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Studies on correlation and path analysis for yield and its contributing traits in rice (*Oryza sativa* L) grown in two different environments

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Abstract
The present investigation is carried out to study the correlation and path analysis in seventy-three genotypes of rice (*Oryza sativa* L.). Grain yield being a complex trait, to achieve the basic aim of plant breeders of improving the yielding potential of existing varieties along with creation of new varieties with high yielding potential, this experiment was carried out to study the association of yield attributing characters with grain yield and path analysis in seventy-three rice genotypes at two farms with different sodicity levels. The phenotypic correlation coefficient analysis revealed the positive and highly significant association of biological yield per plant followed by Productive tillers/plant, fertile spikelet per panicle, 1000-grains weight, panicle length, Spikelet fertility at agronomy farm, selection for these traits can improve yield. At Main Experiment Station result showed that grain yield per plant exhibited highly significant and positive correlation with biological yield per plant followed by Productive tillers/plant, fertile spikelet per panicle, 1000- grain weight, and panicle length; while there is not found any negative and significant correlation at both farms. Path analysis showed, biological yield/plant. harvest index, and productive tillers per plant exerted very high positive direct effect on grain yield per plant (g). Biological yield per plant exhibited high order of positive indirect effects on grain yield per plant via, Productive tillers per plant, followed by fertile spikelets per panicle, and panicle length at both farms. Hence, direct selection of any traits namely biological yield per plant, harvest index and productive tillers per plant can be effective for future breeding programs to improve yield trait in rice. Improvement in these traits will result in simultaneous improvement of yield.

Keywords: Correlation, path analysis, yield, rice, genotypes, yield attributing traits

1. Introduction

Rice (*Oryza sativa* L.) is a Kharif and photo-periodically short-day plant belongs to Family Poaceae (Gramineae), Genus: *Oryza*, Species: *sativa*, Sub-species: Indica has 2n=24 Chromosome number and haploid chromosome number is 12 and basic chromosome number is 5. The genus Oryza has 24 species out of which, 22 are wild and two species *Oryza sativa* and *Oryza glaberrima* are both cultivated. All varieties of *Oryza sativa* found in Asia, America and Europe and varieties found in West Africa belong to *Oryza glaberrima*. Further, *Oryza sativa* rice varieties are commonly grouped into three sub species *viz*., Indica, Japonica and Javanica. The world will have to produce 60% more rice by 2030 than what it produced in 1995 estimated. Therefore, to increase production of rice plays a very important role in poverty alleviation and food security. Theoretically, there is still a lot of yield potential for rice that can be realized, and there are various means to do so, including the construction of irrigation systems, the enhancement of soil properties, cultural practices, and the breeding of high yielding varieties. To fulfill the growing demand, rice output must expand, and crop enhancement programs must be well underway before the predicted 1 billion population growth predicted for 2050 (UN, 2015) [25]. Inland salinity areas in Uttar Pradesh are primarily found in the Azamgarh, Ayodhya, Raibareilly, Pratapgarh, Unnao, Lucknow and Sultanpur districts. India is the world's second-biggest rice producer and largest rice exporter. The correlation studies calculate the strength and direction of the association between two or more variables and reveal the factors that affect the yield.

The purpose of the current study was to comprehend the interactions between various features in order to choose suitable rice genotypes and to comprehend the direct and indirect effects on yield and the characteristics that contribute to it. (Singh, S.K.2020). It can be used in breeding to pinpoint the traits that can be used for selection to increase yield and to help pick elite genotypes from a variety of populations. (Johnson *et al*. 1955) [11]. Path coefficient analysis was developed by Wright in 1921 [26] and it was used for plant selection for first time by Dewey and Lu. and divided correlation coefficient into direct and indirect effects. Information on the relationships between traits and the direct and indirect effects that each attribute has on rice yield is useful for selection and, consequently, breeding programs. Grain yield is a complex trait which is a result of interaction between various genetic and environmental fluctuation (Wattoo *et al.,* 2010) [10]. According to Wattoo *et al.* (2010) [10], grain yield is a complex feature that depends on various variables that contribute to grain production. Path analysis aids in providing insight into the immediate and immediate consequences of yield component parts. While correlation studies show the association between plant properties and the strength of their linear relationship, path coefficient analysis clarifies the division of the two features into components that evaluate the direct and indirect effects. In order to increase rice production through breeding programs and improve rice yield, this experiment was conducted to examine the correlation between yield and yield-attributing characteristics and the path analysis of those characteristics.

