

## **Correlation and path coefficient analysis for yield and yield attributing traits in Rice (*Oryza sativa* L.)**

### **Abstract**

This study aimed to investigate the correlations among yield and yield component traits and estimate the direct and indirect effects of these traits on grain yield in rice. The experiment was conducted during *kharif* 2022. Correlation coefficients and path coefficients were analyzed to determine the relationships between these traits and seed yield. The results showed significant positive correlations between seed yield and traits such as effective tillers per plant, total tillers per plant, number of filled grains, spikelet fertility, biological yield, harvest index, and 100 seed weight. The genotypic correlations were slightly higher than the corresponding phenotypic correlations. Path coefficient analysis revealed that biological yield had the maximum direct effect on seed yield, followed by harvest index, panicle length, and number of filled grains per panicle, plant height, and effective tillers per plant, 100 seed weight, and days to 50% flowering. These findings provide valuable information for selecting superior cross combinations in hybrid rice breeding programs to improve grain yield.

Keywords: Correlation, path coefficient analysis, rice, *Oryza sativa* L.

### **Introduction**

Rice (*Oryza sativa* L.) ( $2n=24$ ) is a major cereal crop that belongs to the Poaceae family and the Oryzoidea subfamily. It is known as the "Global Grain" because it is a staple food in over 100 countries. Approximately 90% of the world's rice is grown and consumed in Asia, with rice providing food for 50% of the population (Yugandhar *et al*)[1] Rice is one of the most essential staple crops worldwide, serving as a crucial source of nutrition and sustenance for billions of people. Ensuring optimal yield and improving yield-contributing traits in rice is of paramount importance to meet the increasing global demand for food. In this context, understanding the complex relationships between various yield attributes and their correlation with overall yield becomes crucial for effective crop management and breeding programs. (Dhurai *et al*)[2] Yield is a complex character, which is highly influenced by the environment, hence direct selection for yield alone limit the selection efficiency and ultimately results in limited success in yield improvement. Thus, effective improvement in yield may be brought about through selection of yield component characters. Yield component characters show association among themselves and also with yield. Plant Breeder has to find significant correlations among yield and yield component traits, and effect of yield component traits on grain yield to predict the superior cross combinations and to select ideal plant type with increased yield. (Thakur *et al*)[3] The present study was undertaken to derive information on correlation among yield and yield component traits and to estimate the direct and indirect effects

of yield component traits on grain yield. This helps in selection of superior cross combinations in hybrid rice.

### **Material and methods**

The current experiment will be conducted at Research cum Instructional farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, Department of Genetics and Plant Breeding, College of Agriculture, IGKV, Raipur (C.G.) during *Kharif 2022*, to determine the most suitable traits to improve the yield and measure them as a selection criteria through studying and analyzing the correlation and path coefficient. The experiment was conducted in a randomized complete block design with three replications. The experimental material consisted of five generations of P<sub>1</sub>, P<sub>2</sub>, F<sub>1</sub>, F<sub>2</sub>, and F<sub>3</sub> which generated from crosses between following parents Rajeshwari, Mahamaya, IGKV R 1244, IC0496940, IC0491194, IC0491254, and IC0558317. The characters studied were, days to 50 per cent flowering, plant height, panicle length, number of effective tillers per plant, total tillers per plant, number of filled grain per panicle, number of unfilled grain per panicle, spikelet fertility, biological yield per plant, harvest index, 100 seed weight, seed yield per plant as a selection index to improve grain yield on five randomly selected plants in each replications.

### **Data analysis**

Correlation coefficient and path coefficients were analyzed by using Windostat Statistical Software Version 9.3. Correlations coefficient were computed by using the formula as given below:

$$r = (\text{Cov}(xy) / \sigma_x \times \sigma_y) \times 100$$

Where,  $r$  = Correlation coefficient  $\text{Cov}(xy)$  = Covariance between the characters 'x' and 'y'  $\sigma_x$  and  $\sigma_y$  = variance of the character 'x' and 'y' respectively.

Whereas, path coefficients were obtained by solving the simultaneous equations, which express the basic relationship between correlations and path coefficients.

