*Original Research Article*

# DIRECT AND INDIRECT EFFECTS OF YIELD CONTRIBUTING TRAITS IN RICE (*Oryza sativa* L.)


ABSTRACT

The present study consists of 20 rice genotypes including one check variety were evaluated atField Experimentation Centre of the Department of Genetics and Plant Breeding, to studygeneticvariability,heritability,geneticadvance,correlationandpathcoefficientfor13quantitative characters. The experiment was conducted by using Randomized Block Designwiththreereplicationsduring*Kharif,2022.* BRRI DHAN-75 (26.133), A.K.DHAN (23.067), showed higher yield over the NDR 359 (check). High tomoderate estimates ofGCV, PCV and Genetic Advance as Percent Mean were recorded for Number of spikelet's/hill, Number of panicles/hill, Biological yield, Number of tillers/hill, Grain yield per hill, Harvest index, Panicle length, Testweight, Days to maturity and Plant height. High tomoderate estimates of Heritability, Genetic advance for number of spikelets per panicle, Biological yield,Plant height, Days to 50% flowering. Grain yield indicated significant positivecorrelation with with biological yield, number of spikelets per panicle, harvest index at both phenotypic level and genotypiclevel.Positive significantdirecteffectsongrainyieldper hillwere exhibited by harvestindex and biological yield at genotypic level and phenotypic level.Thus, these traits are identified as the efficient and potential for indirect selection for theimprovementofriceproductivityin thepresent experimental materials.



***Keywords**:Rice,GCV,PCV,Variability,Heritability,Correlation,Pathanalysis.*




## 1.INTRODUCTION

Rice is a self-pollinated cereal crop belonging to the family Gramineae (Poaceae) under the order Cyperales and class Monocotyledon having chromosome number 2n=24. The genus *Oryza* includes a total of 25 recognized species out of which 23 are wildspecies and two cultivated species, *Oryza sativa* and *Oryza glaberrima*. *Oryza sativa* contains two major subspecies: the sticky, short-grained japonica variety, and the nonsticky, long-grained indica rice variety, third subspecies, which is broad-grained and thrives under tropical conditions, was identified based on morphology and initially called javanica.

The small genome of rice (430 Mb) made it a model plant for studying cereal genetics. With an alarming increase in the population throughout the world, the demand for rice will continue to increase in near future; therefore, rice breeders across the world aim at increasing the grain yield in rice (Singh

*etal*. 2007).

Rice is one of the most important food crops in the world, supporting 21 % of the total calorie intake of the world population and up to 76 % of that of Southeast Asia (Miura *et al.*, 2011).

Genetic variability is the life blood of plant breeding. Genetic advance and exceleration of its relative potential depends on its genetic variation. The presence of a wide genetic variability in rice varieties is a pre-requisite in initiating successful breeding programme Partitioning of observed variability into heritable and non-heritable component by suitable genetic parameters such as genetic coefficient of variation, heritability estimates and genetic advance has been found useful and fruitful.

Heritability ($h^2$~~bs~~) is an index of transmissibility of the characters from the parents tooffspringandhasapredictiverole incropbreeding programme.

Correlationstudieshelpsinbetterunderstandin gofyieldcomponents~~.~~ is the measure of the mutual relationship between two variables.Thestudy of correlations may help the plantbreeder to know how the improvement of onecharacter will bring simultaneous improvement in other characters. Path coefficientanalysisis a standardized regression coefficient and measures the directinfluence of one variableupon the other

**OBJECTIVES**

1. To evaluate 20 rice genotypes for Genetic Variability of grain yield component characters

2. To estimate the association among grain yield characters

3.To study direct and indirect effects of yield contributing traits on grain yield

## 2. MATERIALS AND MATERIALS

The ~~genetic makeup for this~~ study comprised of 20 genotypes of rice from different geographical origin were transplanted in the Randomized block design with 3 replications which was conducted during *Kharif*, 2022 at Field Experimentation centre of Department of Genetics and Plant Breeding, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and sciences, Prayagraj, U.P. The crop was maintained as per the standard agronomic practices. The genotypes were sown on raised bed on 21$^{st}$ June, 2021. Plant spacing between row to row and plant to plant is 20 ~~cm~~ ×15 cm.~~.~~The field observations were recorded for 13 quantitative traits includingDays to 50% flowering,Days to maturity,Flag leaf length(cm),Flag leaf width(cm), Plant height(cm),Number ~~o.~~of total tillers per hill, Number of panicles per hill,Panicle length(cm), Number of spikelets per panicle,Test weight(g), Biological yield(g),Harvest Index(%),Grain yield per hill(g).