2. Materials and Methodology

During Kharif 2021-22, two sets of tests were carried out at Kumarganj, Ayodhya's Agronomy Farm (pH-8.4) with organic carbon 0.29 percent and EC range (0.25-0.4), and Main Experiment Station (pH -9.5) with organic carbon (OC) 0.21 percent, EC range (3.1-3.3). All seventy-three genotypes, as well as three controls (Sarjoo-52, IR-64, and NDR-359), were sown in a Randomized Complete Block Design (RCBD) with three replications and a 5 m row length (inter-and intra-row spacing 20 cm and 15 cm, respectively). The experimental materials for the study included 73 unique genotypes from various agro-climatic regions. These genotypes were obtained from the rice division of ANDUA&T, Kumarganj, Ayodhya's Department of Genetics and Plant Breeding. The following findings were based on five competitive plants that were randomly chosen from each plot and recorded: days to 50% flowering, plant height, productive tiller per plant, panicle length, fertile spikelet per panicle, spikelet fertility, biological yield per plant (g), harvest-index (%), L/B ratio, chlorophyll content, 1000-grain weight, and grain yield per plant (g). The fertilizers were applied @120:60:60 in kg NPK per ha respectively, through urea, DAP and MOP used. Statistical analysis of all characters was done following Dewey and Lu (1959) [7] for path analysis and Singh and Chaudhary (1995) for correlation coefficient analysis among characters were calculated by following the standard procedures with the help of Statistica 2, Genres software's and MSTATC.

3. Results and Discussion

Phenotypic correlation coefficients:

In order to find the essential qualities that may be used for crop improvement through an appropriate breeding program, selection based on the detailed understanding of the size and direction of relationship between yield and its attributes is highly significant. The interrelationships between different features are measured by association analysis, which also identifies the component traits that can be chosen to increase yield. The grain yield per plant exhibited highly significant and positive correlation with Biological yield per plant (0.969) followed by Productive tillers/plant (0.858), fertile spikelet per panicle (0.657), 1000-grains weight (0.421) panicle length (0.293), Spikelet fertility (%) (0.185); while there is no negative and significant correlation was observed at Agronomy Farm and at Main Experiment Station result showed that grain yield per plant exhibited highly significant and positive correlation with Biological yield per plant (0.966) followed by Productive tillers/plant (0.847), fertile spikelet per panicle (0.641), 1000- grain weight (0.380), and panicle length (0.375); while there is not found any negative and significant correlation in Table 2, 4.

The strong positive association of grain yield with the Characters mentioned above has also being reported in rice by earlier workers (Deepak *et al.* (2020) [3]; Rathod *et al.* 2020) [18].

Productive tillers per plant demonstrated positive and significant association with days to 50% flowering, and panicle length highly significant with productive tillers per plant. 1000-grain weight was showed positive and significant correlation with biological yield per plant, followed by productive tillers per plant, spikelet fertility while positive and significant association with fertile spikelets per panicle. Harvest index shows negative and highly significant correlation with biological yield per plant, followed by fertile spikelet per panicle. Biological yield per plant expressed positive and highly significant association with productive tillers per plant followed by fertile spikelet per panicle, panicle length and spikelet fertility. at Agronomy farm. Similar trends of results were also reported by Chavan *et al.* 2022 [2].

1000-grain weight demonstrated positive and significant association with spikelet fertility (%), while negative and highly significant with harvest index, and chlorophyll content negative and highly significant with fertile spikelet per panicle. Biological yield per plant demonstrated positive and significant association with productive tillers per plant followed by fertile spikelet per panicle, and panicle length. Panicle length was showed positive and highly significant correlation with productive tillers per plant and plant height spikelet fertility with productive tillers per plant at Main Experiment Station. Similar trends of results were also reported by Deepthi *et al.* (2022) [4] Thorat *et al.* (2019) [24], Dhurai *et al*. (2016) [8], Sathisha *et al*. (2015) [20] and Nikhil *et al*. (2014) [15].