### **Result and discussions**

#### **Correlations coefficients**

Correlation coefficients are the index of the association between two variables, which is due to linkage, pleiotropies or due to any environmental components. Coefficients of correlation among seed yield and its components for five populations illustrated in table 1. result of the analysis revealed that the seed yield correlated positively, at both phenotypic and genotypic levels with effective tillers per plant ( $r_g=0.427$ ), total tillers per plant ( $r_p=0.335$ ,  $r_g=0.474$ ), number of filled grain ( $r_p=0.506$ ,  $r_g=0.559$ ), spikelet fertility ( $r_p=0.344$ ,  $r_g=0.600$ ), biological

yield ( $r_p=0.811$ ,  $r_g=0.847$ ), harvest index ( $r_p=0.382$ ,  $r_g=0.333$ ), 100 seed weight ( $r_p=0.270$ ,  $r_g=0.290$ ). The results indicated that those above mentioned traits had the strong association with seed yield. These indicated that simultaneous selection of all these traits was important for yield improvement. Almost similar findings have been reported by Bagheri *et al.*[4], Basavaraja *et al.*[5], Bhadru *et al.*[6], Rathod *et al.*[7], Devi *et al.*[8], Giriet *et al.*[9], Naiket *et al.*[10]

The trait days to 50 percent flowering exhibited significant positive correlation with harvest index ( $r_p = 0.546$ ,  $r_g = 0.711$ ) while it was significant negatively correlated with plant height ( $r_p=-0.431$ ,  $r_g=-0.498$ ), panicle length ( $r_p= -0.290$ ,  $r_g=-0.522$ ). Similar findings have been reported by Bagudam *et al.*[11], Solomon and Wegary[12].

The traits plant height showed significant positive correlated with panicle length ( $r_p=0.317$ ,  $r_g=0.545$ ) and 100 seed weight ( $r_p= 0.435$ ,  $r_g = 0.476$ ) on the other hand it was showed negatively significant with no of filled grain ( $r_p= -0.513$ ,  $r_g = -0.587$ ), spikelet fertility ( $r_p = -0.308$ ,  $r_g = -0.617$ ) and harvest index ( $r_p= -0.358$ ,  $r_g= -0.495$ ). Panicle length exhibited positively significant with traits like 100 seed weight ( $r_g= 0.395$ ) followed by effective panicle per plant, biological yield ( $r_g = 0.342$ ) and number of unfilled grain ( $r_g= 0.306$ ). Effective tillers per plant showed positive correlation with traits like total tillers per plant ( $r_p=0.755$ ), spikelet fertility ( $r_p= 0.313$ ,  $r_g= 0.343$ ), biological yield ( $r_g= 0.408$ ), 100 seed weight ( $r_g=0.395$ ). Similar findings have been reported by kalian *et al.* [13], Rashid *et al.*[14], Kumaret *al*[15]

Total tillers plant exhibited significant negative correlation with traits like no of unfilled grain ( $r_p=-0.310$ ,  $r_g= -0.350$ ) and it showed significant positive correlated with traits like spikelet fertility ( $r_p= 0.408$ ,  $r_g= 0.665$ ) followed by no of filled grain ( $r_p= 0.317$ ,  $r_g= 0.479$ ), biological yield ( $r_p= 0.333$ ,  $r_g= 0.443$ ). Number of filled grain showed significant positive correlation with the traits like spikelet fertility ( $r_p= 0.548$ ,  $r_g= 0.857$ ), biological yield ( $r_p= 0.319$ ,  $r_g= 0.328$ ) and harvest index ( $r_p= 0.290$ ,  $r_g = 0.424$ ). While it was showed significant negative correlation with trait like number of unfilled grain ( $r_g= -0.401$ ). Number of unfilled grain exhibited significant negative correlation with spikelet fertility ( $r_p= -0.473$ ,  $r_g= -0.803$ ). Spikelet fertility showed significant positive correlation with biological yield ( $r_p= 0.294$ ,  $r_g= 0.451$ ). Biological yield exhibited significant positive correlation with 100 seed weight ( $r_p= 0.522$ ,  $r_g= 0.528$ ). Harvest index showed significant negative correlation with 100 seed weight ( $r_p= -0.292$ ,  $r_g= -0.328$ ). Similar findings have been reported by Sreedhar and Reddy (2019)[16], Manasa *et al.* (2022)[17], Faysal *et al.* (2022) [18], Kiran *et al.* (2023)[19]. In this present investigation, the genotypic and phenotypic correlations coefficient were similar in directions, while in magnitude genotypic correlations were slightly higher than corresponding

phenotypic correlations which is in agreement with the findings of Dhurai *et al.* [2], Radha *et al.* [20].

