

Original Research Article

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Correlation and Path Analysis for Yield and its Component Traits in NPT Core Set of Rice (*Oryza sativa* L.)

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ABSTRACT

Grain yield in rice is considered as a complex trait, determined by the ultimate expression of its individual component traits. Establishing an association between yield and its component traits plays a vital role in stabilizing the trait 'overall yield'. Correlation and path analysis were examined in 46 rice genotypes including tropical *japonica* accessions, *indica* land races and elite *indica* cultivars as New plant type (NPT) core set along with checks during *kharif* 2017. The data was recorded on twelve quantitative traits viz., days to 50% flowering, plant height, number of tillers, number of panicles, panicle length, panicle weight, grain number, test weight, single plant yield, plot yield, biomass and harvest index. Correlation studies revealed highly significant and positive association of single plant yield with days to 50% flowering, tillers per plant, productive tillers per plant and biomass, indicating that these characters are very important for yield improvement and concurrent selection will directly lead to high yield. Path coefficient analysis showed that productive tillers per plant exerted highest positive direct effect followed by panicle length, number of grains per panicle, test weight, panicle weight, harvest index and biomass on single plant yield, indicating that selection for these characters is likely to bring about an overall improvement in grain yield per plant directly. In view of the results obtained, it may be concluded that characters like productive tillers per plant and biomass could be used as a direct selection criteria for higher grain yield.

Keywords

Rice, Correlation, PATH analysis, New plant type, Yield, Yield components

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Introduction

Rice is the most essential human nourishment crop in the world for direct feeding a larger number of individuals and continues to be an important area of research on global level. Asia represents 90 percent of worldwide rice utilization and the aggregate rice demand keeps on rising, which is insufficient to meet the sustenance demand for the evaluated nine

billion individuals in 2050 (Khush 2005 and Ray *et al.*, 2013). Crop yield is of prime significance to satisfy the needs attributable to steady increment in population.

Grain yield is an intricate character and determination of superior genotypes in view of yield is troublesome because of the incorporated structure of plant, in which the component characters are administered by a

large number of genes. It has been reported to be influenced by productive tillers (Rashmi *et al.*, 2017 and Harsha *et al.*, 2017), panicle length and effective tillers per plant (Harsha *et al.*, 2017), plant height (Sarawagi *et al.*, 2016), the number of filled grains per panicle (Islam *et al.*, 2015), 1000-grain weight (Chouhan *et al.*, 2014), biomass, harvest index and number of tillers per plant (Patel *et al.*, 2014), panicle weight and productive tillers (Rashmi *et al.*, 2017) and harvest index (Dhurai *et al.*, 2016).

The degree of relationship between traits conferring higher yield will be more helpful to choose the traits to be given significance in selection process. Positive relationship between traits will bring about concurrent change of both the traits while limiting determination to any of the related attributes. Negative relationship between traits necessitates equal weight on both the traits amid selection. At genetic level, a positive correlation occurs because of coupling period of linkage and negative correlation emerges because of repulsion phase of linkage of genes controlling two different traits (Nadarajan and Gunasekaran 2008).

Path coefficient investigation assists plant breeders in identifying traits on which selection pressure ought to be given for enhancing yield. The relationship of different component characters among themselves and with yield is very imperative for devising an effective selection criterion for yield. The total correlation between yield and component characters may be some times misleading, as it may be an over-estimate or under-estimate as a result of its relationship with other characters. Thus, indirect selection by correlated response may not be productive some times. At the point, when numerous characters are influencing a given character, splitting the total correlation into direct and indirect effects of cause as contrived by Wright (1921) would give more significant

elucidation to the cause of association between the dependent variable like yield and independent variables like yield components. This sort of data will be useful in formulating the selection criteria, indicating the selection for these characters is likely to bring about on overall improvement in single plant yield directly. Accordingly, present investigation was framed to study the relationship between yield related traits to build up suitable plant attributes for selection to enhance the yield of rice.

Materials and Methods

46 rice genotypes comprising NPT core set (Jyothi *et al.*, 2018) of tropical *japonica* accessions, *indica* land races along with checks were evaluated for yield and component traits during Kharif 2017 in Randomized Block Design (RBD) with three replications at ICAR-Indian Institute of Rice Research (ICAR-IIRR), Ramachandrapuram farm, ICRISAT campus, Hyderabad. Thirty days old seedlings were transplanted by adopting a spacing of 15 cm between plants and 20 cm between rows. Recommended agronomic and plant protection measures for raising a healthy nursery and main crop were taken up during the experiment.

