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Correlation and path coefficient analysis using a set of diverse genotypes of *Oryza* spp.

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Abstract

Considering the component traits is the important factor in selection for improvement of grain yield. Fifty-nine rice genotypes were field evaluated for yield traits in three consecutive crop seasons. Analysis of variance indicated the existence of significant differences among the genotypes for yield and its component characters during three seasons. The character association studies revealed that single plant grain yield had significant positive association with days to maturity, number of total tillers per plant, number of productive tillers per plant, panicle length, panicle weight, spikelet fertility, thousand grain weight, biomass per plant, biological yield per plant, harvest index and per day productivity indicating that these characters are very important for yield improvement and simultaneous selection of these characters will ultimately result in high yield. Path coefficient analysis revealed that number of filled grains per panicle exerted the highest positive direct effect on single plant grain yield followed by biological yield per plant, per day productivity, days to 50% flowering, thousand grain weight and plant height indicating that the selection for these characters was likely to bring about an overall improvement in grain yield.

Key words: Rice, Correlation, Path analysis, Grain yield

Introduction

Study of character association helps the breeder in fixing selection criteria for grain yield in parental lines, such that selections will be effective in isolating the plants with desired combination of characters. Various morphological and physiological plant characters contribute to yield and heading date. Yield contributing components are interrelated with each other and show a complex chain of relationship. Several workers have studied the correlation coefficients in rice and contradictory associations have been reported for almost all the character pairs which may be due to the experimental material and genotypic backgrounds in the studies. Interrelationship and relative contribution of each component trait towards yield is elucidated through path analysis. The path coefficient analysis which was initially developed by Wright (1921) and described by Dewey and Lu (1959) allows partitioning of correlation coefficient into direct and indirect effects of various traits towards dependent variable and thus helps in assessing the cause-effect relationship as well as effective selection. This is used in plant breeding programs to determine the nature of the relationships between yield and yield components that are useful as selection criteria to improve the crop yield. If the cause and effect relationship is well defined, it is possible to present the whole system of variables in the form of a path-diagram. In agriculture, path analysis has been used by plant breeders to assist in identifying traits that are useful as selection criteria to improve crop yield (Dewey and Lu, 1959). The present investigation was undertaken for screening and detecting trait association of rice genotypes belonging to different maturity groups.

Materials and Methods

Fifty-eight lines along with a check variety Prasanna (early maturing variety) were evaluated during *Rabi* 2014-2015, *Kharif* 2015 and *Rabi* 2015-2016 to estimate the genetic variability parameters among the genotypes for yield, and the extent of association between yield and its component characters including direct and indirect effects. The experiment was laid out in a Randomized Complete Block Design with three replications at Indian Institute of Rice Research, Hyderabad, Rajendranagar, during three seasons.

Estimation of Correlation Coefficients: Correlation coefficients were calculated using the formulae suggested by Karl Pearson (1920). Correlation coefficients were estimated based on pooled data of three seasons.

$$r_{xy} = \frac{\text{cov}(xy)}{S_x \bullet S_y}$$

Where,

r_{xy}	=	correlation between x and y
Cov (xy)	=	covariance for characters x and y
S	=	Standard deviation
r	=	correlation coefficient
xy	=	two independent variables

Path Coefficient Analysis: The direct and indirect effects both at genotypic and phenotypic level were estimated by taking grain yield as dependent variable, using path coefficient analysis suggested by Wright (1921) and Dewey and Lu (1959). Direct and indirect effects were estimated based on pooled data of three seasons for 59 lines.

Results and Discussion

Crop yield is the end product of the interaction of a number of often interrelated attributes. A thorough understanding of the interaction of characters among themselves had been of great use in plant breeding. The efficiency of selection for yield mainly depends on the direction and magnitude of association between yield and its component characters and also among themselves. Character association provides information on the nature and extent of association between pairs of metric traits and helps in selection for the improvement of the character. Pooled genotypic correlations were worked out on single plant grain yield and yield contributing characters in fifty-nine genotypes. Results of pooled genotypic correlation analysis were presented in Table 1.

