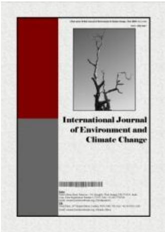

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# Correlation and Path Analysis for Yield and Quality Traits in Hybrid Rice (*Oryza sativa* L.)

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***Authors' contributions***

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

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## ABSTRACT

24 hybrids generated by crossing four male sterile lines with six testers in line x tester fashion were studied along with their parents and checks (BIO-799 and PA 6129) for correlation and path analysis. The results emphasized the need for selection, based on plant type with greater plant height, number of productive tillers per plant, head rice recovery, milling percentage, spikelet fertility, panicle length and kernel length. Since, these traits were found to be the important direct contributors for grain yield.

*Keywords: Correlation; correlation coefficients; grain yield per plant; path analysis and residual effect.*

## 1. INTRODUCTION

Rice is the leading food crop in the world, directly feeding nearly half of the world's population and plays an important role in ensuring food security. To meet the demand of increasing population and to combat food security in India, the present yield levels needs to be increased up to 121 million tonnes by 2050 and the production of rice needs to be increased by almost two million tons every year.

The grain yield is the result of multiple interaction between various yield components and this

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necessitates thorough understanding of trait association and direct and indirect effects contributed by each character on grain yield before initiating any breeding programme.

Correlation [1] is the mutual relationship between two variables. Correlation coefficient is a statistical measure of degree (strength) and direction of relationship between two or more variables. Correlation coefficient analysis helps to know the mutual relationship between various plant characters and determines the component characters on which selection can be based for genetic improvement in yield.

Direct selection for yield is not a reliable approach, since it is complex inherited character controlled polygenically, contributed by several component traits and influenced by the environment [2-4]. Therefore, it is essential to identify the component characters through which yield can be improved. The concept of path analysis or cause and effect analysis was developed by Wright, [5] and it was used for plant selection by Dewey and Lu, 1959. Path coefficient is a standardized partial regression coefficient which splits the correlation coefficient into the measures of direct and indirect effects.

Correlation and path coefficient analysis gives the information regarding strength, direction of association between yield attributing traits and also direct and indirect effects of Yield components. Generally, in farming community, to increase the yield, farmers are looking towards the usage of chemical fertilizers, having no proper idea of the quantity of usage they are applying doses higher than recommended quality [6-8]. This results in the contamination of soil and groundwater resources and also cause long term residual effect. To reduce this pollution, farmers must reduce the usage of chemical fertilizers that will happen when they have high yielding cultivars which is environment friendly. Yield of the cultivars can be improved by proper understanding of association, direct and indirect effects of yield attributing traits.

## 2. MATERIALS AND METHODS

The present investigation was undertaken during *Rabi,* 2018-19 (crossing programme) and *Kharif,* 2019 (evaluation) at Regional Agricultural Research Station (RARS), Polasa, Jagtial of Telangana state and the experimental material used for the present experiment comprised of four lines *viz.,* JMS 17A, JMS 13A, JMS 18A, CMS 14A, six restorer lines *viz*., JGL 35039, JGL 34450, JGL 34985, JGL 34990, JMBR 44 and IRTON 270 and their 24 hybrids produced by crossing lines and testers in Line X tester fashion along with two hybrid checks (BIO-799 and PA 6129). Four lines and six testers were planted in a crossing block with a spacing of 20 x 15 cm and crossing programme is carried out in a four x six, Line x tester mating design to produce 24 hybrids during *Rabi,* 2018-19. Hybridization and clipping method was followed to obtain hybrids and during *Kharif*, 2019, 30 days old seedlings of 36 entries (four lines, six testers, 24 hybrids and 2 checks) were transplanted in the main field in Randomized Block Design in two replications. Each entry was planted in two rows of four meters length with a spacing of 20 x 15 cm in two replications. Five sample plants were randomly selected from each entry excluding the border plants to minimize error due to the border effect and the following data were recorded: Days to 50% flowering, plant height (cm), panicle length (cm),number of productive tillers per plant, number of grains per panicle, spikelet fertility (%), 1000-grain weight (g), grain yield per plant (g),hulling percentage, milling percentage, head rice recovery (%), kernel length (mm), kernel breadth (mm), L/B ratio, amylose content (%), gelatinization temperature ($^{O}$C), gel consistency (mm) and alkali spreading value. Collected data were subjected to statistical analysis using line × tester analysis by Kempthorne (1957).