## 3 RESULTS AND DISCUSSION

### 3.1 Analysis of Variance for Quantitative Characters in Rice (*Oryza sativa* L.)

The analysis of variance revealed highly significant differences within the genotypes for all the 13 yield characters indicating the

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existence of significant amount of variability among the characters studies (Table 1). The presence of significant amount of variability in the initial breeding material assures the production of suitable recombinants for crop improvement.Among 20 Rice genotypes BRRI DHAN-75(69.17gm), DHAN-47(56.02gm), DHAN-55(55.97gm),BINADHAN-17(54.41gm) and A.K.DHAN(50.82gm)were found to be superior in grain yield.

Variability is a measure by estimation of genotypic coefficient of variations (GCV), Phenotypic Coefficient of Variations (PCV), Heritability ($h^2$) in the broad sense, Genetic advance, and Genetic advance as percentage of mean.

Thecharactersstudiedinthepresentinvestigationexhibitedlow(lessthan10%),moderate (10-20%) and high (more than 20%) phenotypic and genotypic coefficient of variationas proposed by Sivasubramaniam and Menon (1973).

High estimates of PCV were recorded for grain yield per hill (31.312), biological yield (27.207), number of spikelets per panicle (25.142), number of panicles per hill (24.389), number of tillers per hill (21.309).High estimates of GCV were recorded Grain yield per hill (29.005), biological yield (25.313), number of spikelets per panicle (23.837), number of panicles per hill (22.923).

### 3.2 Heritability

Johnson et al., (1955) Classified heritability as low (60%) heritability (broad sense) ranged from 62.536 to 89.893. The highest heritability(above 60%) was observed for number of spikelets per panicle (89.893), number of panicles per hill (88.34),biological yield (86.56), number of tillers per hill (86.446), grain yield per hill (85.807), harvest index (72.897), panicle length (71.839) , flag leaf length (64.799), flag leaf width (64.366), test weight (64.326), days to maturity (62.827), plant height (62.568) and days to 50% flowering (62.536). There is no medium and low heritability values ~~are present~~.

### 3.3 Genetic Advance as Percent Mean

The estimation of genetic advance as percent mean is classified to be~~as~~ low (20%) as proposed by Johnson et al., 1955.

Highest GAM was recorded for grain yield per hill (55.348), biological yield (48.514), number of spikelets per panicle (46.557), number of panicles for hill (44.384), number of tillers per hill (37.947) and harvest index (27.61).Moderate estimates ofgenetic advance as per cent mean was recorded for (what?) followed by flagleaf width (18.278), test weight (18.206), panicle length (17.347), flag leaf (16.319), plant height (14.188), days to maturity (13.163) and days to 50%flowering(11.593).

### 3.4 Correlation Coefficient of Analysis

Correlation analysis among the yield and its contributingcharacters revealed that the genotypic correlation coefficients in most cases were higher thantheir phenotypic correlation coefficients indicating the association was largely due to geneticreason, at both phenotypic and genotypiccorrelation coefficient analysis

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revealed that Grainyield per hill exhibited positive and significant correlation with Plant height, Harvest index, Number ofpanicles per hill,Numberoftillers per hill,Numberofspikelets per Panicles,Biologicalyield and negative significant with days to maturity.

### 3.5 Path Analysis

In Path analysis, at both phenotypic andgenotypic level the diagonal values showed Direct, high and Positive effect ~~at~~ onharvest index,biologicalyield, test weight, flag leaf width, plant height, days to maturity withgrainyieldperhill.
It showed direct,high and negative effect ~~at~~ ondays to 50%flowering,flag leaf length,number of grains per panicle.