Comment [a1]: The reason for lower phenotypic correlation

### Path coefficient analysis

Among all traits, biological yield showed a positive direct effect on seed yield followed by spikelet fertility, harvest index, panicle length, Number of filled grain per panicle, Plant height. (Table 2.) Similar results were also reported by Thakur *et al.* (2023) [3], Giri *et al.* (2021) [9], Mukesh *et al.* (2018) [21] for biological yield, Solomon and Wegary (2016) [12], Dhurai *et al.* (2014) [2] for harvest index, Kiran *et al.* (2023) [19] for plant height, Bagheri *et al.* (2011) [4] for panicle length, Kiani *et al.* (2012) [22] for number of filled grains per panicle. Traits like effective tillers per plant, 100 seed weight, days to 50% flowering; total tillers per plant and number of unfilled grains per panicle were showed negative direct effect on seed yield.

The indirect effect of biological yield via days to 50% flowering, plant height, panicle length, nu of filled grain, no of unfilled grain were observed positive on seed yield. . The indirect effect of plant height via effective tillers per plant, total tillers per plant, number of filled grain, number of unfilled grain, 100seed weight were found positive on seed yield. The indirect effect of panicle length showed on yield via days to 50% flowering, panicle length, biological yield were found positive. These results are in the agreement with the finding of Selviet *et al.* [23], Manasa *et al.*, Rathod *et al.* [7], Gauraha and Rao. [24]

### Conclusion:

This study investigated the correlations among yield and yield component traits in rice and assessed their direct and indirect effects on grain yield. The results revealed several significant associations between yield-related traits and seed yield. Traits such as effective tillers per plant, total tillers per plant, number of filled grains, spikelet fertility, biological yield, harvest index, and 100 seed weight showed positive correlations with seed yield. Additionally, path coefficient analysis identified biological yield as the trait with the highest direct effect on seed yield. These findings emphasize the importance of considering multiple yield-contributing traits in rice breeding programs to enhance grain yield. By selecting superior cross combinations based on these traits, breeders can develop rice varieties with increased yield potential. Ultimately, this research contributes to the sustainable improvement of rice productivity and supports global food security efforts.

## References

1. Yugandhar RP, Kota S, Kiran UB, Shridhar M. Principal component analysis for agro-morphological and quality characters in germplasm of rice (*Oryza sativa* L.). *Int. J Adv. Biol. Res* 2018;8(2):268-273.
2. Dhurai SY, Reddy DM, Bhati PK. Correlation and path coefficient analysis for yield and quality traits under organic fertilizer management in rice (*Oryza sativa* L.). *Electronic Journal of Plant Breeding*. 2014 Nov 7;5(3):581-7.
3. Thakur K, Sarma MK, Banu S, Saharia DD, Borgohain I, Deka SD. Genetic variation and character association for grain yield and component traits in traditional rice (*Oryza sativa* L.) cultivars of Assam. *Electronic Journal of Plant Breeding*. 2023; 14(1):349-53.
4. Bagheri N, Babaeian-Jelodar N, Pasha A. Path coefficient analysis for yield and yield components in diverse rice (*Oryza sativa* L.) genotypes. *Biharean biologist*. 2011 Jun 1; 5(1):32-5.
5. Basavaraja T, Gangaprasad S, Kumar D, Hittlamani BM. Correlation and path analysis of yield and yield attributes in local rice cultivars (*Oryza sativa* L.). *Electronic Journal of plant breeding*. 2011;2(4):523-6.
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):112-6.
7. Rathod R, Rao S, Babu R, Bharathi M. Correlation and path coefficient analysis for yield, yield attributing and nutritional traits in rice (*Oryza sativa* L.). *Int. J. Curr. Microbiol. App. Sci*. 2017;6(11):183-8.
8. Devi KR, Chandra BS, Lingaiah N, Hari Y, Venkanna V. Analysis of variability, correlation and path coefficient studies for yield and quality traits in rice (*Oryza sativa* L.). *Agricultural Science Digest-A Research Journal*. 2017;37(1):1-9.
9. Giri A, Saxena RR, Sahoo B, Saha S, Rawte S, Saxena RR, Verma SK, Verulkar SP. Correlation and path analysis for yield and attributing traits in rice (*Oryza sativa* L.). 2021; 10(10): 1409-1412
10. Naik MV, Pillai MA, Saravanan S. Assessment of correlation and path coefficient analysis for yield attributing and quality traits in promising rice varieties cultivated in Tamil Nadu. *J Phytopharmacol*. 2021;10(2):139-43.
11. Bagudam R, Eswari KB, Badri J, Rao PR. Correlation and path analysis for yield and its component traits in NPT core set of rice (*Oryza sativa* L.). *Int. J. Curr. Microbiol. App. Sci*. 2018; 7(9):97-108.
12. Solomon H, Wegary D. Phenotypic correlation and path coefficient analysis of yield and yield component in rice (*Oryza Sativa*). *Int J Res Rev*. 2016;3(7):1-5.

