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Research Article

Genetic variability, correlation and path coefficient analysis in segregating population of rice

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Abstract

A study was conducted to evaluate the genetic variability parameters, correlation and path coefficient analysis for eight yield related traits in segregating F_2 population of an aerobic restorer AR 9-18 \times YPK 198 (Donor for yield enhancing genes *Gn1a* and *OsSPL14*) at ICAR-IIRR, Hyderabad during the *kharif*, 2019. The results indicated that, productive tiller number, grain number per panicle and plant yield showed high PCV and GCV. Height of plant, productive tiller number, grain number per panicle and plant yield exhibited a high heritability and also high genetic advance as per cent of mean which indicates simple selection would be effective for enhancement of these traits. Correlation studies indicated that plant yield was associated significantly positive with height of plant, productive tiller number, length of panicle and grain number per panicle. High positive direct effect on plant yield was recorded by productive tiller number, grain number per panicle and height of plant.

Key words

Rice, Variability, F_2 segregating population, Correlation, Path analysis

INTRODUCTION

Rice (*Oryza sativa* L.) is a major staple food grain crop of more than 50 per cent of the world's population (Khush, 2005). It serves as a pillar for food security in many developing countries. Thus, production of rice has to be improved and maintained for global food security. It was anticipated that by 2030 world should produce 60 per cent more rice than what it produced in 1995. Plateauing shift in the yield of HYVs, decreasing and degrading natural resources and acute labour shortage make the mission of increasing rice production quite challenging. Among the innovative breeding approaches available for enhancing the rice production and productivity in India and other rice growing countries, hybrid rice is one of the highly adapted

and practically viable choice of breeding (Ahmed and Siddiq, 1998).

Selection in segregating generation is mainly focussed for obtaining a better yielding plant. Variability for yield and its related traits are the basic factors to be focussed during selection. Generally, environment role is estimated by phenotypic coefficient of variation while, heritable variability is estimated by the genotypic coefficient of variation. Other important selection parameters are heritability and genetic advance. During selection, the traits to be taken into consideration are determined by using the estimates of heritability. For predicting the gain

under selection and for selecting superior varieties the parameters to be considered are estimates of heritability and genetic advance (Ali *et al.*, 2002).

Correlation measure degree of interrelationship among the yield traits, however it gives only the relation between two variables, considering that path coefficient analysis measures the direct and indirect causes of association (Dewey and Lu, 1959). In addition to that path coefficient analysis plays a role in planning effective breeding methods for superior plant development. Combined with path analysis, correlation provides relationships of cause and effect between different pairs of traits (Jayasudha and Sharma, 2010).

MATERIALS AND METHODS

The research was carried out at ICAR-Research Farm, Indian Institute of Rice Research (IIRR), Hyderabad, Telangana during the wet season of *kharif*, 2019. For the present genetic study, the experimental material consists of 205 segregating F_2 population of AR 9-18 x YPK 198. Thirty days old seedlings of F_2 population along with parents were transplanted with 15 × 20 cm spacing between the plants and rows, respectively in non-replicated trial. Phenotypic data was recorded for eight yield and related traits *viz.*, days to maximum flowering, height of plant (cm), productive tiller number, length of panicle (cm), fertility of spikelet (%), grain number per panicle, weight of 1000 grains (g) and plant yield (g) on all the two hundred and five F_2 segregating population and parental lines based on flowering duration and maturity. During the experiment for raising a healthy nursery and main crop recommended cultural practices and crop protection measures were taken up. **Table 1** represents the characteristic features of parental lines.

Table 1. Characteristic features of parental lines

Parents	traits
AR 9-18	Mid-early duration, medium tall plant stature, long bold grain, restorer line suitable for aerobic conditions.
YPK 198	Medium duration with medium tall plant stature, high grain number per panicle and medium slender grain type possessing yield enhancing genes (<i>Gn1a</i> and <i>OsSPL14</i>).