## 4. CONCLUSION

Among 20 genotypes of rice,BRRI-DHAN-75, A.K.DHANwere found superior for Grainyield per hillover the check (NDR-359). High PCV, GCV, and Genetic Advance as Percent of Mean were recorded for grain yield per hill and high Heritability, Genetic advance for number of spikelets per panicle indicating predominance ofadditive genes effect.Correlation at both genotypic and phenotypic level,Grain yield per hill showed highly positive significant association with biological yield, number of spikelets per panicle and harvest index. In Path analysis, at both phenotypic and genotypic levelthe diagonal values showed Direct, high and Positive effectat harvest index,biologicalyield, test weight, flag leaf width, plant height and days to maturity withgrainyieldperhill. These characters provide broadspectrum of variability in segregation and may be used as parents in the future hybridizationprogrammetodevelopdesirable genotypesforgrain yieldimprovementinricegenotypes.

**Table 1.~~:~~ AnalysisofVariancefor13quantitativecharactersof20ricegenotypes during*kharif*~~,~~2022**

| Sl.No. | Source | Replication | Treatment | Error |
|---|---|---|---|---|
| | Degrees of freedom | 2 | 19 | 38 |
| 1 | Days to 50% flowering | 6.0170 | 243.442** | 40.522 |
| 2 | Days to maturity | 30.4170 | 333.785** | 54.986 |
| 3 | Plant height (cm) | 155.780 | 469.734** | 78.1 |
| 4 | Flag leaf length (cm) | 14.0830 | 46.074** | 7.064 |
| 5 | Flag leaf width (cm) | 0.0160 | 0.051** | 0.008 |
| 6 | Number of tillers per hill | 0.6330 | 9.709** | 0.482 |
| 7 | Number of panicles per hill | 1.2450 | 9.97** | 0.42 |
| 8 | Panicle length (cm) | 1.350 | 22.603** | 2.612 |
| 9 | Number of spikelets per panicle | 86.2060 | 2509.917** | 90.664 |
| 10 | Test weight (g) | 1.6660 | 23.142** | 3.611 |
| 11 | Biological yield (g) | 32.5430 | 331.81** | 16.329 |
| 12 | Harvest Index (%) | 10.3320 | 181.964** | 20.065 |
| 13 | Grain yield per hill | 12.4020 | 94.724** | 4.95 |

* and ** indicate Significant at 5% and 1% level of significance

**Table 2. Estimation of variability and genetic parameters for 13 quantitative characters in rice genotypes ~~germplasm for~~during*kharif* 2022**

| Sl.No. | Characters | GCV | PCV | $h^2$ (Broad Sense) | Genetic Advancement 5% | Gen.Adv as % of Mean 5% |
|---|---|---|---|---|---|---|
| 1 | Days to 50% flowering | 7.117 | 8.999 | 62.536 | 13.398 | 11.593 |
| 2 | Days to maturity | 8.061 | 10.17 | 62.827 | 15.741 | 13.163 |
| 3 | Plant height | 8.707 | 11.008 | 62.568 | 18.618 | 14.188 |
| 4 | Flag leaf length | 9.841 | 12.225 | 64.799 | 5.98 | 16.319 |
| 5 | Flag leaf width | 11.059 | 13.785 | 64.366 | 0.198 | 18.278 |
| 6 | Number of tillers per hill | 19.812 | 21.309 | 86.446 | 3.359 | 37.947 |
| 7 | Number of panicles per hill | 22.923 | 24.389 | 88.34 | 3.455 | 44.384 |
| 8 | Panicle length | 9.935 | 11.722 | 71.839 | 4.507 | 17.347 |
| 9 | Number of spikelets per panicle | 23.837 | 25.142 | 89.893 | 55.464 | 46.557 |
| 10 | Test weight | 11.019 | 13.739 | 64.326 | 4.216 | 18.206 |
| 11 | Biological yield | 25.313 | 27.207 | 86.56 | 19.654 | 48.514 |
| 12 | Harvest Index | 15.698 | 18.386 | 72.897 | 12.921 | 27.61 |
| 13 | Grain yield per hill | 29.005 | 31.312 | 85.807 | 10.439 | 55.348 |

$h^2$ =Heritability, GCV= Genotypic Coefficient of Variation, PCV=Phenotypic Coefficient of Variation