Genotypic correlation coefficient

The Grain yield per plant was showed highly significant and positive correlation with Biological yield per plant (0.979) followed by productive tillers per plant (0.871), 1000- grain weight (0.439), panicle length (0.335), spikelet fertility (0.201), and positive with significant fertile spikelet per panicle; while negative and significant correlation was not observed at Student Instructional Farm and at Main Experiment Station Grain yield per plant was showed highly significant and positive correlation with Biological yield per plant (0.977) followed by productive tillers per plant (0.859), fertile spikelet per panicle (0.669), panicle length(0.442), and 1000- grain weight (0.428); while negative and significant correlation was not observed Table 1, 3.

Panicle length was showed positive and highly significant correlation with Productive tillers per plant, plant height. Fertile spikelet per panicle was showed positive and highly significant correlation with panicle length and productive tillers per plant; Fertile spikelet per panicle shows positive and highly significant correlation with plant height and fertile spikelet per panicle. Biological yield per plant was demonstrated positive and highly significant correlation with productive tillers per plant, fertile spikelet per panicle and panicle length. Harvest index had highly significant and negative with biological yield per plant and positive and highly significant correlation with spikelet fertility. L/B ratio exhibited positive and highly significant correlation with plant height and significant panicle length. Chlorophyll content was showed negative and highly significant association with fertile spikelet per panicle. 1000- grain weight was demonstrated positive and highly significant correlation with biological yield per plant followed by panicle length, productive tillers per plant; while negative and highly significant with L/B ratio, and positive and significant correlation with fertile spikelet per panicle followed by spikelet fertility. at Main experiment station. Panicle length showed positive and highly significant correlation with harvest index productive tillers per plant and plant height. Biological yield per plant (g) was showed positive and highly significant correlation with productive tiller per plant followed by panicle length. 1000- grain weight showed positive and highly significant correlation with biological yield per plant followed by productive tillers per plant, spikelet fertility; while negative and significant correlation with L/B ratio. Harvest index showed positive and highly significant correlation with panicle length; while negative and highly significant correlation with biological yield per plant. Spikelet fertility showed positive and highly significant correlation with fertile spikelet per panicle and plant height at Agronomy Farm. (Mahto *et al.*, (2003) [13], Devi *et al.*, (2017) [5] and Kalyan *et al.*, (2017) [12].

Table 1: Genotypic correlations- Agronomy farm (E1) 2021-2022

Chrs	Days to 50% flowering	Plant height (cm)	Productive tiller /plant	Panicle length (cm)	Fertile spikelet /panicle	Spikelet fertility %	Biological yield /plant (g)	Harvest index %	L/B ratio	Chlrophyll content	1000-grain weight (g)	Grains yield (g/plant)
	1	2	3	4	5	6	7	8	9	10	11	12
1	1.000	0.121	0.145*	-0.012	-0.096	0.087	0.033	0.047	-0.091	-0.050	0.002	0.058
2			-0.110	0.174**	0.079	0.189**	-0.052	-0.172*	0.154*	0.049	-0.016	-0.077
3				0.215**	0.308**	0.170*	0.833**	0.071	0.118	-0.016	0.348**	0.871**
4					0.238**	0.006	0.292**	0.176**	0.113	0.009	0.141*	0.335**
5					0.265**	0.207**	0.168*	-0.021	0.088	-0.084	-0.100	0.168*
6							0.219**	-0.126	-0.007	0.051	0.283**	0.201**
7								-0.195**	0.087	-0.122	0.472**	0.979**
8									-0.044	0.014	0.102	0.007
9										0.098	-0.143*	0.087
10											0.008	-0.130
11												0.493**
12												1.000