## 3. RESULTS AND DISCUSSION

### 3.1 Correlation Analysis

The results of genotypic correlation analysis were presented in (Table 1).

Days to 50 per cent flowering showed significant and negative correlation with grain yield per plant (-0.4077**).Hence, these findings reveal that late flowering types may have more chance of contribution towards grains yield.

Plant height recorded positive and significant association with grain yield per plant (0.5847**).Selection based on the plant height simultaneously improves grain yield per plant.

Panicle length is positively and significantly correlated with grain yield per plant (0.3595**).Direct selection of genotypes having long panicles favors improvement in grain yield per plant.

**Table 1. Phenotypic (P) and Genotypic (G) correlation coefficients of yield and quality traits in rice (*Oryza sativa* L.)**

| SOURCE | | DFF | PH | PL | NPT | NGP | SF | 1000 GW | H% | M% | HRR | KL | KB | L/B | AC | GT | GC | ASV | GYP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **6** | **P** | **1.000** | -0.1803 | -0.4183** | -0.0539 | 0.2461* | -0.1041 | -0.3549** | -0.0883 | -0.1392 | -0.0197 | -0.3133** | -0.2922* | -0.0801 | -0.0136 | -0.1944 | 0.0735 | 0.1699 | -0.3914** |
| | **G** | **1.000** | -0.2179 | -0.5798** | -0.0805 | 0.2702* | -0.1129 | -0.3914** | -0.1278 | -0.1657 | -0.0090 | -0.4949** | -0.2962* | -0.1789 | -0.0168 | -0.2045 | 0.0754 | 0.1864 | -0.4077** |
| **PH** | **P** | | **1.000** | 0.4046** | 0.5382** | -0.0349 | 0.4340** | 0.0263 | 0.3073** | 0.3127** | 0.3628** | 0.1719 | 0.0660 | 0.0527 | 0.3685** | 0.2576* | -0.3603** | -0.3599** | 0.5698** |
| | **G** | | **1.000** | 0.4957** | 0.5709** | -0.0198 | 0.4721** | 0.0324 | 0.3539** | 0.3649** | 0.3781** | 0.2023 | 0.0174 | 0.0603 | 0.4013** | 0.2888* | -0.4040** | -0.3772** | 0.5847** |
| **PL** | **P** | | | **1.000** | 0.1994 | -0.2324* | 0.1789 | 0.4936** | 0.2287 | 0.2348* | 0.0239 | 0.2293 | 0.1724 | 0.0682 | 0.0924 | 0.3405** | -0.1689 | -0.2539* | 0.2745** |
| | **G** | | | **1.000** | 0.2127 | -0.2747* | 0.2401* | 0.6283** | 0.3341** | 0.2654* | 0.0434 | 0.4725** | 0.3071* | 0.1103 | 0.1133 | 0.4341** | -0.2198 | -0.3219** | 0.3595** |
| **NPT** | **P** | | | | **1.000** | 0.0061 | 0.1920 | 0.0388 | 0.3191* | 0.1747 | 0.2208 | 0.2902* | 0.0903 | 0.1310 | 0.0696 | -0.0025 | -0.0587 | -0.0803 | 0.5152** |
| | **G** | | | | **1.000** | 0.0210 | 0.2452* | 0.0318 | 0.3695** | 0.2063 | 0.2188 | 0.4800** | 0.0583 | 0.2687* | 0.0826 | -0.0086 | -0.0785 | -0.0712 | 0.5430** |
| **NGP** | **P** | | | | | **1.000** | -0.2312 | -0.6999** | 0.1282 | 0.0678 | 0.2753* | -0.3773* | -0.4231** | -0.1587 | -0.1134 | -0.1338 | 0.1636 | 0.1441 | 0.1480 |
| | **G** | | | | | **1.000** | -0.2376* | -0.7351** | 0.1453 | 0.0983 | 0.3155** | -0.6150** | -0.4620** | -0.2565* | -0.1196 | -0.1352 | 0.1708 | 0.1456 | 0.1766 |