Days to 50 % flowering showed positive significant association at genotypic level with days to maturity, panicle length, panicle weight, number of filled grains per panicle, number of unfilled grains per panicle, number of total grains per panicle, biomass per plant and biological yield per plant. The similar findings were reported by Hasan *et al.* (2013), Patel *et al*. (2014) and Ravi *et al.* (2014) for days to maturity, Soni *et al*. (2013) for panicle length, panicle weight and biological yield per plant, Ratna *et al*. (2015) for number of filled grains per panicle and Patel *et al*. (2014) for biomass per plant. It showed positive non-significant association at genotypic level with spikelet fertility and single plant grain yield. Panwar (2006) and Mishra *et al*. (2014) for spikelet fertility, Golam *et al.* (2015) and Mishu *et al.* (2016) reported similarly for single plant grain yield. This trait showed negative significant association at genotypic level with plant height, thousand grain weight, harvest index and per day productivity. It expressed negative non–significant association at genotypic level with number of total tillers per plant, number of productive tillers per plant and sterility percentage. Similar results were reported by Chandra *et al.* (2009) and Ravi *et al.* (2014) for plant height, Bhadru *et al* (2012) for thousand grain weight and per day productivity, Madhavilatha (2002) and Ratna *et al*. (2015) for number of productive tillers per plant and Mishu *et al.* (2016) for sterility percentage.

Plant height (cm) showed positive significant association at genotypic level with panicle length, spikelet fertility, thousand grain weight, and biomass per plant and biological yield per plant. Ganapati *et al*. (2014), Patel *et al*. (2014), Golam *et al.*(2015) and Moosavi *et al.* (2015) showed positive significant association or panicle length, Soni *et al*. (2013) and Mishra *et al*. (2014) for spikelet fertility and thousand grain weight, Patel *et al*. (2014) for biomass per plant and Soni *et al*. (2013) for biological yield per plant. Positive non-significant association at genotypic level with panicle weight and per day productivity was observed in case of plant height. These results are in accordance with Bhadru *et al.* (2012) for per day productivity. Plant height also showed negative significant association at genotypic level with number of total tillers per plant, number of productive tillers per plant, number of unfilled grains per panicle, sterility percentage and harvest index. It expressed a negative non-significant association at genotypic level with number of filled grains per panicle, number of total grains per panicle and single plant grain yield. Similarly, negative association of these traits were reported by Golam *et al.* (2015) for number of total tillers per plant and number of productive tillers per plant, Panwar (2006) and Ganapati *et al*. (2014) for harvest index, Dilruba *et al*. (2014) and Ratna *et al*. (2015) for filled grains per panicle, Seyoum *et al.* (2012) and Rahman *et al.* (2014) for single plant grain yield.

Number of productive tillers per plant showed positive significant association at genotypic level with spikelet fertility, harvest index, per day productivity and single plant grain yield as reported by Hasan *et al*. (2013), Soni *et al*. (2013) and Mishra *et al*. (2014) for spikelet fertility, Ramanjaneyulu *et al*. (2014) for harvest index, Bhadru *et al*. (2012) for per day productivity, Rashid *et al.* (2014),

Table 1: Pooled genotypic correlation coefficient analysis of single plant grain yield and yield contributing characters in rice

	DFF	DM	PH(cm)	TN	PTN	PL(cm)	PW(g)	FG	UFG	TGP	SF (%)	SP (%)	TGW(g)	BM(g)	BY(g)	HI	PP(g)	SPY(g)
DFF	1	0.96**	-0.34**	-0.10	-0.10	0.22**	0.50**	0.74**	0.48**	0.72**	0.01	-0.01	-0.44**	0.60**	0.40**	-0.74**	-0.44**	0.01
DM		1	-0.37**	-0.04	-0.04	0.16*	0.55**	0.76**	0.50**	0.74**	0.05	-0.05	-0.47**	0.58**	0.46**	-0.63**	-0.32**	0.15**
PH(cm)			1	-0.69**	-0.61**	0.15*	0.13	-0.03	-0.27**	-0.07	0.44**	-0.44**	0.26**	0.38**	0.19*	-0.48**	0.04	-0.12
TN				1	0.94**	-0.52**	-0.75**	-0.80**	-0.78**	-0.82**	0.51**	-0.51**	0.07	-0.22**	0.09	0.51**	0.49**	0.49**
PTN					1	-0.61**	-0.75**	-0.72**	-0.69**	-0.74**	0.45**	-0.45**	-0.07	-0.18*	0.12	0.53**	0.51**	0.51**
PL(cm)						1	0.72	0.55**	0.38**	0.54**	-0.06	0.06	0.48**	0.62**	0.60**	-0.16*	0.28**	0.38**
PW(g)							1	0.87**	0.88**	0.90**	-0.22**	0.22**	0.19**	0.73**	0.58**	-0.60**	-0.07	0.20**
FG								1	0.76**	0.99**	0.00	-0.00	-0.33**	0.53**	0.32**	-0.74**	-0.37**	-0.05
UFG									1	0.83**	-0.65**	0.65**	-0.12	0.22**	0.05	-0.38**	-0.39**	-0.19*
TGP										1	-0.10	0.10	-0.30**	0.50**	0.28**	-0.70**	-0.38**	-0.08
SF (%)											1	-1.00**	-0.17*	0.21**	0.23**	-0.33**	0.16*	0.19**
SP (%)												1	0.17*	-0.21**	-0.23**	0.33**	-0.16*	-0.19**
TGW(g)													1	0.09	0.27**	0.45**	0.56**	0.42**
BM(g)														1	0.90**	-0.63**	0.23**	0.49**
BY(g)															1	-0.27**	0.59**	0.82**
HI																1	0.52**	0.28**
PP(g)																	1	0.88**
SPY(g)																		1

