Original Research Article

CORRELATION AND PATH COEFFICIENT ANALYSIS STUDIES IN RICE HYBRIDS (ORYZA SATIVA L.)

ABSTRACT

The present investigation was carried out at Agricultural Polytechnic, Polasa, Jagtial, Telangana, to delineate the correlation and path analysis for yield and yield attributing traits for 38 genotypes including 3 checks in Randomized Block Design replicated thrice during *Rabi*, 2022. Association studies revealed that genotypic correlation values were higher than that of phenotypic correlations. Important traits i.e., spikelet fertility followed by 1000 grain weight exhibited the highest positive significant association with single plant yield. Path coefficient analysis also revealed that the traits spikelet fertility and 1000 grain weight had reported the highest positive direct effect of on single plant yield at both genotypic and phenotypic levels. Hence, these traits could be used as selection indices for heterotic rice hybrid development.

Comment [A1]: writing the research objectives according to the introduction

Comment [A2]: write in numbers

Key words: Correlation, Path coefficient analysis, Rice.

1. INTRODUCTION

Rice (*Oryza sativa* L.) is an important staple crop for more than half of the population on the globe and hence referred as "Global grain" [1]. Considering the ever-growing population, the goal of any plant breeder is always to boost yield in food crops, especially rice. It is anticipated that by 2030, there is an acute need to produce 60 per cent higher rice yields than it did in 1995 [2]. Increasing rice production is critical to achieve food security and ultimately the world poverty alleviation. Understanding the type and degree of genetic variation influencing the inheritance of quantitative traits such as yield and its components is critical for efficient genetic improvement. It is familiar that the development of "hybrid varieties" is the most efficient and cost-effective method that can be currently accessible in rice. Hybrid technology became part of the crop improvement programme.

Comment [A3]: complete with data

Higher diversity in population facilitates effective selection to develop the cultivars with high yield with desirable characteristics.

Since grain yield is a complex trait that is due to involvement of various independent variable traits apart from environmental conditions. Selection based on yield alone will result in lesser yield improvement. Hence, association between grain yield and its yield attributing traits will be useful criteria for yield improvement. To identify superior hybrids with desirable plant types, plant breeders should have the knowledge on associations between yield and it's component traits and their influence on grain yield. Correlation and path analysis reveals the magnitude of the relationship between grain yield and its components along with their direct and indirect effects. The present study was conducted to understand the relationship between yield and yield component traits as well as to estimate the direct and indirect effects of yield attributing traits on grain yield.

Comment [A4]: explain if you don't need to delete

2. MATERIAL AND METHODS

The material used in the present investigation comprised of 38 genotypes which included eight lines, three testers and twenty-four hybrids developed through Line X Tester mating design (Kempthorne, 1957) [3] along with three checks. The experiment was carried out during *Rabi*, 2022, at Agricultural Polytechnic, Jagtial, which is situated at an altitude of 243.4 m above mean sea level on 18°49'40" N latitude and 78°56'45"E longitudes in Northern Zone of Telangana State. The experimental material was planted in a Randomized block design with three replications. Each replication consisted of three rows of 3 m length with a spacing of 15 cm between the rows and 15 cm between the plants. All required precautions were taken to ensure a uniform plant population in each treatment per replication. Five plants were selected at random and observations were recorded from each replication. The characters studied were Days to 50% flowering, Plant height (cm), Panicle length (cm), Productive tillers per plant, Filled grains per panicle, Unfilled grains per panicle, Spikelet fertility (%), 1000 grain weight (g) and Single plant yield (g). Relevant data was collected and subjected to statistical analysis by employing the methods suggested by Singh and Chaudhary [4] for Correlation coefficient and Dewey and Lu (1959) [5] for Path analysis.

Comment [A5]: complete with an image of the research map

Comment [A6]: clarified at what age the recording was done

3. RESULTS AND DISCUSSION

Phenotypic selection is always misleading as it will be influenced by various biotic and abiotic factors. Hence, selection based on the set of traits which have true association with the grain yield will be beneficial in any crop improvement programme.