*, ** Significant at 5% and 1% level, respectively

Table 2: Phenotypic correlations- Agronomy farm (E1) 2021-2022

Chrs	Days to 50% flowering	Plant height (cm)	Productive tiller /plant	Panicle length (cm)	Fertile spikelet /panicle	Spikelet fertility %	Biological yield /plant (g)	Harvest index %	L/B ratio	Chlrophyll content	1000-grain weight (g)	Grains yield (g/plant)
	1	2	3	4	5	6	7	8	9	10	11	12
1	1.000	0.080	0.138*	-0.070	-0.063	0.056	0.047	0.021	-0.090	-0.055	0.039	0.043
2			-0.116	0.167*	0.057	0.191**	-0.051	-0.115	0.145*	0.041	-0.021	-0.068
3				0.177**	0.291**	0.136*	0.822**	0.068	0.123	-0.015	0.301**	0.858**
4					0.215**	-0.077	0.251**	0.152*	0.115	0.027	0.103	0.293**
5						0.188**	0.673**	-0.186**	0.033	-0.305**	0.141*	0.657**
6							0.185**	-0.057	-0.059	0.041	0.260**	0.185**
7								-0.192**	0.092	-0.129	0.436**	0.969**
8									-0.065	0.033	0.047	0.020
9										0.084	-0.116	0.082
10											-0.032	-0.126
11												0.421**
12												1.000

*, ** significant at 5% and 1% level, respectively

Table 3: Genotypic correlations- Main experiment station (E2)-2021-22

Chrs	Days to 50% flowering	Plant height (cm)	Productive tiller /plant	Panicle length (cm)	Fertile spikelet /panicle	Spikelet fertility %	Biological yield /plant (g)	Harvest index %	L/B ratio	Chlrophyll content	1000-grain weight (g)	Grains yield (g/plant)
	1	2	3	4	5	6	7	8	9	10	11	12
1	1.000	0.166*	0.062	0.125	-0.021	0.014	0.038	-0.018	0.069	-0.102	0.060	0.028
2			-0.040	0.233**	0.003	0.221**	-0.021	-0.066	0.232**	-0.057	0.022	-0.044
3				0.359**	0.263**	-0.013	0.832**	-0.041	-0.091	-0.005	0.185**	0.859**
4					0.309**	-0.040	0.375**	0.165*	0.160*	0.005	0.202**	0.442**

5						0.184**	0.630**	0.070	-0.007	-0.323**	0.171*	0.660**
6							0.053	0.218**	0.021	0.050	0.143*	0.098
7								-0.227**	-0.114	-0.106	0.430**	0.977**
8									0.033	0.012	0.023	-0.012
9										-0.044	-0.230**	-0.117
10											0.111	-0.119
11												0.428**
12												1.000

*, ** significant at 5% and 1% level, respectively

Table 4: Phenotypic correlations- Main experiment station (E2)-2021-22

Chrs	Days to 50% flowering	Plant height (cm)	Productive tiller /plant	Panicle length (cm)	Fertile spikelet /panicle	Spikelet fertility %	Biological yield /plant (g)	Harvest index %	L/B ratio	Chlrophyll content	1000-grain weight (g)	Grains yield (g/plant)
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1	1.000	0.108	0.075	0.024	-0.027	0.014	0.026	0.003	0.054	-0.082	0.023	0.037
2			-0.051	0.232**	0.009	0.205**	-0.020	-0.090	0.224**	-0.054	0.020	-0.045
3				0.285**	0.245**	0.001	0.819**	-0.033	-0.100	-0.003	0.145*	0.847**
4					0.288**	-0.056	0.341**	0.127	0.145*	-0.018	0.172*	0.375**
5						0.129	0.612**	0.056	0.004	-0.308**	0.162*	0.641**
6							0.037	0.206**	0.003	0.049	0.058	0.086
7								-0.223**	-0.108	-0.107	0.394**	0.966**
8									0.011	0.015	0.026	-0.009
9										-0.051	-0.186**	-0.115
10											0.088	-0.112
11												0.380**
12												1.000

*, ** significant at 5% and 1% level, respectively

Path-coefficient Analysis:

The genotypic correlations were divided into direct and indirect effects by route coefficient analysis; therefore, the correlation does not accurately reflect the true contribution of each character to the yield. It allows separating the direct effect and their indirect effects through other attributes by apportioning the Correlations (Wright, 1921) [26] for better interpretation of cause-and-effect relationship. The path coefficient estimations for yield and yield component characters are provided. in Table 5,6,7,8.

Phenotypic path coefficients

At phenotypic level, biological yield/plant (g) (0.8526), harvest index (0.1897) and productive tillers per plant (0.1257) exerted very high positive direct effect on grain yield per plant (g). Fertile spikelet per panicle (0.0796), panicle length (0.0100), plant height (0.0056) and chlorophyll content (0.0005), also exerted moderate direct effect on Grain yield/plant. Days to 50% flowering (-0.0126), 1000-grain weight (-0.0094) and L/B ratio (-0.0080), exerted high negative direct effect on grain yield per plant (g).

