and percentage of filled grains per panicle.

### Path coefficient analysis

The path coefficient analysis (Table 3) has direct effect on grain yield per hill and indirect effect through component of different characters which shows some influence on yield. In path coefficient analysis, phenotypic level is considered for the studies because in plant breeding selection is based upon phenotype expression not at genotype. The results on phenotype path coefficient analysis were represented in table 3. Path coefficient analysis at phenotypic level revealed that the traits of 1000-grain weight (0.538), no of filled Spikelet's per panicle (0.420), protein content (mg/g) (0.327), no spikelet's per panicle (0.317), number of panicles per hill (0.127) showed high positive direct effect on grain yield per hill. These results are in close conformity with the findings of Sudeepthi *et al.,* (2020) [23], Aynew *et al.,* (2019), Neethu-francis *et al.,* (2018) [16], Sharma *et al.,* (2012), and Kole *et al.,* (2008) [13] for all the characters except protein content. Gopinath *et al.,* (2018) found similar result for protein content in Blackgram. The traits like straw yield per hill (0.095), no of tillers per hill (0.062), days to 50% flowering (0.057), panicle length (0.051) showed positive and negligible direct effect on grain yield. The similar results are reported in Dey *et al.,* (2019) [17], Sudeepthi *et al.,* (2020) [23], Aparna and Indradeo (2020), Akter *et al.,* (2019) [2], Kishore *et al.,* (2018) [9], Reddy *et al.,* (2013) [11], Kole *et al.,* (2008) [13].

**Table 1:** Genotypic correlation coefficients for morphological and biochemical characters in traditional rice genotypes

| Traits | PH (cm) | DF | FLA ($cm^2$) | NTH | NPH | PL (cm) | NSP | NFSP | PFGP (%) | 1000G. wt | SYH | TSS (%) | PC (mg/g) | SC (%) | GYH |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PH (cm) | 1.000 | -0.47** | 0.441** | 0.372** | 0.412** | 0.116 | -0.638** | 0.660** | -0.575** | -0.020 | -0.045 | 0.283* | 0.098 | -0.432** | -0.396** |
| DF | | 1.000 | -0.335** | -0.413** | -0.361** | 0.171 | 0.727** | 0.761** | 0.462** | -0.170 | 0.486** | -0.250* | -0.394** | 0.493** | 0.495** |
| FLA($cm^2$) | | | 1.000 | 0.531** | 0.212 | 0.325** | -0.506** | -0.483** | - 0.348** | 0.181 | 0.241 | -0.065 | -0.124 | -0.408** | -0.351** |
| NTH | | | | 1.000 | 0.310* | 0.087 | -0.391** | -0.438** | -0.393** | -0.017 | -0.060 | 0.042 | -0.043 | -0.315* | -0.283* |
| NPH | | | | | 1.000 | -0.208 | -0.527** | -0.556** | -0.273* | 0.181 | -0.162 | 0.182 | 0.091 | -0.436** | -0.123 |
| PL (cm) | | | | | | 1.000 | 0.125 | 0.069 | -0.025 | -0.088 | 0.340** | -0.121 | -0.239 | 0.132 | -0.004 |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NSP | | | | | | | 1.000 | 0.931** | 0.450** | -0.170 | 0.431** | -0.276* | -0.374** | 0.825** | 0.572** |
| NFSP | | | | | | | | 1.000 | 0.577** | -0.040 | 0.474** | -0.213 | -0.381** | 0.712** | 0.675** |
| PFGP(%) | | | | | | | | | 1.000 | 0.223 | 0.134 | -0.172 | -0.342** | 0.307* | 0.509** |
| 1000GW | | | | | | | | | | 1.000 | 0.083 | -0.098 | -0.151 | -0.249* | 0.493** |
| SYH | | | | | | | | | | | 1.000 | -0.023 | -0.414** | 0.461** | 0.412** |
| TSS (%) | | | | | | | | | | | | 1.000 | 0.340** | 0.082 | -0.038 |
| PC (mg/g) | | | | | | | | | | | | | 1.000 | -0.217 | -0.455** |
| SC (%) | | | | | | | | | | | | | | 1.000 | 0.375** |

* & **: Significant level at 5% and 1%; PH (cm): Plant height at harvest (cm), DFF: Days to 50% flowering, FLA ($cm^2$): Flag leaf area, NTP: Number of tillers per Hill, NPH: Number of Panicles per Hill, PL(cm): Panicle Length, NSP: Number of Spikelet's per panicle, NFSP: Number of Filled Spikelet's per panicle, PFSP (or) Spikelet fertility (%): Percentage of Filled Grains per panicle, 1000-gwt : 1000-Grains weight, SYH: Straw yield per hill, TSS (%): Total Soluble Sugars, PC (mg/g) : Protein content, SC (%) : Starch content, GYH : Grain yield per hill.