Comment [A7]: replace with softer language

Correlation studies on various yield and yield attributing traits will be useful to demonstrate the degree and direction of association among various traits which is the key of selection process to develop high yielding cultivars. Path coefficient analysis provides the base about direct and indirect effects of various independent variables on the ultimate dependent variable i.e., grain yield.

The phenotypic and genotypic correlation coefficients among yield and yield components i.e., days to 50 per cent flowering, plant height, panicle length, number of productive tillers per plant, number of filled grains per panicle, number of unfilled grains per panicle, spikelet fertility and 1000 grain weight were assessed and the results have been presented in Table 1.

The results indicated that the genotypic correlation coefficients were consistently greater than the phenotypic correlation coefficients for all the characters under investigation demonstrating that the association between yield and its component traits was mainly attributed to the genetic factors.

Single plant yield was found to be positively and significantly correlated both at genotypic and phenotypic levels with days to 50% flowering (0.6201**/0.6257) and plant height (0.5469**/0.5600) which were similar with the findings of Bhadru et al. [6] and Babu et al. [2] for plant height and 50% flowering. From the above findings, it appears that late blooming cultivars may have better possibility of synthesis of higher quantity of assimilates and better partitioning resulting in more grains and yield.

Comment [A8]: written in numbers how many days the plant is

Panicle length and productive tillers also exhibited the similar trend of significant positive association with single plant yield. Similar results were reported by Pratap et al. [7] for productive tillers; Devi et al. [8] for panicle length. This will be due to increased number of productive tillers per plant, resulted in increased number of panicles per plant while increase in panicle length leads to the accommodation of more number of grains per panicle resulting in a higher single plant yield.

Number of filled grains per panicle (0.6201**/0.6229), spikelet fertility (0.8151**/0.8199) and 1000 grain weight (0.7889**/0.7956) also registered a positive significant relationship with single plant yield, which will have a direct impact on the seed yield. These results are in accordance with the findings of Hasan et al. [9] and Tiwari et al. [10] for spikelet fertility, Babu et al. [2] for filled grains, Eswaran et al. [11], Tiwari et al. [10] and Jasmine et al. [12] for 1000 grain weight, Pratap et al. [7] for spikelet fertility percentage, filled grains per panicle and 1000 grain weight. These interactions can be exploited as grain yield indices during selection process to increase the grain production.

Interrelationships among yield attributing traits revealed that days to 50% flowering was significantly and positively correlated with plant height, panicle length, number of productive tillers per plant, number of filled grains per panicle, spikelet fertility and single plant yield, while negative and significant association was registered with number of unfilled grains per panicle. Similar positive associations were found by Babu et al. [2] for days to 50% flowering with other traits such as plant height, panicle length and number of filled grains per panicle; Sarker et al. [13] for number of unfilled grains per panicle.

Days to 50% flowering, panicle length, number of productive tillers per plant, number of filled grains per panicle, spikelet fertility, 1000 grain weight and single plant yield showed a significant positive association with plant height while a significant negative correlation was observed with number of unfilled grains per panicle. These findings of substantial and positive relationship were in line with those of Srijan et al. [14] for panicle length and number of filled grains per panicle; Bhadru et al. [6] for panicle length, productive tillers per plant, spikelet fertility and filled grains per panicle.

Panicle length was significantly and positively correlated with number of filled grains per panicle, spikelet fertility, 1000 grain weight and single plant yield while negative and non-significantly correlated with number of unfilled grains per panicle.

Number of productive tillers per plant reported positive and significant association with1000 grain weight, panicle length, spikelet fertility, number of filled grains per panicle and single plant yield, while significant and negative association with number of unfilled grains per panicle. The findings are consistent with previous reports of Tripathi et al. [15].