Biological yield per plant exhibited high order of positive indirect effects on grain yield per plant via, Productive tillers per plant (0.7011), followed by fertile spikelets per panicle (5737), and panicle length (0.2141). Productive tillers per plant expressed high order of positive indirect effects on grain yield per plant via, biological yield per plant (0.1034). In contrasts high order of negative indirect effects were extended by biological yield per plant (-0.1637) on grain yield per plant. Harvest–index exhibited high order of positive indirect effect on grain yield per plant via, spikelet fertility (0.0288). The remaining estimates of indirect effects in this analysis were very low or negligible at Agronomy Farm and at Main Experiment Station same result found with little bit difference in data of phenotypic path. The estimate of residual effect was (0.0122) indicated that most of the yield contributing traits were taken into account in the present study at Agronomy Farm and Main Experiment Station in Table 6,8

These results are in conformity to that of Mishra and Verma (2002) [14]. Supported related findings were carried out by Zahid *et al.* (2006) [27], Fiyaz *et al*. (2011) [9] Akhtar *et al.* (2011) [1], Sudeepthi *et al.* (2020) [22] and Devi *et al.* (2022) [6]. According to the partitioning of correlation values, several of the features were unable to establish a significant connection with single plant yield, which may have been caused by extremely strong adverse direct effects. The results of character association and route analysis were critically analyzed, and the results showed that biological yield per hill and harvest index had both strong positive associations and direct effects. Therefore, choosing individuals with these features could result in an increase in yield and yield components.

Genotypic Path coefficient

The direct and indirect effects of various characters on grain yield/plant using genotypic correlation coefficient estimated from the Agronomy Farm and Main Experiment Station are given in Table -5,7.

The highest positive direct contribution on grain yield/plant at genotypic level was expressed by biological yield/plant (g) (o.6842) followed by productive tillers per plant (0.2108), fertile spikelet per panicle (0.1558), Harvest index (%) (0.1332). In addition to very high direct contribution made by these 4 characters, biological yield/plant also showed considerable positive direct contribution towards Grain yield per plant. In contrast negative direct effect on Grain yield/plant was exerted by spikelet fertility (-0.0226), plant height (-0.0102). Patil and Sarawgi (2006) [16] and Perveen *et al.* (2020) [17]. The direct effect of rest of the characters on Grain yield/plant was very less or negligible. The high positive indirect effects on Grain yield per plant of biological yield per plant via productive tillers per plant followed by biological yield per plant. High positive indirect effects on

Grain yield per plant of fertile spikelet per panicle via biological yield per plant at Student Instructional Farm and at Agronomy Farm same result found with little bit difference in data of genotypic path. (Suman *et al.* (205) [23].

Table 5: Genotypic path with Grain yield per plant- Agronomy farm (E1) 2021-22

Chrs	Days to 50% flowering	Plant height (cm)	Productive tiller /plant	Panicle length (cm)	Fertile spikelet /panicle	Spikelet fertility %	Biological yield /plant (g)	Harvest index %	L/B ratio	Chlrophyll content	1000-grain weight (g)	Grains yield (g/plant)
	1	2	3	4	5	6	7	8	9	10	11	12
1	0.0166	-0.0012	0.0305	-0.0003	-0.0150	-0.0020	0.0225	0.0062	-0.0018	-0.0001	0.0001	0.058
2	0.0020	-0.0102	-0.0232	0.0046	0.0124	-0.0043	-0.0353	-0.0229	0.0031	0.0001	-0.0010	-0.077
3	0.0024	0.0011	0.2108	0.0057	0.0480	-0.0038	0.5698	0.0094	0.0024	0.0000	0.0216	0.871**
4	-0.0002	-0.0018	0.0454	0.0265	0.0370	-0.0001	0.2000	0.0234	0.0023	0.0000	0.0088	0.335**
5	-0.0016	-0.0008	0.0649	0.0063	0.1558	-0.0054	0.4671	-0.0207	0.0007	-0.0006	0.0096	0.675**
6	0.0015	-0.0019	0.0359	0.0002	0.0376	-0.0226	0.1496	-0.0168	-0.0001	0.0001	0.0176	0.201**
7	0.0006	0.0005	0.1755	0.0077	0.1064	-0.0049	0.6842	-0.0260	0.0018	-0.0002	0.0293	0.979**
8	0.0008	0.0018	0.0149	0.0047	-0.0242	0.0029	-0.1337	0.1332	-0.0009	0.0000	0.0063	0.007
9	-0.0015	-0.0016	0.0249	0.0030	0.0056	0.0002	0.0595	-0.0058	0.0201	0.0002	-0.0089	0.087
10	-0.0025	-0.0022	-0.0141	0.0091	-0.0036	-0.0031	-0.0634	-0.0085	0.0070	0.0003	-0.0043	-0.107
11	0.0000	0.0002	0.0734	0.0037	0.0240	-0.0064	0.3230	0.0135	-0.0029	0.0000	0.0620	0.493**