13. Kalyan B, Krishna KR, Rao LS. Correlation coefficient analysis for yield and its components in rice (*Oryza sativa* L.) genotypes. International journal of current microbiology and applied sciences. 2017;6(7):2425-30.
14. Rashid MM, Hassan L, Das B, Begum SN. Correlation and Path Coefficient Analysis of Yield and Yield Contributing Traits in Rice (*Oryza sativa* L.). Int. J. Sustain. Crop Prod.2017. 12(2):1-6.
15. Kumar S, Chauhan MP, Tomar A, Kasana RK, Kumar N. Correlation and path coefficient analysis in rice (*Oryza sativa* L.). The Pharma Innovation Journal. 2018; 7(6):20-6.
16. Sreedhar S, Reddy UR. Association studies for yield and its traits in rice (*Oryza sativa* L.) genotypes. International J. of Current Microbiology and Applied Sci. 2019; 8(1):2337-42.
17. Manasa S, Reddy SM, Murthy K, Meena A. Studies on correlation and path coefficient analysis of yield and yield attributing characters in rice landraces (*Oryza sativa* L.). International Journal of Environment and Climate Change. 2022 Jul 16;12(11):442-51
18. Faysal AS, Ali L, Azam MG, Sarker U, Ercisli S, Golokhvast KS, Marc RA. Genetic variability, character association, and path coefficient analysis in transplant Aman rice genotypes. Plants. 2022 Nov 2; 11(21):2952.
19. Kiran AK, Sharma DJ, Subbarao LV, Gireesh C, Agrawal AP. Correlation coefficient and path coefficient analysis for yield, yield attributing traits and nutritional traits in rice genotypes.2023; 12(2): 1978-1983
20. Radha T, Satheesh Kumar P, Saravanan K, Suganthi S. Genetic variability, association and path analysis for grain yield and quality traits in Rice (*Oryza sativa* L.). Plant Arch. 2019; 19:2522-6.
21. Mukesh M, Vidyabhushan J, Anand K, Mankesh K, Shweta K. Correlation and path coefficient analysis in rice (*Oryza sativa* L.) genotypes for yield and its attributing traits. Journal of Pharmacognosy and Phytochemistry. 2018;7(4S):285-90.
22. Kiani G, Nematzadeh G. Correlation and path coefficient studies in F2 populations of rice. Notulae Scientia Biologicae. 2012 May 10;4(2):124-7.
23. Selvi NR, Saraswathi R, Geetha S, Gopalakrishnan C. Genetic studies on false smut disease resistance and yield components in rice (*Oryza sativa* L.). Electronic Journal of Plant Breeding. 2023; 14(1):96-10
24. Gauraha D, Rao SS. Association analysis for yield and its characters in linseed (*Linum usitatissimum* L.). Research J. Agric. Sci. 2011;2:258-60.