Spikelet fertility was significantly and positively correlated with number of filled grains per panicle,1000 grain weight and single plant yield while it was significantly negatively correlated with number of unfilled grains per panicle. Similar findings were reported by Umarani et al. [16]

Filled grains per panicle were significantly and positively correlated with spikelet fertility, 1000 grain weight and single plant yield while it was negatively correlated with number of unfilled grains per panicle. The results were in accordance with Islam et al. [17]

PATH COEFFICIENT ANALYSIS

It is well known fact that simple correlation does not reveal the true association of the characteristics to yield, which will not explain the cause and effect association between the various yield attributes and eventually, the yield. The path analysis technique provides information on the real contribution of an independent attributes on yield by dividing the correlation coefficients into direct and indirect effects.

If the correlation coefficient is positive while the direct effect is negative, it will be due to the indirect effects which cause positive correlation, which should be given priority during selection process. However, if the correlation coefficient is negative but the direct effect is positive, a restriction must be set to exclude the undesirable indirect effects so that direct effects can be used.

For the yield and yield component traits, path coefficient analysis estimates have been presented in Table 2. From the path analysis it was observed that, spikelet fertility (0.4906) showed the most positive direct effect on single plant yield. High positive direct effect of this trait has been nullified by the negative indirect effect of number of unfilled grains per panicle (-0.4621), however indirect effects via number of filled grains per panicle,1000 grain weight, plant height and productive tillers per plant was very high bringing the total correlation to r=0.8151 with yield. The results were in agreement with the findings of Akter et al. (2019) [18], Vennela et al. (2022) [19].

The trait, 1000 grain weight was noticed as the second most important character with a positive direct effect of (0.3879) on single plant yield. It's indirect effect via number of productive tillers per plant, spikelet fertility, panicle length, plant height and days to 50% flowering was high, while it's effect with the number of unfilled grains per panicle was proved negative. The results were in accordance with the findings of Kiruthikadevi et al. [20], Parimala et al. [21].

Number of productive tillers per plant (0.1929) reported a positive direct effect on single plant yield due to indirect positive effects through 1000 grain weight, plant height, spikelet fertility, panicle length, days to 50% flowering and number of filled grains per panicle, while it's effect with the number of unfilled grains per panicle was negative. The results are in line with the findings of Nandha et al. [22], Guptha et al. [23].

The traits, days to 50% flowering, plant height and number of filled grains per panicle also showed a positive direct effect on single plant yield. Similar results were reported by Kiruthikadevi et al. [20] for days to 50% flowering and number of filled grains per panicle; Pratap et al. [7] for plant height.

Though the correlation coefficient of panicle length (0.3975) was positive, it's direct effect on single plant yield was negative and low, which is mainly due to negative indirect effects of days to 50% flowering, 1000 grain weight, plant height, number of productive tillers per plant, spikelet fertility and number of filled grains per panicle, while it has a positive indirect effect through number of unfilled grains per panicle. The similar results were reported by Vennela et al. [19].

Number of unfilled grains per panicle (0.0802) reported a positive direct effect on single plant yield, while it's correlation coefficient was negative (-0.7572) which was mainly due to negative indirect effects through spikelet fertility, number of filled grains per panicle, 1000 grain weight, number of productive tillers per plant, days to 50%flowering, plant height and panicle length. These findings were similar to that of Hossain et al. [24].

CONCLUSION:

Correlation and Path analysis studies revealed that the important yield attributing traits like spikelet fertility, 1000-grain weight and number of productive tillers per plant exhibited a highly significant correlation values both at genotypic and phenotypic levels. Further, the same traits also exhibited a higher values of direct effects on single plant yield during Path analysis. Hence, these traits should be given the top priority while developing the superior rice hybrids.

Comment [A9]: write the value

Comment [A10]: The results of the indirect effects also need to be included

COMPETING INTERESTS DISCLAIMER:

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

REFERENCES:

Comment [A11]: some references have been too long need updating

1. Prasannakumari M, Akilan M, Kalaiselvan S, Subramanian A, Janaki P, Jeyaprakash P. Studies on genetic parameters, correlation and path analysis for yield attributes and Iron

content in a backcross population of rice [Oryza sativa (L.)]. Electronic Journal of Plant Breeding. 2020;11(03):881-886.