| **SF** | **P** | | | | | | **1.000** | 0.1642 | 0.0593 | 0.1552 | 0.1866 | -0.0002 | 0.0950 | -0.0937 | 0.2867* | 0.0863 | -0.3003* | -0.2045 | 0.3839** |
| | **G** | | | | | | **1.000** | 0.1687 | 0.0756 | 0.1322 | 0.1822 | 0.0260 | 0.0773 | -0.0796 | 0.2984* | 0.0979 | -0.3138** | -0.2246 | 0.3968** |
| **1000GW** | **P** | | | | | | | **1.000** | 0.0912 | -0.1009 | -0.3428** | 0.4525** | 0.4969** | 0.0829 | 0.0777 | 0.2753* | -0.1219 | -0.2253 | -0.1203 |
| | **G** | | | | | | | **1.000** | 0.1209 | -0.1059 | -0.3565** | 0.6070** | 0.6088** | 0.1092 | 0.0793 | 0.2784* | -0.1233 | -0.2265 | -0.1245 |
| **H%** | **P** | | | | | | | | **1.000** | 0.4095** | 0.4189** | 0.0315 | -0.0550 | 0.1447 | 0.2892* | 0.3979** | -0.3312** | -0.3515** | 0.2783* |
| | **G** | | | | | | | | **1.000** | 0.4081** | 0.4429** | 0.1390 | -0.0669 | 0.1684 | 0.3164** | 0.4429** | -0.3732** | -0.3988** | 0.3124** |
| **M%** | **P** | | | | | | | | | **1.000** | 0.7171** | 0.0611 | 0.2662* | -0.0624 | 0.1865 | 0.2130 | -0.2142 | -0.1919 | 0.4596** |
| | **G** | | | | | | | | | **1.000** | 0.7606** | 0.1873 | 0.3210** | -0.1177 | 0.2063 | 0.2379** | -0.2350* | -0.2192 | 0.4975** |
| **HRR** | **P** | | | | | | | | | | **1.000** | -0.2128 | -0.0848 | -0.0845 | 0.0361 | 0.0218 | -0.0528 | -0.0153 | 0.5148** |
| | **G** | | | | | | | | | | **1.000** | -0.3548** | -0.1776 | -0.0973 | 0.0417 | 0.0219 | -0.0619 | -0.0171 | 0.5328** |
| **KL** | **P** | | | | | | | | | | | **1.000** | 0.4136** | 0.4915** | 0.0715 | 0.0633 | -0.0509 | -0.0897 | 0.1964 |
| | **G** | | | | | | | | | | | **1.000** | 0.4949** | 0.4707** | 0.1046 | 0.0943 | -0.0938 | -0.1307 | 0.2462* |
| **KB** | **P** | | | | | | | | | | | | **1.000** | -0.2290 | 0.0334 | 0.0491 | -0.0406 | -0.1165 | 0.0803 |
| | **G** | | | | | | | | | | | | **1.000** | -0.3716** | 0.0472** | 0.0521 | -0.0588 | -0.1422 | 0.0061 |
| **L/B** | **P** | | | | | | | | | | | | | **1.000** | 0.2690* | 0.1784 | -0.2593* | -0.1997 | 0.0622 |
| | **G** | | | | | | | | | | | | | **1.000** | 0.3815** | 0.2532* | -0.3537** | -0.2742* | 0.0690 |
| **AC** | **P** | | | | | | | | | | | | | | **1.000** | 0.7803** | -0.9660** | -0.9121** | 0.1105 |
| | **G** | | | | | | | | | | | | | | **1.000** | 0.7872** | -0.9718** | -0.9212** | 0.1181 |
| **GT** | **P** | | | | | | | | | | | | | | | **1.000** | -0.8019** | -0.8931** | 0.0349 |
| | **G** | | | | | | | | | | | | | | | **1.000** | -0.8084** | -0.9036** | 0.0323 |
| **GC** | **P** | | | | | | | | | | | | | | | | **1.000** | 0.9254** | -0.1357 |
| | **G** | | | | | | | | | | | | | | | | **1.000** | 0.9343** | -0.1418 |
| **ASV** | **P** | | | | | | | | | | | | | | | | | **1.000** | -0.1135 |
| | **G** | | | | | | | | | | | | | | | | | **1.000** | -0.1130 |

