

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 at Field Experimentation Centre of the Department of Genetics and Plant Breeding, to study genetic variability, heritability, genetic advance, correlation and path coefficient for 13 quantitative characters. The experiment was conducted by using Randomized Block Design with three replications during Kharif, 2022. BRR1 DHAN-75 (26.133), A.K. DHAN (23.067), showed higher yield over the NDR 359 (check). High to moderate estimates of GCV, 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

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 wild species 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

yield per hill, Harvest index, Panicle length, Test weight, Days to maturity and Plant height. High to moderate estimates of Heritability, Genetic advance for number of spikelets per panicle, Biological yield, Plant height, Days to 50% flowering. Grain yield indicated significant positive correlation with biological yield, number of spikelets per panicle, harvest index at both phenotypic level and genotypic level. Positive significant direct effects on grain yield per hill were exhibited by harvest index and biological yield at genotypic level and phenotypic level. Thus, these traits are identified as the efficient and potential for indirect selection for the improvement of rice productivity in the present experimental materials.

Keywords: *Rice, GCV, PCV, Variability, Heritability, Correlation, Path analysis,*

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-requisit 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) is an index of transmissibility of the characters from the parents to offspring and has a predictive role in crop breeding programme.

Correlation studies help in better understanding of yield components. is the measure of the mutual relationship between two variables. The study of correlations may help the plant breeder to know how the improvement of one character will bring simultaneous improvement in other characters. Path coefficient analysis is a standardized regression coefficient and measures the direct influence of one variable upon 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 METHODS

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 21st 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 including Days to 50% flowering, Days to maturity, Flag leaf length (cm), Flag leaf width (cm), Plant height (cm), No. 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

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

The characters studied in the present investigation exhibited low (less than 10%), moderate (10-20%) and high (more than 20%) phenotypic and genotypic coefficient of variations as proposed by **Sivasubramaniam and Menon (1973)**.

High estimates of PCV were recorded grain yield per hill (31.312), biological yield (27.207), number of spiklets 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 spiklets 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 spiklets 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 as low (20%) proposed by Johnson et al., 1955.

Highest GAM was recorded for grain yield per hill (55.348), biological yield (48.514), number of spiklets per panicle (46.557), number of panicles per hill (44.384), number of tillers per hill (37.947) and harvest index (27.61). Moderate estimates of genetic advance as per cent mean was recorded for followed by flag leaf 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 contributing characters revealed that the genotypic correlation coefficients in most cases were higher than their phenotypic correlation coefficients indicating the association was largely due to genetic reason, at both phenotypic and genotypic correlation coefficient analysis revealed that Grain yield per hill exhibited positive and significant correlation with Plant height, Harvest index, Number

of panicles per hill, Number of tillers per hill, Number of spikelets per panicles, Biological yield and negative significant with days to maturity.

3.5 Path Analysis

In Path analysis, at both phenotypic and genotypic level the diagonal values showed Direct, high and Positive effect at harvest index, biological yield, test weight, flag leaf width, plant height, days to maturity with grain yield per hill.

It showed direct, high and negative effect at days to 50% flowering, flag leaf length, number of grains per panicle.

4. CONCLUSION

Among 20 genotypes of rice, BRRI-DHAN-75, A.K. DHAN were found superior for Grain yield per hill over 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 of additive 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 level the diagonal values showed Direct, high and Positive effect at harvest index, biological yield, test weight, flag leaf width, plant height and days to maturity with grain yield per hill. These characters provide broad spectrum of variability in segregation and may be used as parents in the future hybridization program to develop desirable genotypes for grain yield improvement in rice genotypes.