2. Babu VR, Shreya K, Dangi KS, Usharani G, Shankar AS. Correlation and path analysis studies in popular rice hybrids of India. International Journal of Scientific and Research Publications. 2012;2(3):1-5.
3. Kempthorne O. 1957. An Introduction to Genetic Statistics. John Wiley and Sons Inc: New York.
4. Singh PK, Prasad MK, Chaudhari LB. Diversity study in maize (Zea mays L.). Journal of Applied Biology. 1977;9 (2):129 – 132.
5. Dewey, D.R and Lu, K.H. A correlation and path coefficient analysis of components of crested wheat grass seed production. Agronomy Journal. 1959; 51:515- 518.
6. Bhadru D, Reddy DL, Ramesha MS. Correlation and path coefficient analysis of yield and yield contributing traits in rice hybrids and their parental lines. Electronic Journal of Plant Breeding. 2011; 2(1):112-116.
7. Pratap A, Bisen P, Loitongbam B, Singh PK. Assessment of genetic variability for yield and yield components in rice (Oryza sativa L.) germplasms. International Journal of Bio-resource and Stress Management. 2018; 9(1) :87-92.
8. Devi KR, Satish B, Chandra N, Lingaiah Y, Hari, Venkanna V. Analysis of variability, correlation and path coefficient studies for yield and quality traits in rice (Oryza sativa L.). International Journal of Current Microbiology and Applied Sciences. 2019; 8(4): 355-362.
9. Hasan MU, Kulsum MJ, Akter A, Masuduzzaman, ASM, Ramesha MS. Genetic variability and character association for agronomic traits in hybrid rice (Oryza sativa L.). Bangladesh Journal of Plant Breeding and Genetics. 2013;24 (1): 45-51.
10. Tiwari JK. Association analysis and selection strategies for various yield contributing traits in rice genotypes. Applied Biological Research.2017; 19 (1): 35-40.
11. Eswaran R, Anandan A. Investigation of correlation between traits and path analysis of rice (Oryza sativa L.) grain yield under coastal salinity. Electronic Journal of Plant Breeding. 2011; 2(4):538-542.

Comment [A12]: the reference source is too old

Comment [A13]: writing according to others

Comment [A14]: the reference source is too old

Comment [A15]: the reference source is too old

12. Jasmine C, Shivani D, Senguttuvel P, Naik DS. Genetic variability and association studies in maintainer and restorer lines of rice [Oryza sativa (L.)]. The Pharma Innovation Journal. 2022; 11(1): 569-576.
13. Sarker MM, Hassan L, Islam MM, Rashid MM, Seraj S. Correlation and path coefficient analysis of some exotic early maturing rice (Oryza sativa L.) lines. Journal of Bioscience and Agriculture Research. 2014;1(1):01-07.
14. Srijan A, Sudheer Kumar S, Damodar Raju Ch, Jagadeeshwar, R. Character association and path coefficient analysis for grain yield of parents and hybrids in rice (Oryza sativa L.). Journal of Applied and Natural Science. 2016; 8(1):167-172.
15. Tripathi N, Verma OP, Singh PK, Rajpoot P. Studies on correlation and path coefficient analysis for yield and its components in rice (Oryza sativa L.) under salt affected soil. Journal of Pharmacognosy and Phytochemistry.2018; 7(3):1626-1629.
16. Umarani E, Hemalatha V, Subbarao LV, Neeraja CN, Suneetha K, Reddy NS. 2019. Studies on character association and path coefficient analysis for anaerobic germination traits, yield and its contributing characters in rice (Oryza sativa L.). International Journal of Current Microbiology and Applied Sciences.2019; 8(4):355-362.
17. Islam SS, Nualsri C, Hasan AK.Character association and path analysis studies in upland rice (Oryza sativa) genotypes. Research on Crops.2021; 22(2).
18. Akter A, Hasan MJ, Latif MA, Kulsum MU, Biswas PL, Rahman MH, Majumder RR, Lipi LF, Quddus MR, Akter F, Ara A. Genetic variability, heritability, correlation and path coefficient studies for yield and yield components of some promising rice hybrids. Bangladesh Rice Journal. 2019;23(2):27-34.
19. Vennela M, Srinivas B, Reddy VR, Balram N. Studies on Correlation and Path Coefficient Analysis in Hybrid Rice (Oryza sativa L.) for Yield and Quality Traits. International Journal of Bio-Resource & Stress Management.2021;12(5).
20. Kiruthikadevi U, Banumathy S, Arunachalam P, Renuka R, Thirumurugan, T. Correlation, Path Analysis and Stress Indices Studies of Saltol Introgressed Lines of Rice for Salinity Tolerance. Electronic Journal of Plant Breeding.2020;11(1): 230-237.