**Table 2:** Phenotypic correlation coefficients for morphological and biochemical characters in traditional rice genotypes.

| Traits | PH (cm) | DF | FLA ($cm^2$) | NTH | NPH | PL (cm) | NSP | NFSP | PFGP (%) | 1000G. wt | SYH | TSS (%) | PC (mg/g) | SC (%) | GYH |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PH (cm) | 1.000 | -0.47** | 0.441** | 0.372** | 0.412** | 0.116 | -0.638** | 0.660** | -0.575** | -0.020 | -0.045 | 0.283* | 0.098 | -0.432** | -0.396** |
| DF | | 1.000 | -0.335** | -0.413** | -0.361** | 0.171 | 0.727** | 0.761** | 0.462** | -0.170 | 0.486** | -0.250* | -0.394** | 0.493** | 0.495** |
| FLA($cm^2$) | | | 1.000 | 0.531** | 0.212 | 0.325** | -0.506** | -0.483** | - 0.348** | 0.181 | 0.241 | -0.065 | -0.124 | -0.408** | -0.351** |
| NTH | | | | 1.000 | 0.310* | 0.087 | -0.391** | -0.438** | -0.393** | -0.017 | -0.060 | 0.042 | -0.043 | -0.315* | -0.283* |
| NPH | | | | | 1.000 | -0.208 | -0.527** | -0.556** | -0.273* | 0.181 | -0.162 | 0.182 | 0.091 | -0.436** | -0.123 |
| PL (cm) | | | | | | 1.000 | 0.125 | 0.069 | -0.025 | -0.088 | 0.340** | -0.121 | -0.239 | 0.132 | -0.004 |
| NSP | | | | | | | 1.000 | 0.931** | 0.450** | -0.170 | 0.431** | -0.276* | -0.374** | 0.825** | 0.572** |
| NFSP | | | | | | | | 1.000 | 0.577** | -0.040 | 0.474** | -0.213 | -0.381** | 0.712** | 0.675** |
| PFGP(%) | | | | | | | | | 1.000 | 0.223 | 0.134 | -0.172 | -0.342** | 0.307* | 0.509** |
| 1000GW | | | | | | | | | | 1.000 | 0.083 | -0.098 | -0.151 | -0.249* | 0.493** |
| SYH | | | | | | | | | | | 1.000 | -0.023 | -0.414** | 0.461** | 0.412** |
| TSS (%) | | | | | | | | | | | | 1.000 | 0.340** | 0.082 | -0.038 |
| PC (mg/g) | | | | | | | | | | | | | 1.000 | -0.217 | -0.455** |
| SC (%) | | | | | | | | | | | | | | 1.000 | 0.375** |

*, **: Significant level at 5% and 1%; PH (cm): Plant height at harvest (cm), DF: Days to 50% flowering, FLA ($cm^2$): Flag leaf area, NTP: Number of tillers per Hill, NPH: Number of Panicles per Hill, PL(cm): Panicle Length, NSP: Number of Spikelet's per panicle, NFSP: Number of Filled Spikelet's per panicle, PFSP (or) Spikelet fertility (%): Percentage of Filled Grains per panicle, 1000-gwt : 1000-Grains weight, SYH: Straw yield per hill, TSS (%): Total Soluble Sugars, PC (mg/g) : Protein content, SC (%) : Starch content, GYH : Grain yield per hill.

**Table 3:** Phenotypic path coefficient analysis for fifteen quantitative and biochemical traits of twenty one traditional rice genotypes