Resi- 0.00171

*, ** significant at 5% and 1% level, respectively

Table 6: Phenotypic path with grain yield per plant- Agronomy farm (E1) 2021-22

Chrs	Days to 50% flowering	Plant height (cm)	Productive tiller /plant	Panicle length (cm)	Fertile spikelet /panicle	Spikelet fertility %	Biological yield /plant (g)	Harvest index %	L/B ratio	Chlrophyll content	1000-grain weight (g)	Grains yield (g/plant)
	1	2	3	4	5	6	7	8	9	10	11	12
1	-0.0126	0.0005	0.0174	-0.0007	-0.0050	0.0004	0.0398	0.0041	0.0007	-0.0002	-0.0004	0.043
2	-0.0010	0.0056	-0.0146	0.0017	0.0046	0.0014	-0.0436	-0.0218	-0.0012	0.0001	0.0002	-0.068
3	-0.0017	-0.0007	0.1257	0.0018	0.0232	0.0010	0.7011	0.0129	-0.0010	-0.0001	-0.0028	0.858**
4	0.0009	0.0009	0.0223	0.0100	0.0171	-0.0006	0.2141	0.0288	-0.0009	0.0001	-0.0010	0.293**
5	0.0008	0.0003	0.0366	0.0021	0.0796	0.0014	0.5737	-0.0352	-0.0003	-0.0010	-0.0013	0.657**
6	-0.0007	0.0011	0.0171	-0.0008	0.0150	0.0075	0.1576	-0.0107	0.0005	0.0001	-0.0024	0.185**
7	-0.0006	-0.0003	0.1034	0.0025	0.0535	0.0014	0.8526	-0.0364	-0.0007	-0.0004	-0.0041	0.969**
8	-0.0003	-0.0007	0.0085	0.0015	-0.0148	-0.0004	-0.1637	0.1897	0.0005	0.0001	-0.0004	0.020
9	0.0011	0.0008	0.0154	0.0011	0.0026	-0.0004	0.0782	-0.0123	-0.0080	0.0003	0.0011	0.082
10	0.0013	0.0009	-0.0070	0.0019	0.0003	0.0013	-0.0684	-0.0018	-0.0014	0.0005	0.0016	-0.060
11	-0.0005	-0.0001	0.0378	0.0010	0.0112	0.0020	0.3716	0.0089	0.0009	-0.0001	-0.0094	0.421**

Resi-0.0122

*, ** significant at 5% and 1% level, respectively

Table 7: Genotypic path with Grain yield per plant- Main experiment station (E2)-2021-22