Observations were recorded on five randomly selected plants in each genotype in each replication for twelve quantitative traits *viz.*, days to fifty percent flowering (DFF), plant height (PH) (cm), tillers per plant (TN), number of panicles (PN), panicle length (PL) (cm), panicle weight (PW) (g), grain number (GN), thousand grain weight (TW) (g), single plant yield (SPY) (g), plot yield (PY) (kg m^{-2}), biomass (BM) (g) and harvest index (HI) (%). The mean of five plants for each metric trait was considered for statistical analysis using WINDOSTAT software version 9.2. Correlation coefficients were calculated following Falconer and Mackay (1964) and

path analysis by Dewey and Lu (1959). By keeping single plant yield as dependent variable and other eleven traits as independent variables, simultaneous equations which express the basic relationship between path coefficients were solved to estimate the direct and indirect effects.

Results and Discussion

Correlation

Selection based on magnitude and direction of association between yield and its component traits is very important in identifying the key characters, which can be exploited for crop improvement through suitable breeding programme. Correlation between yield and yield components were computed and the results are presented in (Table 1). In the present investigation, single plant yield exhibited positive and significant association with tillers per plant, days to 50% flowering, biomass and productive tillers per plant. Similar results were reported by Veni *et al.*, (2013), Khare *et al.*, (2014), Islam *et al.*, (2015) for days to 50% flowering, Sanghera *et al.*, (2013), Norain *et al.*, (2014) for tillers per plant, Awaneet and Senapati (2013), Harsha *et al.*, (2017) for productive tillers per plant and Konate *et al.*, (2016) for biomass. These traits could be considered as the selection criteria for the improvement of grain yield in rice.

Days to 50 % flowering exhibited positive and significant correlation with plant height, panicle length, plot yield, biomass and panicle weight. The results are in conformity with Aditya and Anuradha (2013) for plant height, grain yield per plant and panicle length, Patel *et al.*, (2014) for biomass.

At the same time, DFF was significantly and negatively correlated with harvest index as reported previously by Solomon and Wegary (2016).

Plant height was significantly and positively correlated with panicle weight, biomass, panicle length, test weight and number of grains per panicle. Similar results were reported by Ranawake and Amarasinghe (2014) for panicle weight, Solomon and Wegary (2016) for biomass, Dhurai *et al.*, (2016) and Harsha *et al.*, (2017) for panicle length, Babu *et al.*, (2012) and Ramya *et al.*, (2017) for test weight and Rahman *et al.*, (2014) for number of grains per panicle. Significant and negative correlation of plant height was observed with harvest index and number of panicles per plant. Similar findings were earlier reported by Solomon and Wegary (2016) for harvest index and Ravindra Babu *et al.*, (2012) for number of panicles per plant.

Tillers per plant was significantly and positively correlated with plot yield, as reported by Sanghera *et al.*, (2013), Norain *et al.*, (2014) and productive tillers per plant as reported earlier by Aditya and Anuradha (2013) and Konate *et al.*, (2016), whereas significantly and negatively correlated with panicle weight and test weight.

The results are in conformity with Padmaja *et al.*, (2011) for test weight, Laxuman *et al.*, (2011) for panicle weight.

The trait 'productive tillers per plant' were significantly and negatively correlated with panicle weight and test weight as reported by Padmaja *et al.*, (2011) and Rahman *et al.*, (2014). Significant and positive correlation was observed between panicle length and two traits, panicle weight and biomass. Similar results were reports by Solomon and Wegary (2016) for panicle length and biomass and Laxuman *et al.*, (2011) for panicle length and panicle weight. However, significant and negative correlation was observed between panicle length and harvest index and similar such correlations were reported earlier by Li *et al.*, (2012).