| Traits | PH (cm) | DF | FLA ($cm^2$) | NTH | NPH | PL (cm) | NSP | NFSP | PFGP | 1000G.wt | SYH | TSS (%) | PC (mg/g) | SC (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PH (cm) | -0.004 | 0.002 | -0.002 | -0.002 | -0.002 | -0.001 | 0.003 | 0.201 | 0.002 | 0.001 | 0.216 | 0.074 | 0.000 | 0.002 |
| DF | -0.027 | 0.057 | -0.019 | -0.024 | -0.021 | 0.010 | 0.042 | 0.044 | 0.026 | -0.010 | 0.028 | -0.014 | -0.023 | 0.028 |
| FLA($cm^2$) | -0.121 | 0.092 | -0.275 | -0.146 | -0.058 | -0.089 | 0.139 | 0.133 | 0.096 | -0.050 | -0.066 | 0.018 | 0.034 | 0.112 |
| NTH | 0.023 | -0.026 | 0.052 | 0.062 | 0.019 | 0.006 | -0.024 | -0.027 | -0.025 | -0.001 | -0.004 | 0.003 | -0.003 | -0.020 |
| NPH | 0.052 | -0.046 | 0.027 | 0.039 | 0.127 | -0.027 | -0.067 | -0.071 | -0.035 | 0.023 | -0.021 | 0.023 | 0.012 | -0.055 |
| PL (cm) | 0.006 | 0.192 | 0.017 | 0.020 | -0.011 | 0.051 | 0.006 | 0.004 | 0.160 | -0.005 | 0.017 | -0.006 | -0.012 | 0.007 |
| NSP | -0.202 | 0.231 | -0.160 | -0.124 | -0.188 | 0.040 | 0.317 | 0.295 | 0.143 | -0.054 | 0.137 | -0.088 | -0.119 | 0.261 |
| NFSP | -0.277 | 0.320 | -0.203 | -0.184 | -0.234 | 0.029 | 0.391 | 0.420 | 0.242 | -0.017 | 0.199 | -0.090 | -0.160 | 0.299 |
| PFGP | 0.022 | -0.018 | 0.013 | 0.015 | 0.010 | 0.001 | -0.017 | -0.022 | -0.038 | -0.009 | -0.005 | 0.007 | -0.383 | -0.012 |
| 1000GW | -0.011 | -0.092 | 0.098 | -0.009 | 0.098 | 0.057 | 0.094 | -0.022 | 0.120 | 0.538 | 0.045 | -0.053 | -0.082 | 0.068 |
| SYH | -0.004 | 0.046 | 0.023 | -0.006 | -0.015 | 0.032 | 0.041 | 0.045 | 0.013 | 0.051 | 0.094 | -0.002 | -0.039 | 0.043 |
| TSS (%) | -0.009 | 0.008 | 0.002 | -0.001 | -0.006 | 0.004 | 0.009 | 0.007 | 0.005 | 0.003 | 0.001 | -0.031 | -0.009 | -0.002 |
| PC(mg/g) | 0.032 | -0.129 | -0.041 | -0.014 | 0.030 | -0.078 | -0.122 | -0.125 | -0.112 | -0.050 | -0.135 | 0.095 | 0.327 | -0.069 |
| S.C(%) | 0.125 | -0.142 | 0.118 | 0.091 | 0.126 | -0.038 | -0.238 | -0.205 | -0.088 | 0.072 | -0.133 | -0.015 | 0.061 | -0.288 |
| GYH | -0.008 | 0.007 | 0.002 | -0.001 | -0.005 | 0.003 | 0.008 | 0.006 | 0.005 | 0.003 | 0.0007 | -0.038 | -0.455 | 0.375 |

Residual effect = 0.367

PH (cm): Plant height at harvest (cm), DF: Days to 50% flowering, NTP: Number of tillers per Hill, NPH: Number of Panicles per Hill, PL(cm): Panicle Length, NSP: Number of Spikelet's per panicle, NFSP: Number of Filled Spikelet's per panicle, PFSP (or) Spikelet fertility (%): Percentage of Filled Grains per panicle, 1000-gwt : 1000-Grains weight, SYH: Straw yield per hill, TSS (%): Total Soluble Sugars, PC (mg/g) : Protein content, SC (%) : Starch content, GYH : Grain yield per hill.

## Conclusion

The traits days to 50% flowering, number of spikelets per panicle, number of filled spikelets per panicle, 1000-grain weight, straw yield per hill, starch content (%) showed highly significant positive association with grain yield per hill at both the genotypic and phenotypic level. Path coefficient analysis at phenotypic level showed the traits number of panicles per hill, number of spikelets per panicle, number of filled spikelets per panicle, 1000-grain weight, and protein content had positive direct effect on grain yield per hill. Selection of these traits might have the chance to enhance grain yield per hill and in future breeding programme these are supposed to be given major role importance for develop high yielding varieties.

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**Conflict of Interest**

Authors have not declared any conflict of interest

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