DFF -days to 50% flowering, DM-days to maturity, PH- plant height, PL-panicle length, PW-panicle weight, FG- number of filled grains/panicle, UFG-number of unfilled grains/panicle, TGP- number of total grains/panicle, TGW- thousand grain weight, SPY-single plant grain yield TN- number of tillers plant, PTN-number of productive tillers/plant, SF- spikelet fertility, SP- sterility percentage, BM- biomass /plant, BY -biological yield /plant, HI -harvest index, PP -productivity/day

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

and Golam *et al*. (2015) for single plant grain yield and Mishra *et al.* (2014) for biological yield per plant. Number of productive tillers per plant showed negative significant association at genotypic level with panicle length, panicle weight, number of filled grains per panicle, number of unfilled grains per panicle, number of total grains per panicle, sterility percentage and biomass per plant. It expressed negative non-significant association at genotypic level with thousand grain weight. Similar results were reported by Babu *et al*. (2012), Rahman *et al*. (2014) and Ratna *et al*. (2015) for panicle length and Naseer *et al*. (2015) for total grains per panicle, Satyavathi *et al.* (2001) for number of filled grains per panicle and Golam *et al*. (2015) for thousand grain weight.

Panicle length (cm) had a positive significant association at genotypic level with number of filled grains per panicle, number of total grains per panicle, thousand grain weight, biomass per plant, biological yield per plant and single plant grain yield and a positive non-significant association at genotypic level with panicle weight and sterility percentage. The similar findings were reported by Patel *et al.* (2014) and Ramanjaneyulu *et al.* (2014) for number of total grains per panicle, Ganapati *et al*. (2014) for number of filled and unfilled grains per panicle, Patel *et al.* (2014) for thousand grain weight and biomass per plant, Soni *et al*. (2013) for biological yield per plant, Sindhumole *et al.* (2015) and Mishu *et al*. (2016) for single plant grain yield, Nandeshwar (2010) and Moosavi *et al*. (2015) for panicle weight and Mishu *et al.* (2016) for sterility percentage. It also showed negative significant association at genotypic level with harvest index and a negative non-significant association at genotypic level with spikelet fertility. Similar results were reported by Nandeshwar (2010) for spikelet fertility.

Panicle weight (g) showed positive significant association at genotypic level with filled grains per panicle, unfilled grains per panicle, total grains per panicle, sterility percentage, thousand grain weight, and biomass per plant, biological yield per plant and single plant grain yield as reported in the association studies of Ranwake and Amarasighe (2014) for total grains per panicle and filled grains per panicle, Soni *et al.* (2013) for thousand grain weight and biological yield per plant, Nandeshwar (2010), Bhadru *et al.* (2011), Awaneet and Senapati (2013), Soni *et al.* (2013) and Ranwake and Amarasighe (2014) for single plant grain yield. This trait showed negative significant association at genotypic level with spikelet fertility and harvest index.

Number of total grains per panicle showed positive significant association with biomass per plant and biological yield per plant. It showed positive non-significant association at genotypic level with sterility percentage. It showed negative significant association at genotypic level with thousand grain weight, harvest index and per day productivity. Spikelet fertility (%) showed positive significant association at genotypic level with biomass per plant, biological yield per plant, per day productivity and single plant grain yield. The results are in accordance with Soni *et al.* (2013) for biological yield per plant and Hasan *et al*. (2013), Soni *et al.* (2013) and Naseer *et al.* (2015) for single plant grain yield. This trait showed negative significant association at genotypic level with the traits, sterility percentage, thousand grain weight and harvest index. The results are in accordance with Divya *et al.* (2015) for sterility percentage.