Fig.1 Phenotypic path diagram for single plant yield in rice

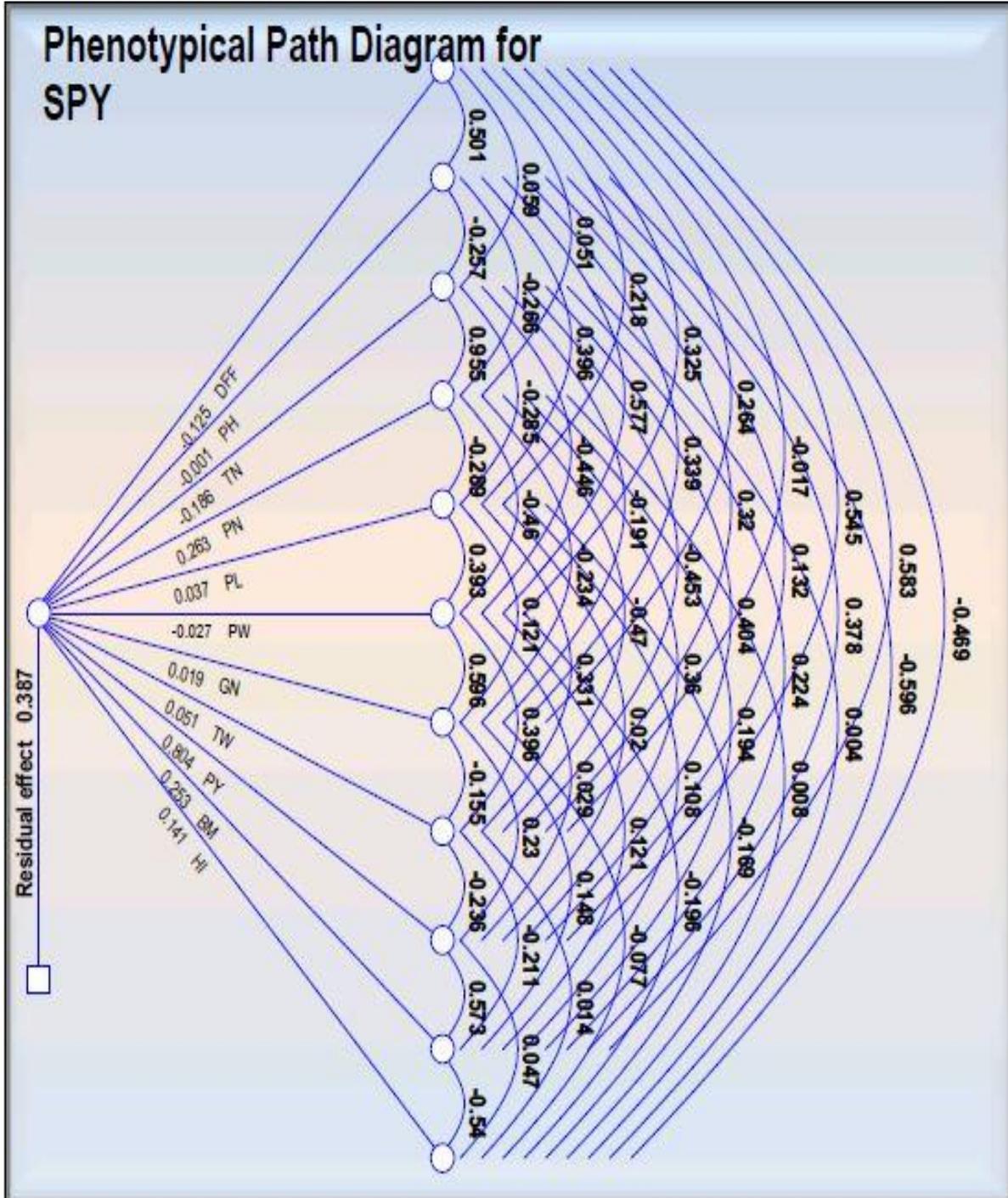


Fig.2 Genotypic path diagram for single plant yield in rice

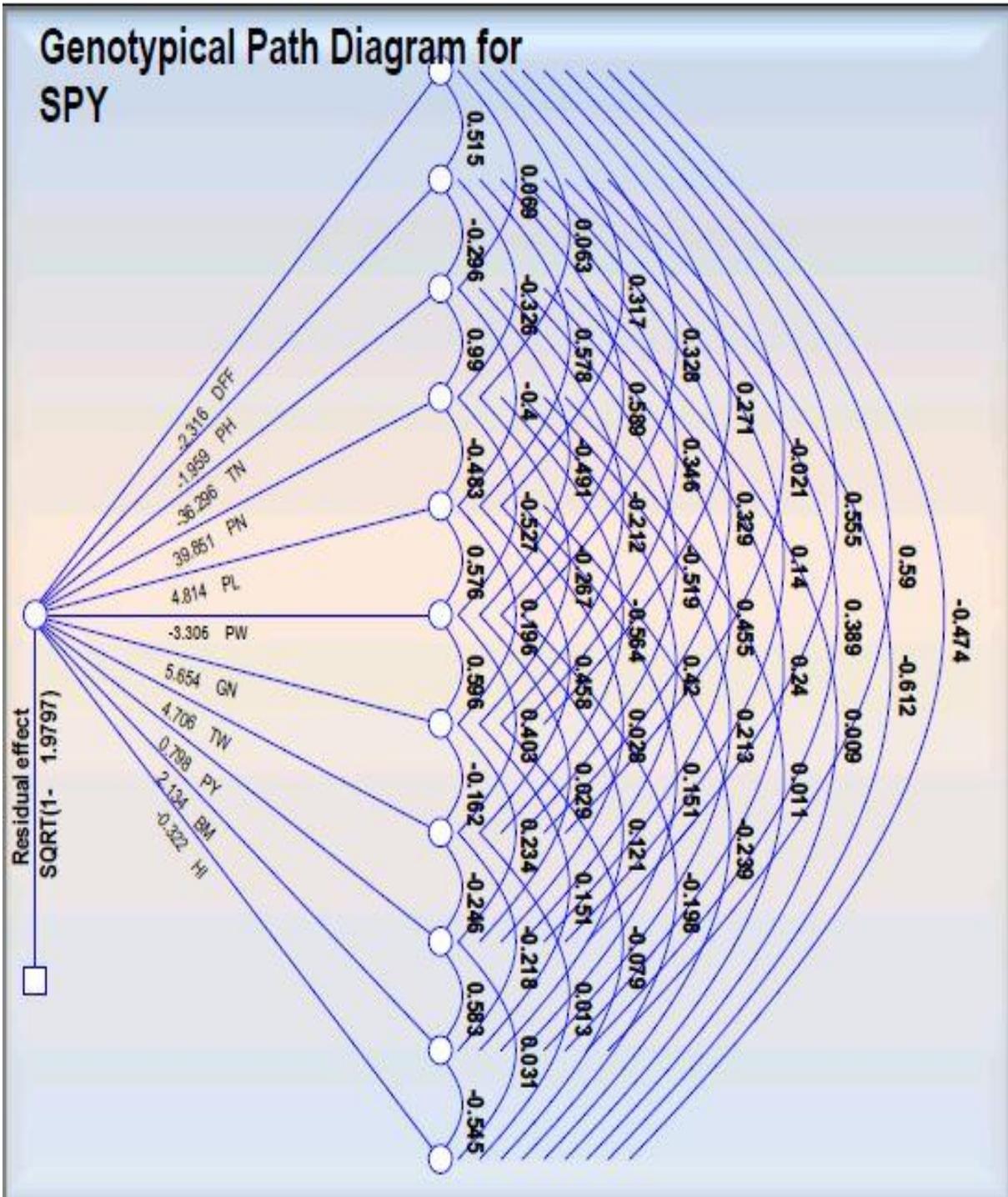


Table.1 Correlations between yield and its component traits

Traits	DFF	PH	TN	PN	PL	PW	GN	TW	SPY	PY	BM	HI
DFF	1.00	0.51 **	0.10	0.06	0.26 **	0.32 *	0.27	-0.02	0.40 **	0.55 **	0.58 **	-0.47 **
PH		1.00	-0.26	-0.29 *	0.49 **	0.58 **	0.34 *	0.32 *	0.06	0.14	0.38 **	-0.60 **
TN			1.00	0.96**	-0.32	-0.46 **	-0.19	-0.48 **	0.47 **	0.46 **	0.26	0.01
PN				1.00	-0.39	-0.49 **	-0.25	-0.53 **	0.43 **	0.40 **	0.20	0.00
PL					1.00	0.57**	0.28	0.23	0.018	0.22	0.13 **	-0.47 **
PW						1.00	0.59 **	0.40 **	-0.03	0.03	0.12	-0.20
GN							1.00	-0.16	0.15	0.23	0.15	-0.08
TW								1.00	-0.23	-0.24	-0.21	0.01
SPY									1.00	0.99 **	0.57 **	0.04
PY										1.00	0.58 **	0.04
BM											1.00	-0.68 **
HI												1.00