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| TRAITS | | DFT | DM | PH | FLL | FLW | NTT | NPT | PL | NGPP | TW | BM | H.I | GYP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **DFT** | P | 1.0000 | 0.0684 | -0.0039 | -0.0614 | 0.2115 | -0.262* | -0.1655 | -0.1161 | -0.310* | 0.2335 | -0.1565 | -0.0980 | -0.1910 |
| | G | 1.0000 | 0.262* | -0.0557 | -0.0716 | 0.342* | -0.460** | -0.272* | -0.0827 | -0.405* | 0.294* | -0.285* | -0.1813 | -0.334* |
| **DM** | P | | 1.0000 | -0.0880 | 0.2256 | 0.2001 | -0.336* | -0.1503 | -0.1018 | -0.0148 | -0.0570 | -0.1620 | -0.486** | -0.407* |
| | G | | 1.0000 | -0.0724 | 0.431** | 0.2183 | -0.431** | -0.1716 | -0.1392 | -0.0006 | -0.308* | -0.1371 | -0.658** | -0.453** |
| **PH** | P | | | 1.0000 | 0.2285 | 0.0531 | 0.0600 | 0.1086 | 0.450** | 0.1719 | 0.1935 | 0.609** | -0.0050 | 0.502** |
| | G | | | 1.0000 | 0.2107 | 0.0346 | 0.0588 | 0.1622 | 0.699** | 0.1835 | 0.2304 | 0.787** | -0.0531 | 0.617** |
| **FLL** | P | | | | 1.0000 | 0.0667 | 0.0753 | 0.0593 | 0.2301 | -0.1308 | -0.1065 | 0.0231 | -0.285* | -0.1573 |
| | G | | | | 1.0000 | 0.0167 | 0.0597 | 0.0582 | 0.305* | -0.2075 | -0.0576 | 0.0973 | -0.595** | -0.264* |
| **FLW** | P | | | | | 1.0000 | -0.350* | -0.449** | 0.0888 | -0.355* | 0.0349 | 0.0677 | -0.0641 | 0.0144 |
| | G | | | | | 1.0000 | -0.577** | -0.678** | 0.1204 | -0.461** | 0.0722 | 0.0385 | -0.1775 | -0.0809 |
| **NTT** | P | | | | | | 1.0000 | 0.852** | 0.1173 | 0.523** | 0.0616 | 0.410* | 0.1879 | 0.466** |
| | G | | | | | | 1.0000 | 0.883** | 0.1929 | 0.569** | 0.0503 | 0.450** | 0.0948 | 0.439** |
| **NPT** | P | | | | | | | 1.0000 | 0.1919 | 0.586** | 0.0057 | 0.475** | 0.0139 | 0.422** |
| | G | | | | | | | 1.0000 | 0.2011 | 0.634** | 0.0168 | 0.553** | -0.1237 | 0.420** |
| **PL** | P | | | | | | | | 1.0000 | 0.1558 | 0.0934 | 0.371* | -0.1762 | 0.1900 |
| | G | | | | | | | | 1.0000 | 0.1983 | 0.1629 | 0.501** | -0.299* | 0.255* |
| **NGPP** | P | | | | | | | | | 1.0000 | -0.0179 | 0.507** | 0.1312 | 0.506** |
| | G | | | | | | | | | 1.0000 | -0.0073 | 0.563** | 0.1072 | 0.539** |
| **TW** | P | | | | | | | | | | 1.0000 | 0.0324 | 0.1552 | 0.1226 |
| | G | | | | | | | | | | 1.0000 | 0.0584 | 0.255* | 0.1953 |
| **BM** | P | | | | | | | | | | | 1.0000 | -0.0623 | 0.807** |
| | G | | | | | | | | | | | 1.0000 | 0.0008 | 0.843** |
| **H.I** | P | | | | | | | | | | | | 1.0000 | 0.532** |
| | G | | | | | | | | | | | | 1.0000 | 0.535** |

**Table 3. Correlation coefficient analysis**

DF50: Days to 50% Flowering, DM: Days to Maturity, PH: Plant Height, FLL: Flag Leaf Length, FLW: Flag Leaf Width, NTT: Number of Total Tillers, NPT: Number of Productive Tillers, PL: Panicle Length, BM: Biological Yield, H.I: Harvest Index, NGPP: Number of Grains per Panicle, TW: Test Weight, GYP: Grain Yield per Plant, P: Phenotypic, G: Genotypic