Chrs	Days to 50% flowering	Plant height (cm)	Productive tiller /plant	Panicle length (cm)	Fertile spikelet /panicle	Spikelet fertility %	Biological yield /plant (g)	Harvest index %	L/B ratio	Chlrophyll content	1000-grain weight (g)	Grains yield (g/plant)
	1	2	3	4	5	6	7	8	9	10	11	12
1	-0.0120	-0.0024	0.0075	0.0042	-0.0012	0.0002	0.0328	-0.0032	-0.0005	0.0025	0.0009	0.028
2	-0.0020	-0.0146	-0.0048	0.0077	0.0002	0.0025	-0.0183	-0.0118	-0.0016	0.0014	0.0003	-0.044
3	-0.0008	0.0006	0.1209	0.0119	0.0155	-0.0002	0.7138	-0.0073	0.0006	0.0001	0.0028	0.859**
4	-0.0015	-0.0034	0.0434	0.0331	0.0182	-0.0005	0.3220	0.0294	-0.0011	-0.0001	0.0031	0.442**
5	0.0003	0.0000	0.0319	0.0102	0.0588	0.0021	0.5405	0.0125	0.0001	0.0079	0.0026	0.660**
6	-0.0002	-0.0032	-0.0016	-0.0013	0.0108	0.0115	0.0458	0.0388	-0.0001	-0.0012	0.0022	0.098
7	-0.0005	0.0003	0.1006	0.0124	0.0371	0.0006	0.8576	-0.0405	0.0008	0.0026	0.0066	0.977**
8	0.0002	0.0010	-0.0049	0.0055	0.0041	0.0025	-0.1950	0.1782	-0.0002	-0.0003	0.0004	-0.012
9	-0.0008	-0.0034	-0.0110	0.0053	-0.0004	0.0002	-0.0979	0.0059	-0.0069	0.0011	-0.0035	-0.117
10	0.0000	-0.0034	-0.0118	0.0049	-0.0031	0.0021	-0.0559	-0.0132	-0.0019	-0.0099	0.0018	-0.091
11	-0.0007	-0.0003	0.0224	0.0067	0.0101	0.0016	0.3688	0.0040	0.0016	-0.0027	0.0153	0.428**

Resi = 0.0246

*, ** significant at 5% and 1% level, respectively

Table 8: Phenotypic path with grain yield per plant - Main experiment station (E2)-2021-22

Chrs	Days to 50% flowering	Plant height (cm)	Productive tiller /plant	Panicle length (cm)	Fertile spikelet /panicle	Spikelet fertility %	Biological yield /plant (g)	Harvest index %	L/B ratio	Chlrophyll content	1000-grain weight (g)	Grains yield (g/plant)
	1	2	3	4	5	6	7	8	9	10	11	12
1	0.0039	-0.0013	0.0177	0.0003	-0.0036	0.0002	0.0178	0.0004	-0.0006	-0.0001	0.0009	0.037
2	0.0004	-0.0120	-0.0122	0.0025	0.0013	0.0030	-0.0142	-0.0125	-0.0025	0.0000	0.0008	-0.045
3	0.0003	0.0006	0.2381	0.0030	0.0334	0.0000	0.5702	-0.0045	0.0011	0.0000	0.0059	0.847**
4	0.0001	-0.0028	0.0679	0.0106	0.0393	-0.0008	0.2378	0.0177	-0.0016	0.0000	0.0070	0.375**
5	-0.0001	-0.0001	0.0583	0.0031	0.1366	0.0019	0.4265	0.0078	0.0000	-0.0002	0.0066	0.641**
6	0.0001	-0.0025	0.0002	-0.0006	0.0177	0.0145	0.0255	0.0287	0.0000	0.0000	0.0023	0.086
7	0.0001	0.0002	0.1950	0.0036	0.0836	0.0005	0.6964	-0.0311	0.0012	-0.0001	0.0160	0.966**
8	0.0000	0.0011	-0.0078	0.0013	0.0076	0.0030	-0.1553	0.1395	-0.0001	0.0000	0.0010	-0.009
9	0.0002	-0.0027	-0.0239	0.0015	0.0005	0.0000	-0.0754	0.0015	-0.0110	0.0000	-0.0075	-0.115

10	0.0001	-0.0018	-0.0196	0.0012	-0.0109	0.0018	-0.0368	-0.0039	-0.0025	0.0002	0.0013	-0.069
11	0.0001	-0.0002	0.0346	0.0018	0.0221	0.0008	0.2745	0.0036	0.0020	0.0001	0.0405	0.380**

Resi = 0.176 Resi-0.0170

*, ** Significant at 5% and 1% level, respectively

4. Conclusion

According to the findings, there was a favorable association between biological yield per plant, chlorophyll content, productive tillers per plant, and 1000 grain weight, as well as a positive direct effect on grain output. Therefore, direct selection of these qualities is possible in rice breeding projects. Grain yield will increase concurrently with improvements in these qualities.

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