* Significant at 5%

** Significant at 1%

DFF- Days to 50% flowering, PH- Plant height, TN- Tillers per plant, PN- number of panicles or productive tillers per plant, PL- Panicle length, PW- Panicle weight, GN- Grain number, TW- Test weight, SPY- Single plant yield, PY- Plot yield, BM- Biomass, HI- Harvest index

Table.2 Phenotypic and Genotypic path coefficients of yield and its component traits in rice

Traits		DFE	PH	TN	PN	PL	PW	GN	TW	PY	BM	HI	SPY
DFE	G	-1.280	-0.660	-0.088	-0.081	-0.406	-0.420	-0.347	0.027	-0.710	-0.755	0.607	0.411
	P	-0.136	-0.068	-0.008	-0.007	-0.030	-0.044	-0.036	0.002	-0.074	-0.079	0.064	0.401
PH	G	0.484	-0.939	-0.278	-0.306	0.543	0.553	0.325	0.309	0.131	0.365	-0.575	0.062
	P	0.001	-0.002	-0.001	-0.001	0.001	0.001	0.001	0.001	0.000	0.001	-0.001	0.054
TN	G	-1.197	5.150	-17.42	-17.24	6.976	8.548	3.694	9.050	-7.932	-4.177	-0.152	0.481
	P	-0.012	0.053	-0.207	-0.198	0.059	0.092	0.040	0.094	-0.084	-0.046	-0.001	0.415
PN	G	1.153	-5.982	18.15	18.34	-8.857	-9.669	-4.897	-10.35	7.710	3.907	0.205	0.467
	P	0.014	-0.072	0.259	0.271	-0.078	-0.125	-0.063	-0.127	0.098	0.053	0.002	0.393
PL	G	0.802	1.465	-1.014	-1.222	2.533	1.458	0.496	1.159	0.071	0.383	-0.606	0.023
	P	0.010	0.017	-0.013	-0.013	0.044	0.017	0.005	0.015	0.001	0.005	-0.007	0.015
PW	G	-0.470	-0.845	0.703	0.756	-0.825	1.434	-0.854	-0.578	-0.041	-0.174	0.284	-0.036
	P	-0.007	-0.013	0.010	0.010	-0.009	0.022	-0.013	-0.009	-0.001	-0.003	0.004	-0.034
GN	G	0.677	0.864	-0.530	-0.667	0.490	1.489	2.500	-0.405	0.586	0.377	-0.198	0.156
	P	0.005	0.006	-0.003	-0.004	0.002	0.010	0.017	-0.003	0.004	0.003	-0.001	0.152
TW	G	-0.039	0.604	-0.954	-1.037	0.841	0.740	-0.297	1.836	-0.452	-0.401	0.025	-0.243
	P	-0.001	0.015	-0.021	-0.022	0.015	0.018	-0.007	0.046	-0.011	-0.010	0.001	-0.230
PY	G	0.209	0.053	0.171	0.158	0.011	0.011	0.088	-0.093	0.377	0.220	0.012	0.905
	P	0.443	0.107	0.328	0.293	0.017	0.023	0.187	-0.192	0.812	0.465	0.038	0.900
BM	G	0.308	0.203	0.125	0.111	0.079	0.063	0.079	-0.114	0.305	0.522	-0.285	0.582
	P	0.148	0.096	0.057	0.049	0.027	0.031	0.038	-0.054	0.145	0.253	-0.137	0.567
HI	G	-0.532	-0.687	0.010	0.013	-0.268	-0.222	-0.089	0.015	0.035	-0.612	1.123	0.085
	P	-0.056	-0.071	0.000	0.001	-0.020	-0.023	-0.009	0.002	0.006	-0.065	0.120	0.101

Bold values are direct effects; G – Genotypic correlation coefficient; P – Phenotypic correlation coefficient

Panicle weight was significantly and positively correlated with number of grains per panicle and test weight. The results are in conformity with Akinwale *et al.*, (2011) and Ranwake and Amarasighe (2014) for number of grains per panicle and Gour *et al.*, (2017) for test weight. Single plant yield was significantly and positively correlated with plot yield and biomass. The results are in conformity with Konate *et al.*, (2016) for biomass. Plot yield was significantly and positively correlated with biomass. Biomass was significantly and negatively correlated with harvest index as also reported earlier by Solomon and Wegary (2016).