**Table 1 Phenotypic (P) and genotypic (G) correlation coefficients for yield and its components in Rice**

.Traits		DF 50%	PH	PL	ETP	TTP	NFG	NUFG	SF%	BYP	HI	100SW	SYP
DF 50%	P	1.0000	-0.431**	-0.290*	-0.0441	-0.0537	0.1489	-0.0001	0.0265	-0.277*	0.546**	-0.393*	0.0326
	G	1.0000	-0.498**	-0.522**	-0.2081	-0.0985	0.1309	-0.0052	0.0137	-0.299*	0.711**	-0.415*	0.0489
PH	P		1.0000	0.317*	-0.0060	-0.1086	-0.513**	0.1070	-0.308*	0.0747	-0.358*	0.435**	-0.1513
	G		1.0000	0.545**	0.0265	-0.1034	-0.587**	0.0823	-0.617**	0.0996	-0.495**	0.476**	-0.1714
PL	P			1.0000	0.1413	0.1183	-0.0213	0.1572	-0.1017	0.1198	-0.0454	0.2189	0.1191
	G			1.0000	0.373*	0.1161	0.0917	0.306*	0.0403	0.342*	-0.1860	0.395*	0.2504
ETP	P				1.0000	0.755**	0.2501	-0.1455	0.313*	0.2258	-0.0664	0.2016	0.1687
	G				1.0000	0.178	0.371*	-0.1733	0.343*	0.408*	0.0496	0.395*	0.427**
TTP	P					1.0000	0.317*	-0.310*	0.408*	0.333*	0.0180	0.1484	0.335*
	G					1.0000	0.479**	-0.350*	0.665**	0.443**	0.0479	0.1935	0.474**
NFG	P						1.0000	-0.2107	0.548**	0.319*	0.290*	-0.0840	0.506**
	G						1.0000	-0.401*	0.857**	0.328*	0.424*	-0.0843	0.559**
NUFG	P							1.0000	-0.473**	-0.0349	-0.1733	0.1431	-0.1919
	G							1.0000	-0.803**	-0.0307	-0.2021	0.2184	-0.2178
SF%	P								1.0000	0.294*	-0.0020	-0.0611	0.344*
	G								1.0000	0.451**	0.2167	-0.0910	0.600**
BYP	P									1.0000	-0.2056	0.522**	0.811**
	G									1.0000	-0.2109	0.528**	0.847**
HI	P										1.0000	-0.292*	0.382*
	G										1.0000	-0.328*	0.333*
100SW	P											1.0000	0.270*
	G											1.0000	0.290*

DF50%-Days to 50% flowering , PH. -Plant height, ETP-. Effective tillers per plant ,TTP-Total tillers per plant, PL- Panicle length (cm), NFG- Number of filled grains per panicle ,NUFG- Number of unfilled grains per panicle SF%- Spikelet fertility (%) ,BYP-Biological yield per plant (g) . HI-. Harvest index (%) ,100SW-. 100 seed weight (g),SYP-Seed yield per plant (g)