Thousand grain weight (g) showed positive significant association with harvest index, biological yield per plant, per day productivity and single plant grain yield. It showed positive non-significant association at genotypic level with biomass per plant. The results are in similarity with Patel *et al.* (2014) Rahman *et al.* (2014), Naseer *et al*. (2015), Roy *et al*. (2015) and Mishu *et al.* (2016) for single plant grain yield. Biomass per plant (g) was in positive significant association at genotypic level with biological yield per plant, per day productivity and single plant grain yield as that of studies by Patel *et al*. (2014) for harvest index and Patel *et al*. (2014) and Ramanjaneyulu *et al*. (2014) for single plant grain yield. Harvest index had a positive significant association at genotypic level with per day productivity and single plant grain yield. Similarly, Panwar (2006), Soni *et al.* (2013), Patel *et al*. (2014) and Ramanjaneyulu *et al.* (2014) reported for single plant grain yield. Per day productivity (g) showed positive significant association at genotypic level with single plant grain yield as reported by Bhadru *et al*. (2012) for single plant grain yield.

Genotypic correlations revealed that single plant grain yield had significant positive association with days to maturity, number of total tillers per plant, number of productive tillers per plant, panicle length, panicle weight, spikelet fertility, thousand grain weight, biomass per plant, biological yield per plant, harvest index and per day productivity. It showed positive non- significant association with days to 50% flowering at genotypic level. The trait showed negative significant association with number of unfilled grains per panicle and sterility percentage and negative non-significant association with plant height, number of filled grains per panicle and number of total grains per panicle at genotypic level. Pleiotropy or linkage may also be the genetic reasons for this type of negative association. According to NeWall and Eberhart (1961), when two characters show negative genotypic correlation it would be difficult to exercise simultaneous selection for these characters in the development of a variety. Hence, under such situations, judicious selection programme might be formulated for simultaneous improvement of such important developmental and component characters.

Single plant grain yield showed positive significant association with days to maturity, number of total tillers per plant, number of productive tillers per plant, panicle length, panicle weight, spikelet fertility, thousand grain weight, biomass per plant, biological yield per plant, harvest index and per day productivity. Similar kind of association was reported by Ravi *et al.* (2014) and Golam *et al.* (2015) for days to maturity, Ramanjaneyulu *et al.* (2014) and Golam *et al*. (2015) for number of total tillers per plant and number of productive tillers per plant, Soni *et al.* (2013) and Ranwake and Amarasighe (2014) for panicle length and panicle weight, Soni *et al.* (2013) for spikelet fertility and biological yield per plant, Rahman *et al.* (2014), Naseer *et al*. (2015) and Mishu *et al.* (2016) for thousand grain weight, Patel *et al*. (2014) and Ramanjaneyulu *et al*. (2014) for biomass per plant, Panwar (2006), Soni *et al.* (2013) and Patel *et al*. (2014) for harvest index and Bhadru *et al*. (2012) for per day productivity. Hence, these characters could be considered as criteria for selection for higher yield as these were mutually and directly associated with grain yield.

Correlation gives 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). Based on the data recorded on the genotypes across three seasons in the present investigation, the pooled genotypic correlations were estimated to determine direct and indirect effects of single plant grain 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 situation 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. Results of pooled genotypic path coefficient of single plant grain yield and yield contributing characters discussed here under which were presented in Table 2 and Figure 1.