** Significant at 5 per cent level ** Significant at 1 per cent leveL*

*DFF: Days to 50 % flowering, PH: Plant height (cm), PL: Panicle length (cm), NPT: Number of productive tillers per plant, NGP: Number of grains per Gelatinization temperature ($^{O}$C), GC: Gel consistency (mm) and ASV:Alkali spreading value. panicle, SF: Spikelet fertility (%), 1000 GW: 1000 grain weight (g), HP: Hulling percentage, MP: Milling percentage, HRR: Head rice recovery (%), KL: Kernel length (mm), KB: Kernel breadth (mm), L/B: Length/Breadth Ratio, GYP: Grain yield per plant (g), AC: Amylose content (%), GT: : Gelatinization temperature ($^{O}$C), GC: Gel consistency (mm) and ASV:Alkali spreading value*

Number of productive tillers per plant is positively and significantly correlated with grain yield per plant (0.5430**).Hence the selection based on number of productive tillers per plant is suitable as it brings simultaneous improvement in grain yield per plant.

Number of grains per panicle has positive and non-significant correlation with grain yield per plant (0.1766).

Spikelet fertility recorded positive and significant association with grain yield per plant (0.3968**).Hence the selection based on spikelet fertility is suitable as it brings simultaneous improvement in grain yield per plant.

1000-grain weight had negative non-significant association with grain yield per plant (-0.1245).

Hulling percentage had positive and significant association with grain yield per plant (0.3124**).Hence the selection based on hulling percentage is suitable as it brings simultaneous improvement in all other quality parameter traits.

Milling percentage showed positive and significant association with grain yield per plant (0.4975**).The selection based on milling percentage is suitable as it brings simultaneous improvement in grain yield per plant.

Head rice recovery recorded positive and significant correlation with grain yield per plant (0.5328**).Selection based on the head rice recovery brings simultaneous improvement in grain yield per plant.

Kernel length exhibited positive and significant correlation with grain yield per plant (0.2462*).

Kernel breadth recorded positive and non-significant correlation with grain yield per plant (0.0061).

L/B ratio exhibited positive and non-significant correlation with grain yield per plant (0.0690). Direct selection for L/B ratio brings simultaneous improvement in grain yield per plant.

Amylose content showed positive and non-significant correlation with grain yield per plant (0.1181).

Gelatinization temperature recorded positive and non-significant correlation with grain yield per plant (0.0323).

Gel consistency recorded negative and non-significant correlation with grain yield per plant (-0.1418).

Alkali spreading value recorded negative non-significant correlation with grain yield per plant (-0.1130).

The study of genotypic character association among the yield and quality traits revealed that positive association of grain yield per plant with plant height (0.5847**), number of productive tillers per plant (0.5430**), head rice recovery (0.5328**), milling percentage (0.4975**), spikelet fertility (0.3968**), panicle length (0.3595**), hulling percentage (0.3124**) and kernel length (0.2462*).

### 3.2 Path Coefficient Analysis

Path analysis helps to give idea about direct and indirect effects of yield components. While correlation studies gives the relationship among plant characters, their degree of linear relationship, path coefficient analysis more clarifies in partitioning the two traits into components that measures the direct and indirect effects. This is helpful to recognise direct and indirect causes of correlation and also enables us to compare the causual factors on genetic basis of their relative contribution.

The results of phenotypic and genotypic path co-efficient on yield, yield contributing and quality characters measured are presented in figures (Fig 1 and Fig 2).

Days to 50% flowering (-0.4811), Panicle length(-1.1320), Spikelet fertility(-0.2987),Hulling percentage(-0.3827), Head rice recovery (-0.5101),Kernel length (-0.1000), Kernel breadth (-0.5599), Amylose content (-2.2430), Gelatinization temperature (-0.1669), Gel consistency (-1.7599) and Alkali spreading value (-0.3309) recorded direct and negative genotypic effect on grain yield per plant.

Plant height (0.7870). Number of productive tillers per plant (0.1846), Number of grains per panicle(0.9637), 1000 grain weight (1.3153), Milling percentage (1.1944) and L/B ratio (0.3174) expressed a direct positive genotypic effect on grain yield per plant.

### 3.3 Residual Effect

In plant breeding, it is very difficult to have whole understanding of all component traits related to yield. This residual effect permits accurate explanation about the pattern of interaction of other possible components of yield which was not included in the study. The residual effect was 0.5585 for genotypic and 0.5483 for phenotypic path coefficient. This denotes that contribution of component traits that are studied on yield per hectare was 41.15% at genotypic level and 45.17% at phenotypic level, the rest 55.85 at genotypic level and 54.83 at phenotypic level was the contribution of other characters which were not included in the study on dependent variable.