**Comment [a2]:** Follow uniform digits in all values

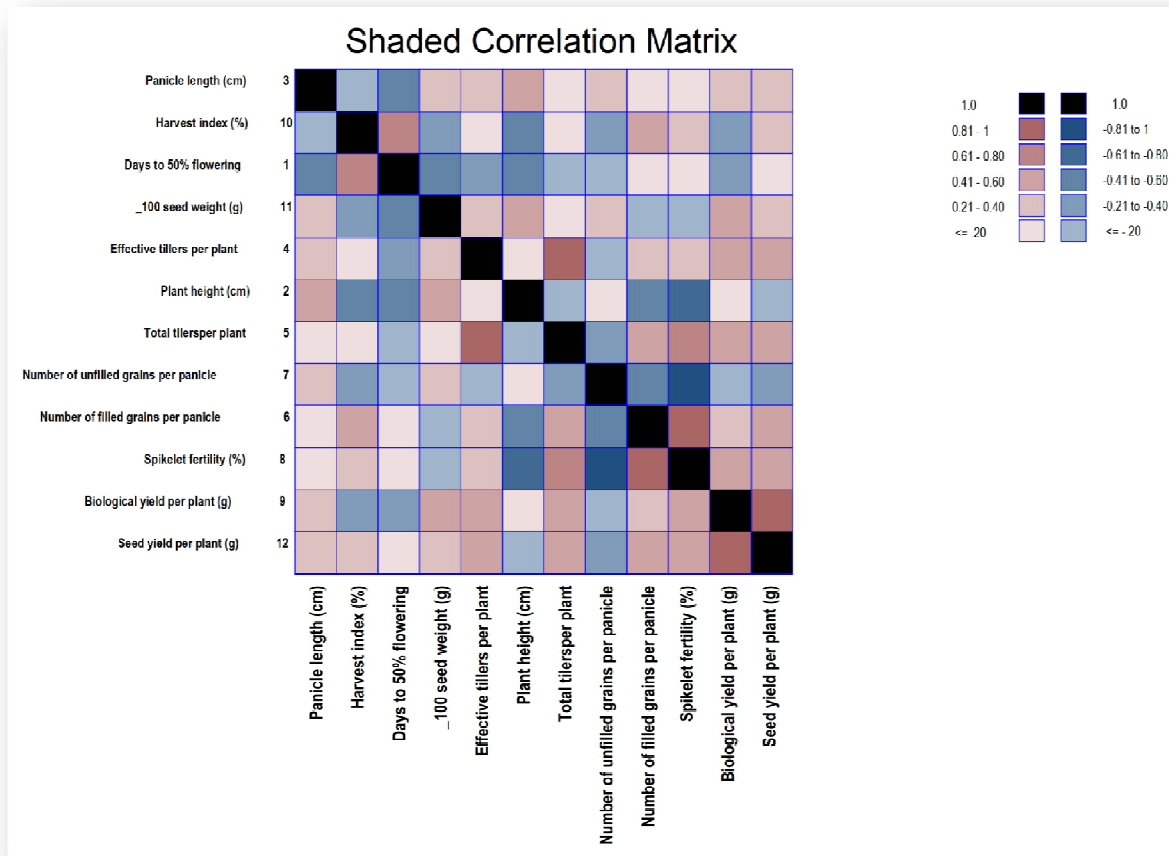


Figure 1: Shaded correlation matrix based on correlation coefficient analysis

Table 2: Direct and Indirect effect relationship among yield attributing traits

Traits	DF 50%	PH	PL	ETP	TTP	NFG	NUFG	SF%	BYP	HI	100SW	SYP
<b>DF 50%</b>	<b>-0.0282</b>	0.0122	0.0082	0.0012	0.0015	-0.0042	0.0000	-0.0007	0.0078	-0.0154	0.0111	0.0326
<b>PH</b>	-0.0050	<b>0.0115</b>	0.0036	-0.0001	-0.0012	-0.0059	0.0012	-0.0035	0.0009	-0.0041	0.0050	-0.1513
<b>PL</b>	-0.0149	0.0163	<b>0.0513</b>	0.0073	0.0061	-0.0011	0.0081	-0.0052	0.0061	-0.0023	0.0112	0.1191
<b>ETP</b>	0.0012	0.0002	-0.0038	<b>-0.0268</b>	-0.0202	-0.0067	0.0039	-0.0084	-0.0060	0.0018	-0.0054	0.1687
<b>TTP</b>	0.0001	0.0002	-0.0002	-0.0015	<b>-0.0020</b>	-0.0006	0.0006	-0.0008	-0.0007	0.0000	-0.0003	0.335*
<b>NFG</b>	0.0033	-0.0112	-0.0005	0.0055	0.0069	<b>0.0219</b>	-0.0046	0.0120	0.0070	0.0064	-0.0018	0.506**
<b>NUFG</b>	0.0000	-0.0037	-0.0054	0.0050	0.0106	0.0072	<b>-0.0341</b>	0.0161	0.0012	0.0059	-0.0049	-0.1919
<b>SF%</b>	0.0016	-0.0187	-0.0062	0.0191	0.0249	0.0334	-0.0288	<b>0.0609</b>	0.0179	-0.0001	-0.0037	0.344*
<b>BYP</b>	-0.2558	0.0689	0.1106	0.2084	0.3075	0.2942	-0.0322	0.2713	<b>0.9231</b>	-0.1898	0.4822	0.811**
<b>HI</b>	0.3068	-0.2010	-0.0255	-0.0373	0.0101	0.1632	-0.0974	-0.0011	-0.1156	<b>0.5621</b>	-0.1642	0.382*
<b>100SW</b>	0.0234	-0.0259	-0.0130	-0.0120	-0.0088	0.0050	-0.0085	0.0036	-0.0311	0.0174	<b>-0.0595</b>	0.270*