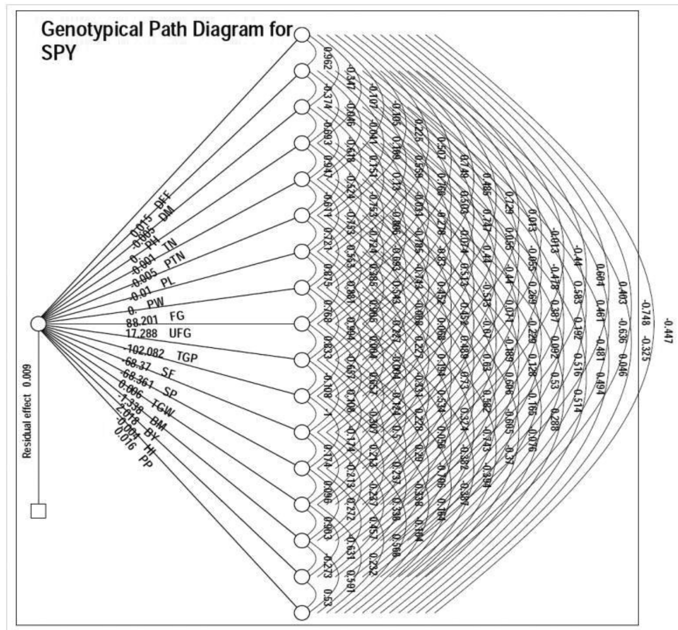

Figure 1: Pooled genotypical path diagram of single plant grain yield

The direct contribution of Days to 50% flowering to single plant grain yield was positive (0.0151) at genotypic level. These results are in agreement with Mohanty *et al.* (2012), Nikhil *et al*. (2014), Ravi *et al.* (2014), Golam *et al*. (2015) and Ratna *et al* (2015). This trait exhibited positive non-significant correlation with single plant grain yield due to indirect positive influence through number of total tillers per plant, number of productive tillers per plant, number of filled grains per panicle, sterility percentage, biological yield per plant and harvest index at genotypic level. The direct effect of Plant height on single plant grain yield was positive at genotypic level. These results are in agreement with Hasan *et al*. (2013), Nagaraju *et al.* (2013), Dilruba *et al.* (2014), Golam *et al.* (2015) and Naseer *et al*. (2015). This trait expressed negative non-significant correlation with single plant grain yield due to indirect positive influence on single plant grain yield through days to maturity, number of total tillers per plant, number of productive tillers per plant, number of total grains per panicle, sterility percentage, thousand grain weight, biological yield per plant, harvest index and per day productivity at genotypic level.

Table 2: Pooled genotypic path coefficient of single plant grain yield and yield contributing characters in rice

Character	DFF	DM	PH (cm)	TN	PTN	PL (cm)	PW(g)	FG	UFG	TGP	SF (%)	SP (%)	TGW(g)	BM(g)	BY(g)	HI	PP(g)	SPY(g)
DFF	**0.02**	0.00	0.00	0.00	0.00	0.00	0.00	66.07	8.38	-74.44	-0.87	0.87	0.00	-0.81	0.81	0.00	-0.01	0.01
DM	0.01	**0.00**	0.00	0.00	0.00	0.00	0.00	67.53	8.69	-76.22	-3.76	3.76	0.00	-0.78	0.93	0.00	-0.01	0.1562**
PH (cm)	-0.01	0.00	**0.00**	0.00	0.00	0.00	0.00	-2.74	-4.80	7.54	-30.08	30.08	0.00	-0.52	0.39	0.00	0.00	-0.13
TN	0.00	0.00	0.00	**0.00**	-0.01	0.01	0.00	-71.11	-13.57	84.68	-35.10	35.10	0.00	0.31	0.19	0.00	0.01	0.4919**
PTN	0.00	0.00	0.00	0.00	**-0.01**	0.01	0.00	-63.86	-11.98	75.84	-30.88	30.88	0.00	0.25	0.26	0.00	0.01	0.5107**
PL (cm)	0.00	0.00	0.00	0.00	0.00	**-0.01**	0.00	48.81	6.66	-55.47	4.67	-4.67	0.00	-0.84	1.22	0.00	0.00	0.3886**
PW(g)	0.01	0.00	0.00	0.00	0.00	-0.01	**0.00**	77.14	15.23	-92.37	15.49	-15.49	0.00	-0.98	1.18	0.00	0.00	0.2062**
FG	0.01	0.00	0.00	0.00	0.00	-0.01	0.00	**88.20**	13.28	-101.48	-0.30	0.30	0.00	-0.71	0.65	0.00	-0.01	-0.06
UFG	0.01	0.00	0.00	0.00	0.00	0.00	0.00	67.76	**17.29**	-85.05	44.95	-44.94	0.00	-0.31	0.11	0.00	-0.01	-0.1904*
TGP	0.01	0.00	0.00	0.00	0.00	-0.01	0.00	87.68	14.40	**-102.08**	7.36	-7.36	0.00	-0.67	0.58	0.00	-0.01	-0.08
SF (%)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.39	-11.37	10.99	**-68.37**	68.36	0.00	-0.28	0.48	0.00	0.00	0.1960**
SP (%)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.39	11.37	-10.99	68.37	**-68.36**	0.00	0.28	-0.48	0.00	0.00	-0.1960**
TGW(g)	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	-29.16	-2.15	31.30	11.87	-11.86	**0.01**	-0.13	0.55	0.00	0.01	0.4219**
BM(g)	0.01	0.00	0.00	0.00	0.00	-0.01	0.00	47.10	3.95	-51.04	-14.53	14.53	0.00	**-1.34**	1.82	0.00	0.00	0.4962**
BY(g)	0.01	0.00	0.00	0.00	0.00	-0.01	0.00	28.59	0.97	-29.56	-16.19	16.18	0.00	-1.21	**2.02**	0.00	0.01	0.8206**
HI	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	-65.49	-6.60	72.09	23.11	-23.11	0.00	0.84	-0.55	**0.00**	0.01	0.2883**
PP(g)	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	-32.67	-6.81	39.48	-11.24	11.24	0.00	-0.31	1.19	0.00	**0.02**	0.8864**