21. Parimala K, Raju CS, Prasad AH, Kumar SS, Reddy SN. Studies on genetic parameters, correlation and path analysis in rice (Oryza sativa L.). Journal of Pharmacognosy and Phytochemistry. 2020; 9(1): 414-417.

22. Nanda K, Bastia DN, Nanda A. Character Association and Path Coefficient Analysis for Yield and its Component Traits in Slender Grain Rice (Oryza Sativa L.). Electronic Journal of Plant Breeding.2019;10(3):963-969.

23. Gupta S, Upadhyay S, Koli GK, Rathi SR, Bisen P, Loitongbam B, Singh PK, Sinha B. Trait Association and Path Analysis Studies of Yield Attributing Traits in Rice (Oryza sativa L.) Germplasm International Journal of Bio-Resource and Stress Management.2020;11(6):508-517.

24. Hossain S, Haque M, Rahman J. Genetic variability, correlation and path coefficient analysis of morphological traits in some extinct local Aman rice (Oryza sativa L). Rice Research. 2015; 4:1.

Character	Days to 50% flowering	Plant height (cm)	Panicle length (cm)	No. of productive tillers plant^{-1}	No. of filled grains panicle^{-1}	No. of unfilled grains panicle^{-1}	Spikelet fertility (%)	1000-grain weight (g)	Single plant yield
Days to 50% flowering	1.000 (1.000)	0.4055** (0.4141)	0.3851** (0.3910)	0.4909** (0.5103)	0.6009** (0.6065)	-0.3705** (-0.3732)	0.4536** (0.4573)	0.3851** (0.3901)	0.6201** (0.6257)
Plant height(cm)		1.000 (1.000)	0.4418** (0.4664)	0.5419** (0.5607)	0.3079** (0.3134)	-0.2726** (-0.2793)	0.3162** (0.3247)	0.4565** (0.4663)	0.5469** (0.5600)
Panicle length (cm)			1.000 (1.000)	0.3861 ** (0.4056)	0.1209 (0.1244)	-0.2446** (-0.2493)	0.2485** (0.2532)	0.4683** (0.4800)	0.3975** (0.4025)
No. of productive tillers plant^{-1}				1.000 (1.000)	0.1704 (0.1800)	-0.2950** (-0.1325)	0.2982** (0.3156)	0.6012** (0.6318)	0.6434** (0.6735)
No. of filled grains panicle^{-1}					1.000 (1.000)	-0.5870** (-0.5900)	0.7795** (0.7804)	0.1746 (0.1748)	0.6201** (0.6229)
No. of unfilled grains panicle^{-1}						1.000 (1.000)	-0.9418** -(0.9446)	-0.5410** (-0.5508)	-0.7572** (-0.7653)
Spikelet fertility (%)							1.000 (1.000)	0.5218** (0.5275)	0.8151** (0.8199)
1000-grain weight(g)								1.000 (1.000)	0.7889** (0.7956)
Single plant yield									1.000 (1.000)