DF50%-Days to 50% flowering , PH. -Plant height, ETP-. Effective tillers per plant ,TTP-Total tillers per plant, PL- Panicle length (cm), NFG- Number of filled grains per panicle ,NUFG- Number of unfilled grains per panicle SF%- Spikelet fertility (%) ,BYP-Biological yield per plant (g) . HI-. Harvest index (%) ,100SW-. 100 seed weight (g),SYP-Seed yield per plant (g)

Residual effect= 0.128

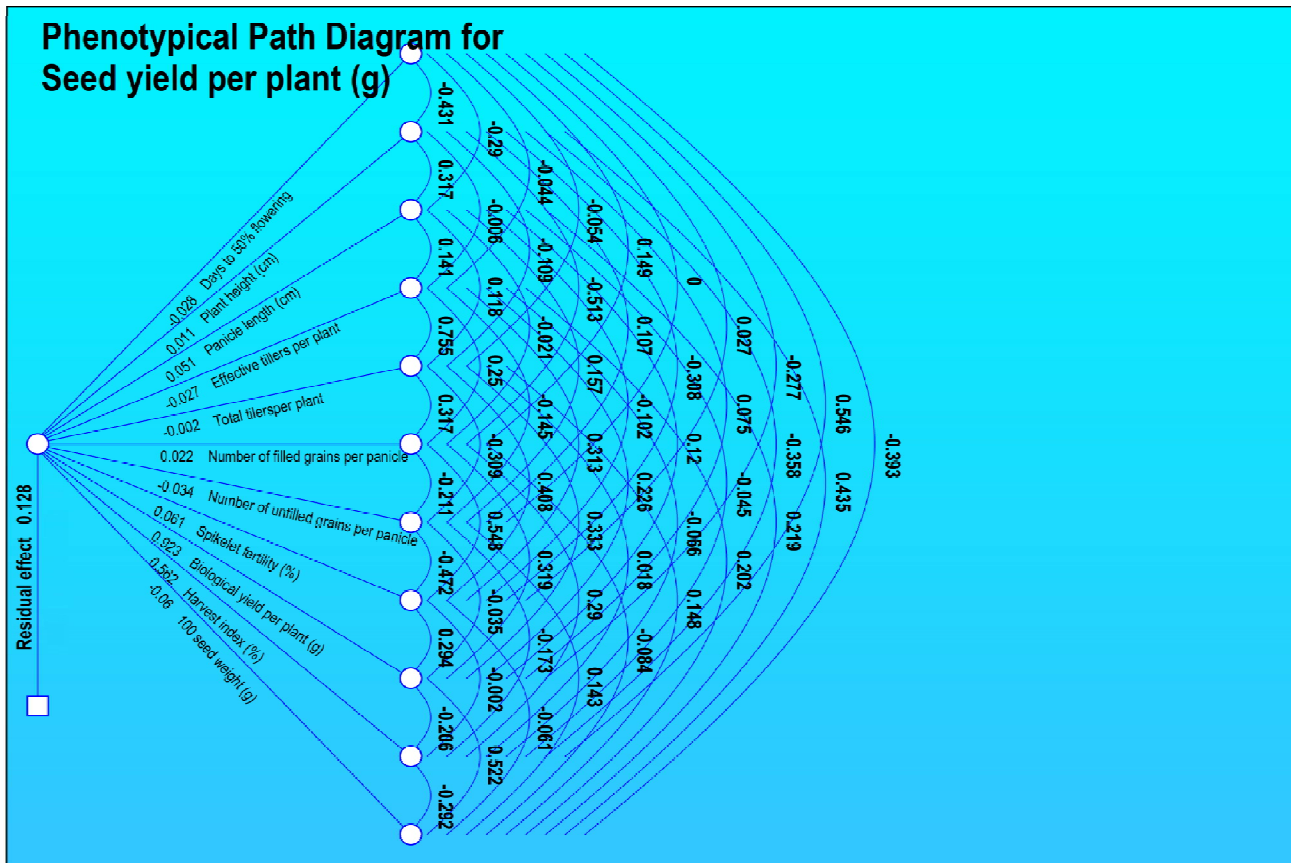


Figure 2: Phenotypical Path diagram showing direct and indirect effect relationship among yield attributing traits