*, ** indicates 5% and 1% significant, respectively

**Table 4. Path coefficient analysis**

| | TRAITS | DF50 | DM | PH | FLL | FLW | NTT | NPT | PL | NGPP | TW | BY | H.I | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **DF50** | | -0.0077 | -0.0005 | 0.0000 | 0.0005 | -0.0016 | 0.0020 | 0.0013 | 0.0009 | 0.0024 | -0.0018 | 0.0012 | 0.0008 | -0.1910 |
| | | -0.0809 | -0.0211 | 0.0045 | 0.0058 | -0.0276 | 0.0372 | 0.0220 | 0.0067 | 0.0328 | -0.0238 | 0.0231 | 0.0147 | -0.334* |
| | **DM** | 0.0016 | 0.0233 | -0.0020 | 0.0053 | 0.0047 | -0.0078 | -0.0035 | -0.0024 | -0.0003 | -0.0013 | -0.0038 | -0.0113 | -0.407* |
| | | 0.0423 | 0.1618 | -0.0117 | 0.0698 | 0.0353 | -0.0697 | -0.0278 | -0.0225 | -0.0001 | -0.0499 | -0.0222 | -0.1065 | -0.453** |
| | **PH** | 0.0000 | -0.0003 | 0.0035 | 0.0008 | 0.0002 | 0.0002 | 0.0004 | 0.0016 | 0.0006 | 0.0007 | 0.0021 | 0.0000 | 0.502** |
| | | -0.0005 | -0.0006 | 0.0081 | 0.0017 | 0.0003 | 0.0005 | 0.0013 | 0.0056 | 0.0015 | 0.0019 | 0.0064 | -0.0004 | 0.617** |
| | **FLL** | 0.0009 | -0.0035 | -0.0035 | -0.0153 | -0.0010 | -0.0012 | -0.0009 | -0.0035 | 0.0020 | 0.0016 | -0.0004 | 0.0044 | -0.1573 |
| | | 0.0057 | -0.0344 | -0.0168 | -0.0799 | -0.0013 | -0.0048 | -0.0046 | -0.0244 | 0.0166 | 0.0046 | -0.0078 | 0.0475 | -0.264* |
| | **FLW** | 0.0001 | 0.0001 | 0.0000 | 0.0000 | 0.0005 | -0.0002 | -0.0002 | 0.0000 | -0.0002 | 0.0000 | 0.0000 | 0.0000 | 0.0144 |
| | | 0.0281 | 0.0179 | 0.0028 | 0.0014 | 0.0822 | -0.0474 | -0.0557 | 0.0099 | -0.0379 | 0.0059 | 0.0032 | -0.0146 | -0.0809 |
| | **NTT** | -0.0013 | -0.0017 | 0.0003 | 0.0004 | -0.0017 | 0.0049 | 0.0042 | 0.0006 | 0.0026 | 0.0003 | 0.0020 | 0.0009 | 0.466** |
| | | 0.0275 | 0.0257 | -0.0035 | -0.0036 | 0.0345 | -0.0597 | -0.0528 | -0.0115 | -0.0340 | -0.0030 | -0.0269 | -0.0057 | 0.439** |
| | **NPT** | -0.0043 | -0.0039 | 0.0028 | 0.0016 | -0.0118 | 0.0223 | 0.0262 | 0.0050 | 0.0153 | 0.0001 | 0.0124 | 0.0004 | 0.422** |
| | | -0.0718 | -0.0452 | 0.0427 | 0.0153 | -0.1785 | 0.2327 | 0.2635 | 0.0530 | 0.1671 | 0.0044 | 0.1456 | -0.0326 | 0.420** |
| | **PL** | 0.0023 | 0.0020 | -0.0090 | -0.0046 | -0.0018 | -0.0024 | -0.0038 | -0.0200 | -0.0031 | -0.0019 | -0.0074 | 0.0035 | 0.1900 |
| | | -0.0069 | -0.0116 | 0.0581 | 0.0254 | 0.0100 | 0.0160 | 0.0167 | 0.0832 | 0.0165 | 0.0136 | 0.0417 | -0.0249 | 0.255* |
| | **NGPP** | 0.0062 | 0.0003 | -0.0034 | 0.0026 | 0.0071 | -0.0104 | -0.0117 | -0.0031 | -0.0199 | 0.0004 | -0.0101 | -0.0026 | 0.506** |
| | | 0.0449 | 0.0001 | -0.0203 | 0.0230 | 0.0511 | -0.0630 | -0.0702 | -0.0219 | -0.1107 | 0.0008 | -0.0623 | -0.0119 | 0.539** |
| | **TW** | 0.0014 | -0.0003 | 0.0011 | -0.0006 | 0.0002 | 0.0004 | 0.0000 | 0.0005 | -0.0001 | 0.0058 | 0.0002 | 0.0009 | 0.1226 |
| | | 0.0085 | -0.0089 | 0.0067 | -0.0017 | 0.0021 | 0.0015 | 0.0005 | 0.0047 | -0.0002 | 0.0289 | 0.0017 | 0.0074 | 0.1953 |
| | **BY** | -0.1326 | -0.1372 | 0.5154 | 0.0195 | 0.0574 | 0.3472 | 0.4020 | 0.3140 | 0.4296 | 0.0274 | 0.8469 | -0.0528 | 0.807** |
| | | -0.2110 | -0.1014 | 0.5820 | 0.0719 | 0.0285 | 0.3326 | 0.4086 | 0.3704 | 0.4165 | 0.0432 | 0.7396 | 0.0006 | 0.843** |
| | **H.I** | -0.0576 | -0.2856 | -0.0029 | -0.1673 | -0.0377 | 0.1104 | 0.0082 | -0.1036 | 0.0771 | 0.0912 | -0.0366 | 0.5876 | 0.532** |
| | | -0.1199 | -0.4350 | -0.0351 | -0.3932 | -0.1174 | 0.0627 | -0.0818 | -0.1978 | 0.0709 | 0.1688 | 0.0006 | 0.6614 | 0.535** |