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

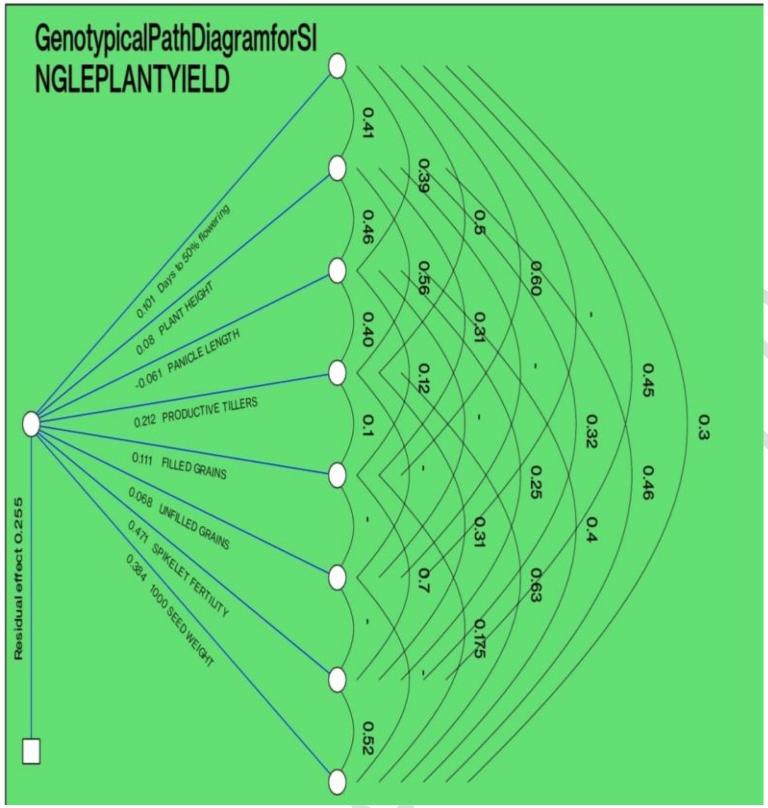
Figures in parenthesis are genotypic correlation coefficients

Table 1. Phenotypic and Genotypic correlation coefficients for yield and yield attributing traits

Table 2. Phenotypic and Genotypic Path coefficients for yield and yield attributing traits

Character	Days to 50% flowering	Plant height (cm)	Panicle length (cm)	No. of productive tillers plant^{-1}	No. of filled grains panicle^{-1}	No. of unfilled grains panicle^{-1}	Spikelet fertility (%)	1000-grain weight (g)	Single plant yield
Days to 50% flowering	**0.1112 (0.1010)**	0.0451 (0.0418)	0.0428 (0.0395)	0.0546 (0.0515)	0.0668 (0.0612)	-0.0412 (-0.0377)	0.0504 (0.0462)	0.0428 (0.0394)	0.6201 (0.6257)
Plant height(cm)	0.0319 (0.0331)	**0.0786 (0.0800)**	0.0347 (0.0373)	0.0426 (0.0449)	0.0242 (0.0251)	-0.0214 (-0.0224)	0.0249 (0.0260)	0.0359 (0.0373)	0.5469 (0.5600)
Panicle length (cm)	-0.0194 (-0.0237)	-0.0223 (-0.0282)	**-0.0505 (-0.0605)**	-0.0195 (-0.02456)	-0.0061 (-0.0075)	0.0123 (0.0151)	-0.0125 (-0.0153)	-0.0236 (-0.0290)	0.3975 (0.4025)
No. of productive tillers plant^{-1}	0.0947 (0.1080)	0.1046 (0.1187)	0.0745 (0.0859)	**0.1929 (0.2117)**	0.0329 (0.0381)	-0.0569 (-0.0662)	0.0575 (0.0668)	0.1160 (0.1338)	0.6434 (0.6735)
No. of filled grains panicle^{-1}	0.0596 0.0675	0.0305 (0.0349)	0.0120 (0.0138)	0.0169 (0.0200)	**0.0991 (0.1112)**	-0.0582 (-0.0656)	0.0773 (0.0868)	0.0173 (0.0194)	0.6201 (0.6229)
No. of unfilled grains panicle^{-1}	-0.0297 -0.0252	-0.0218 -0.0189	-0.0196 (-0.0169)	-0.0236 (-0.0211)	-0.0471 (-0.0399)	**0.0802 (0.0676)**	-0.0755 (-0.0639)	-0.0434 (-0.0373)	-0.7572 (-0.7653)
Spikelet fertility (%)	0.2225 0.2154	0.1551 (0.1529)	0.1219 (0.1193)	0.1463 (0.1487)	0.3825 (0.3676)	-0.4621 (-0.4449)	**0.4906 (0.4711)**	0.2560 (0.2485)	0.8151 (0.8199)
1000-grain weight(g)	0.1494 (0.1496)	0.1771 (0.1788)	0.1816 (0.1841)	0.2332 (0.2423)	0.0677 (0.0670)	-0.2098 (-0.2113)	0.2024 (0.2023)	**0.3879 (0.3835)**	0.7889 (0.7956)