Genotypic residual effect = 0.0088

BOLD values are direct effects

DFF -days to 50% flowering, DM-days to maturity, PH- plant height, PL-panicle length, PW-panicle weight, FG- number of filled grains/panicle, UFG-number of unfilled grains/panicle, TGP- number of total grains/panicle, TGW- thousand grain weight, SPY-single plant grain yield TN- number of tillers plant, PTN-number of productive tillers/plant, SF- spikelet fertility, SP- sterility percentage, BM- biomass /plant, BY -biological yield /plant, HI -harvest index, PP -productivity/day

The direct effect of thousand grain weight (g) on single plant grain yield was positive at genotypic level. These results are in agreement with Dilruba *et al.* (2014), Rahman *et al.* (2014), Ratna *et al*. (2015), Naseer *et al*. (2015) and Golam *et al.* (2015). It expressed positive significant correlation with single plant grain yield due to indirect positive effects of this trait *via* days to maturity, plant height, and number of productive tillers per plant, number of total grains per panicle, spikelet fertility, and biological yield per plant and per day productivity at genotypic level. The direct effect of per day productivity on single plant grain yield was positive at genotypic level. These results are in agreement with Bhadru *et al*. (2012). Perday productivity showed positive significant correlation with single plant grain yield due to indirect positive effects of this trait *via* days to maturity, number of total grains per panicle, sterility percentage, thousand grain weight and biological yield per plant at genotypic level. Whereas, days to 50% flowering, number of total tillers per plant, number of productive tillers per plant, panicle length, number of filled grains per panicle, spikelet fertility, biomass per plant and harvest index showed negative indirect effect at genotypic level.

The association of different component characters among themselves and with yield is quite important for devising an efficient selection criterion for yield. The total correlation between yield and component characters may be some times deceptive, as it might be an over-estimate or under-estimate because of its association with other characters. Hence, indirect selection by correlated response may not be productive always. When many characters are affecting a given character, splitting the total correlation into direct and indirect effects as proposed by Wright (1921) would give more meaningful interpretation to the cause of association between the dependent variable like yield and independent variables like yield components. This kind of information will be helpful in formulating the selection criteria, indicating the selection for these characters is likely to bring about an overall improvement in single plant grain yield directly.

Path coefficient analysis revealed that number of filled grains per panicle exerted the highest positive direct effect on single plant grain yield followed by biological yield per plant, per day productivity, days to 50% flowering, thousand grain weight and plant height indicating that the selection for these characters was likely to bring about an overall improvement in single plant grain yield directly. Therefore, it is suggested that preference should be given to these characters in the selection programme to isolate superior lines with genetic potentiality for high yield in rice genotypes. Negative direct effect on grain yield was exhibited by days to maturity, number of total tillers per plant, number of productive tillers per plant, panicle length, panicle weight, spikelet fertility, sterility percentage, and biomass per plant and harvest index.

In conclusion, a perusal of genetic variability parameters along with trait association revealed that number of total tillers per plant, number of productive tillers per plant, biomass per plant, biological yield per plant and per day productivity across all the three seasons, which indicate preponderance of additive gene action, hence these traits could be used for selection in crop improvement. Character association and path analysis indicated that thousand grain weight, biological yield per plant and per day productivity displayed significant positive correlation as well as positive direct effect on single plant grain yield. The positive direct effect of these traits on yield resulted in strong genetic correlation. Hence, these traits were considered as important attributes in formulating selection criterion for achieving desired targets.

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