Studies on correlation and path coefficient analysis, emphasized the need for selection,

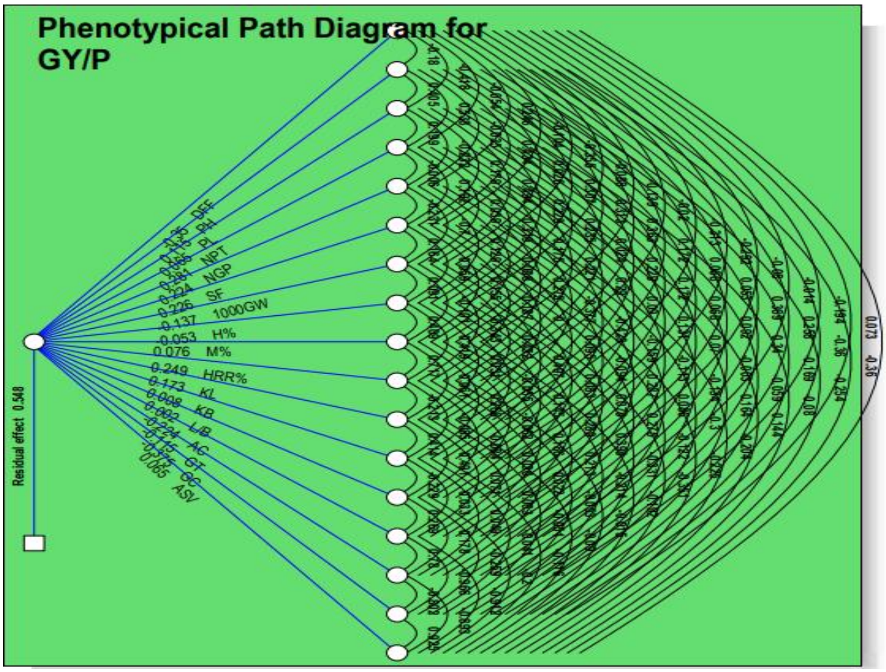


**Fig. 1. Phenotypical path diagram for grain yield per plant (g)**

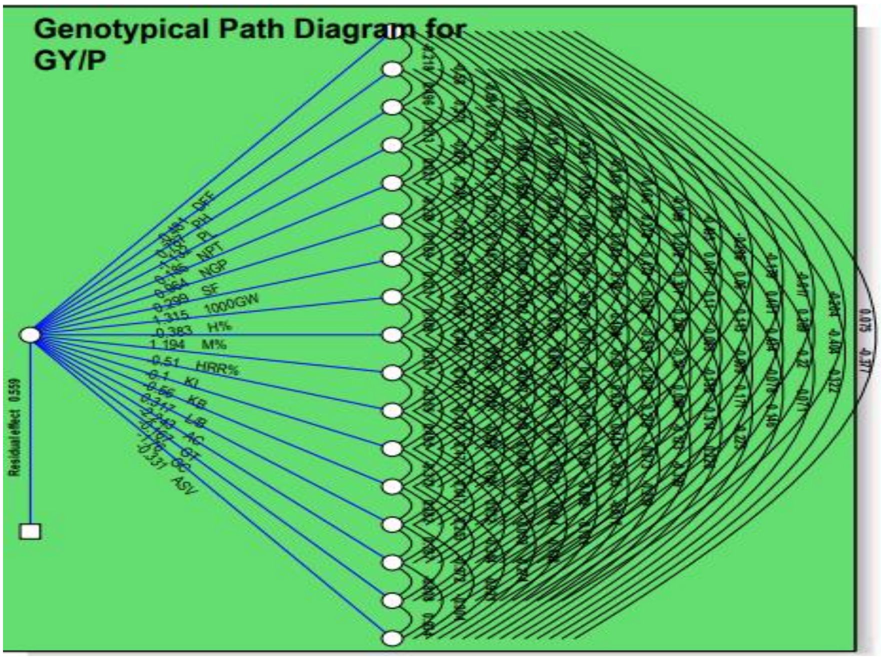


**Fig. 2. Genotypical path diagram for grain yield per plant (g)**

based on plant type with plant height (0.5847**), number of productive tillers per plant (0.5430**), head rice recovery (0.5328**), milling percentage (0.4975**), spikelet fertility (0.3968**), panicle length (0.3595**), hulling percentage (0.3124**) and kernel length (0.2462**).

Studies on correlation and path coefficient analysis, emphasized the need for selection, based on plant type with plant height, number of productive tillers per plant, head rice recovery, milling percentage, spikelet fertility, panicle length and kernel length. Since, these traits were found to be the important direct contributors for grain yield.

## 4. CONCLUSION

Studies on correlation and path coefficient analysis, emphasized the need for selection, based on plant type with plant height, number of productive tillers per plant, head rice recovery, milling percentage, spikelet fertility, panicle length, hulling percentage and kernel length. Since, these traits were found to be the important direct contributors for grain yield.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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