Residual effect (Phenotypic) =0.2779
Residual effect (Genotypic) = 0.2547
Figures in parenthesis are genotypic effects


GenotypicalPathDiagramforSI
NGLEPLANTYIELD
0.101 Days to 50% flowering
0.08 PLANT HEIGHT
-0.061 PANICLE LENGTH
0.212 PRODUCTIVE TILLERS
0.111 FILLED GRAINS
0.068 UNFILLED GRAINS
0.471 SPIKELET FERTILITY
0.384 1000 SEED WEIGHT
Residual effect 0.255

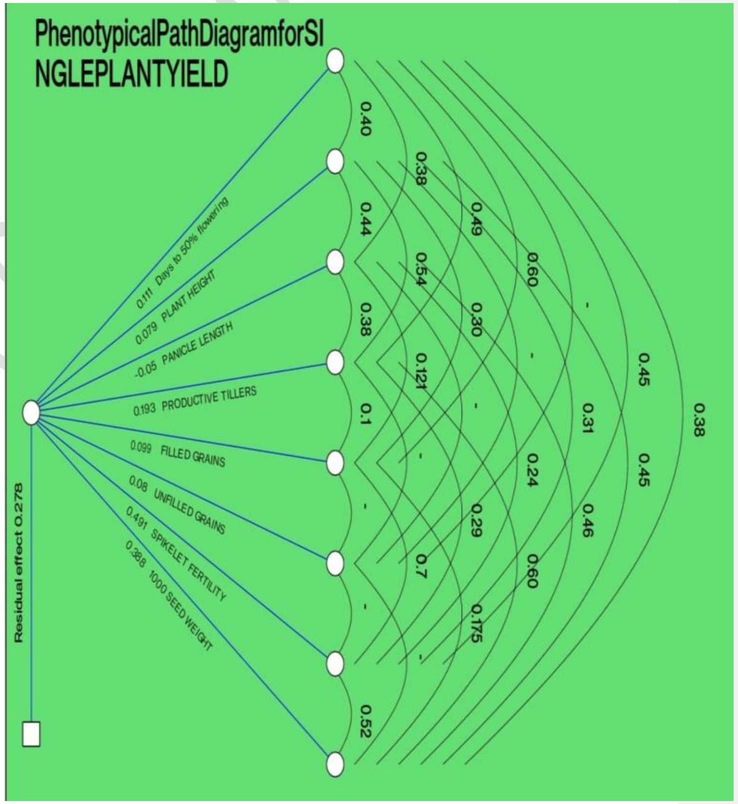

PhenotypicalPathDiagramforSI
NGLEPLANTYIELD
0.111 Days to 50% flowering
0.079 PLANT HEIGHT
-0.05 PANICLE LENGTH
0.193 PRODUCTIVE TILLERS
0.099 FILLED GRAINS
0.08 UNFILLED GRAINS
0.491 SPIKELET FERTILITY
0.388 1000 SEED WEIGHT
Residual effect 0.278

Figure 1 : Geotypical path diagram for SI NGLEPLANTYIELD

Figure 2: Phenotpical path diagram for SI NGLEPLANTYIELD