Table 1 : Analysis of Variance for 13 quantitative characters of 20 rice genotypes during kharif, 2022

Sl.No.	Source	Replication	Treatment	Error
		Degrees of freedom	2	19
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 germplasm for 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

Table 3. Correlation coefficient analysis

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**

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

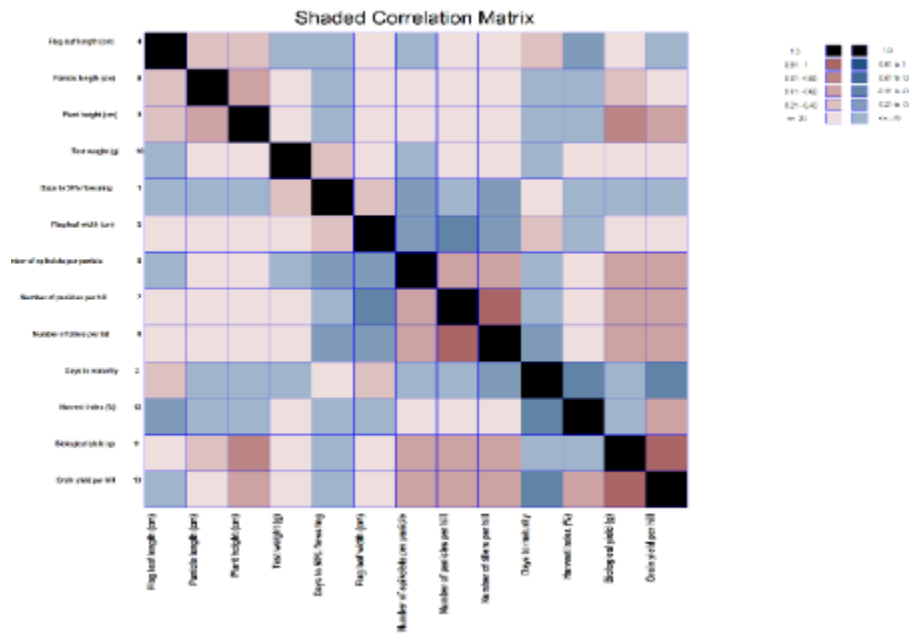


Fig. 1. Phenotypal correlation matrix

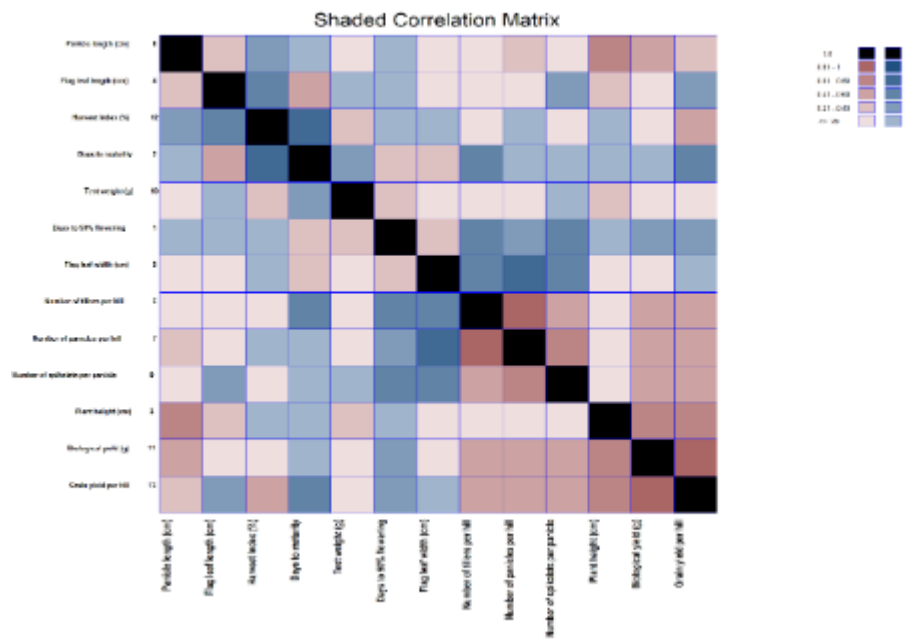


Fig. 2. Genotypical correlation matrix

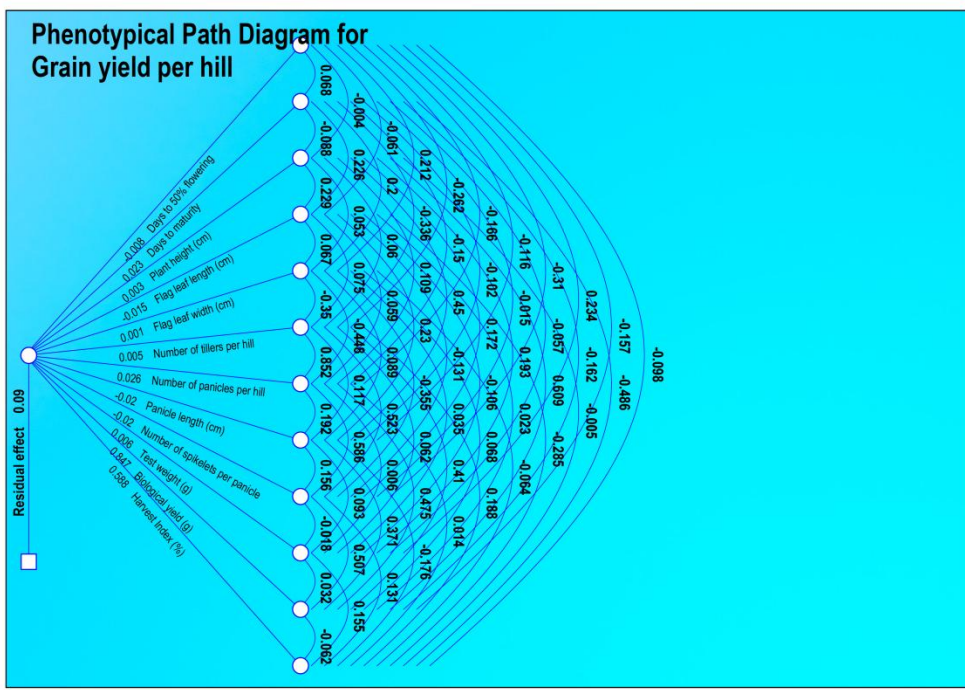


Fig. 3. Phenotypical path diagrams for grain yield per hill

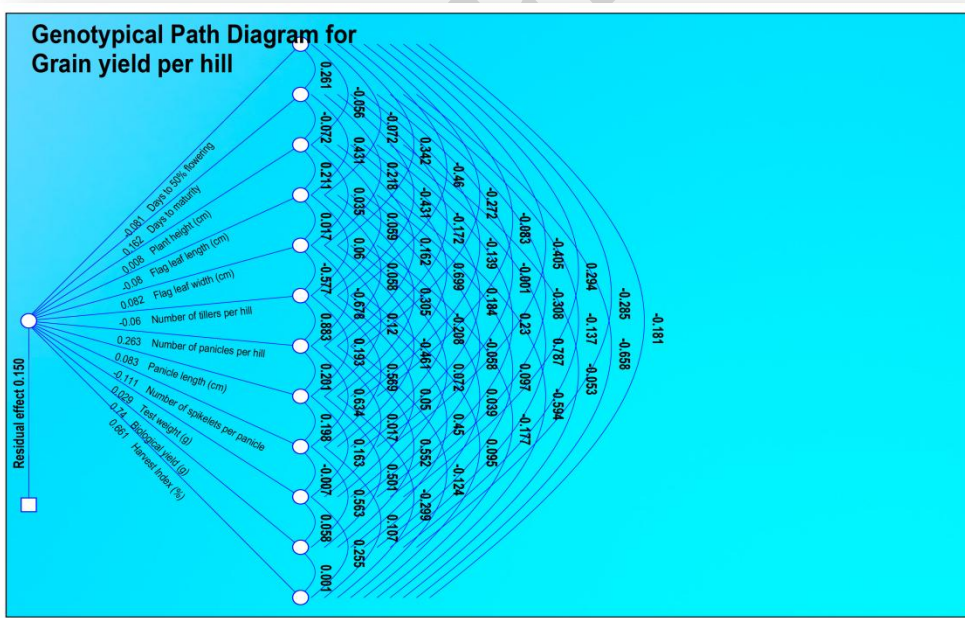


Fig. 4. Genotypical path diagram for grain yield per hill

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UNDER PEER REVIEW