Path coefficient analysis

The genetic architecture of grain yield is based on the overall net effect delivered by various yield components interacting with one another. The association of different component characters among themselves and with yield is quite important for conceiving an efficient selection criterion for yield. Correlation gives only the relation between two variables, whereas path coefficient analysis allows separation of the direct effect and their indirect effects through other attributes by partitioning the correlations (Wright, 1921). In view of the data presented the genotypic and phenotypic correlations were estimated to determine direct and indirect effects of yield and yield contributing characters. If the correlation coefficient between a casual factor and the effect is almost equal to its direct effect, it explains the true relationship and a direct selection through this trait may be useful.

If the correlation coefficient is positive, but the direct effect is negative or negligible, the indirect effects appear to be the cause of that positive correlation. In such circumstance, the other factors are to be considered simultaneously for selection. However if the

correlation coefficient is negative but direct effect is positive and high, a restriction has to be imposed to nullify the undesirable indirect effects in order to make use of direct effect.

Path coefficient analysis (Table 2) revealed that productive tillers per plant exerted highest positive direct effect followed by panicle length, number of grains per panicle, test weight, panicle weight, harvest index and biomass on the single plant yield indicating that selection for these characters is likely to bring about an overall improvement in grain yield per plant directly. The phenotypic and genotypic path diagrams are presented in figures 1 and 2 respectively. The results are in conformity with Kole *et al.*, (2008), Ambili and Radhakrishnan (2011), Rangare *et al.*, (2012), Awaneet and Senapati (2013), Berhanu *et al.*, (2013), Chouhan *et al.*, (2014), Naseem *et al.*, (2014), Sarawagi *et al.*, (2016) and Rashmi *et al.*, (2017) for productive tiller number, Chakraborty *et al.*, (2010), Yadav *et al.*, (2011), Rangare *et al.*, (2012), Awaneet and Senapati (2013), Chouhan *et al.*, (2014), Dhurai *et al.*, (2016), Sarawagi *et al.*, (2016), Rashmi *et al.*, (2017), Gour *et al.*, (2017) and Harsha *et al.*, (2017) for panicle length, Chakravorty and Ghosh (2012), Awaneet and Senapati (2013), Rashmi *et al.*, (2017) and Gour *et al.*, (2017) for panicle weight, Kole *et al.*, (2008), Khan *et al.*, (2009), Pankaj *et al.*, (2010), Aditya and Anuradha (2013), Naseem *et al.*, (2014), Patel *et al.*, (2014), Islam *et al.*, (2015), Dhurai *et al.*, (2016) and Rashmi *et al.*, (2017) for grain number, Kole *et al.*, (2008), Chakraborty *et al.*, (2010), Yadav *et al.*, (2011), Rangare *et al.*, (2012), Chouhan *et al.*, (2014), Dhurai *et al.*, (2016) and Rashmi *et al.*, (2017) for test weight, Ambili and Radhakrishnan (2011) and Patel *et al.*, (2014) for biomass and Ambili and Radhakrishnan (2011), Yadav *et al.*, (2011), Rangare *et al.*, (2012), Rai *et al.*, (2014), Patel *et al.*, (2014), Dhurai *et al.*, (2016) and Gour *et al.*, (2017) for harvest index.

The traits days to 50% flowering, plant height and tillers number exerted negative direct effect on single plant yield. The results are in conformity with Ambili and Radhakrishnan (2011), Yadav *et al.*, (2011), Babu *et al.*, (2012), Rashmi *et al.*, (2017) and Gour *et al.*, (2017) for days to 50% flowering, Babu *et al.*, (2012), Awaneet and Senapati (2013) for plant height and Gour *et al.*, (2017) for tillers number. The residual effect at phenotypic level was 0.386 and genotypic level was 0.826.

The correlation studies revealed that single plant yield exhibited significant positive association with days to 50% flowering, tillers per plant, productive tillers per plant and biomass, indicating that these characters are very important for yield improvement and simultaneous selection will ultimately lead to high yield. Path coefficient analysis revealed that productive tillers per plant exerted highest positive direct effect followed by panicle length, number of grains per panicle, test weight, panicle weight, harvest index and biomass on single plant yield, indicating that selection for these characters is likely to bring about an overall improvement in grain yield per plant directly. Further, studies on correlation and path co-efficient analysis revealed the importance of productive tillers per plant and biomass, which showed highly significant positive correlation and positive direct effect with single plant yield, thus can be used as selection criteria for effective yield improvement.

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