DF50: Days to 50% Flowering, DM: Days to Maturity, PH: Plant Height, FLL: Flag Leaf Length, FLW: Flag Leaf Width, NTT: Number of Total Tillers, NPT: Number of Productive Tillers, PL: Panicle Length, B.Y: Biological Yield, H.I: Harvest Index, NGPP: Number of Grains per Panicle, TW: Test Weight, GYP: Grain Yield per Plant, P: Phenotypic, G: Genotypic *, ** indicates 5% and 1% significant

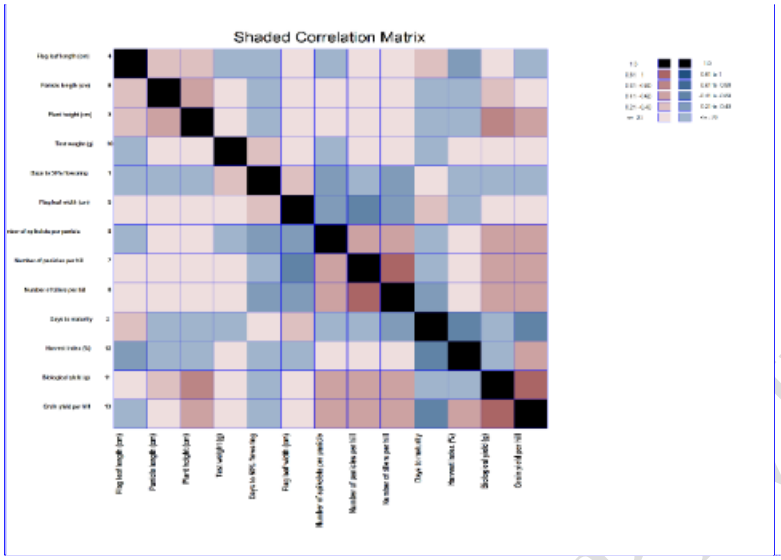


**Fig. 1. Phenotypic~~al~~ correlation matrix**

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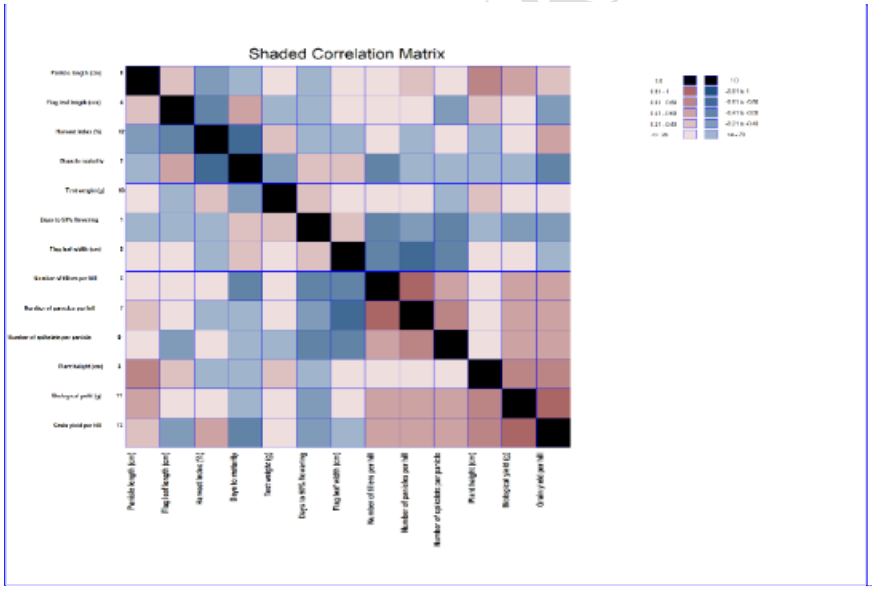


**Fig. 2. Genotypic~~al~~ correlation matrix**

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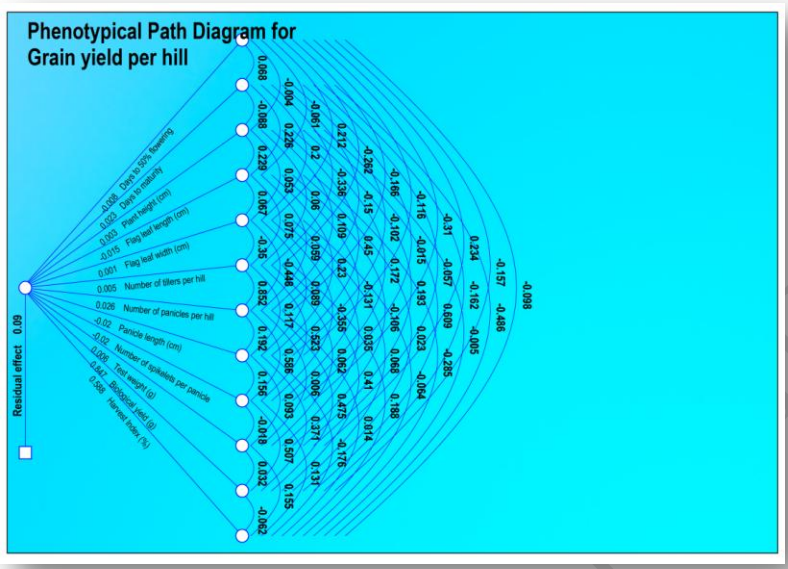


**Fig. 3. Phenotypic~~al~~ path diagrams for grain yield per hill**

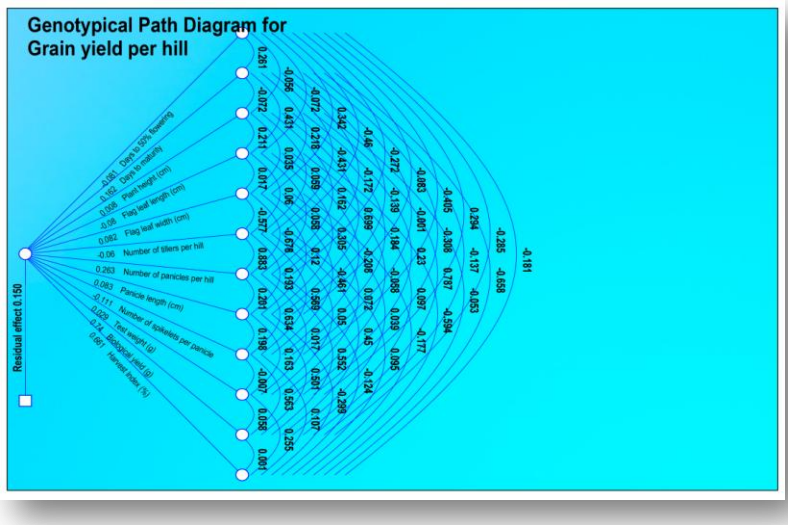


**Fig. 4. Genotypic~~al~~ path diagram for grain yield per hill**

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