Statistical analysis was done for the data recorded on eight yield and related traits *viz.*, Phenotypic Co-efficient of Variation (PCV), Genotypic Co-efficient of Variation (GCV), broad sense heritability and genetic advance as per cent of mean. GCV and PCV were calculated by adopting the technique given by Burton and Dewane (1953). Range of variation were classified as high (> 20%), moderate (10-20%) and low (< 10%) as proposed by Sivasubramanian and Madhavamnen (1973). Lush (1949) and Hanson *et al.* (1956) proposed that broad sense heritability h^2 (bs) was estimated by taking the ratio of genotypic variance to

the total variance and expressed in per cent. According to Robinson *et al.* (1949) the estimates of heritability were categorized as high (> 60%), moderate (30-60%) and low (0-30%). Genetic advance was calculated and classified as high (> 20%), moderate (10-20%) and low (< 10%) as given by Johnson *et al.* (1955). The formula given by Weber and Moorthy (1952) was used for computation of simple correlations and the one given by Dewey and Lu (1959) is used for computation of path analysis.

RESULTS AND DISCUSSION

To uncover the role of environmental effect on different traits GCV and PCV values are vital (Akinwale *et al.*, 2011). **Table 2** indicates the variability parameters calculated in the present study for eight yield and its related traits. For all the traits studied it was observed that PCV values in comparison with GCV values were slightly higher which indicates that the expression of traits was influenced less by the environmental factors. PCV and GCV estimates were recorded high for productive tiller number (30.30 and 29.57, respectively), grain number per panicle (26.31 and 26.17, respectively) and plant yield (27.45 and 26.71, respectively). The above-mentioned traits exhibited high estimates of PCV and GCV which indicates that these traits showed high degree of variability, so for crop improvement direct selection of these traits would be fruitful. Similar results of high PCV and GCV was reported by Bharath *et al.* (2018) and Hema *et al.* (2019) for productive tiller number, Ali *et al.* (2018) for grain number per panicle, Balat (2018) and Patel *et al.* (2018) for plant yield.

The moderate level of PCV and GCV was recorded for height of plant whereas, the traits *viz.*, days to maximum flowering, length of panicle and weight of 1000 grains recorded low level of PCV and GCV, which suggests that these traits exhibited less variability so, the selection may not be fruitful based on these traits. Similar results were given by Hefena *et al.* (2016) and Abhilash *et al.* (2018).

According to Johnson *et al.* (1955) for selection of component traits in improving yield, estimates of PCV and GCV alone is not sufficient, combination of genetic gain and heritability estimates has to be taken together for more reliable results. Johnson *et al.* (1955) suggested that the heritability in narrow sense includes additive components only whereas, Hanson *et al.* (1956) suggested that broad sense heritability comprises of additive and non-additive components of gene effects. In this study, broad sense heritability was estimated and it was observed that all the studied traits exhibited high heritability.

Height of plant, productive tiller number, grain number per panicle and plant yield recorded high heritability and high genetic advance, which favours additive gene action. Earlier researchers, Balat (2018) and Choudhary *et al.* (2018) reported similar findings for plant height and productive tiller number, Ali *et al.* (2018) and Pradeep *et al.* (2018) for grain number per panicle and plant yield.

Table 2. Genetic variability parameters for yield and related traits in the F₂ population of AR 9-18 × YPK 198.

Traits	General mean	Range		PCV (%)	GCV (%)	Heritability in broad sense (h ²) (%)	Genetic Advance as percent of mean
		Minimum	Maximum				
DFF	102.00	84.00	110.00	6.35	6.20	95.34	12.47
PH	104.00	72.00	143.00	11.79	11.66	97.80	23.75
PT	6.00	4.00	14.00	30.30	29.57	95.28	59.47
PL	23.19	20.00	28.50	7.92	6.92	76.33	12.45
SF	80.65	68.30	97.70	9.64	9.54	97.85	19.43
GPP	134.00	86.00	254.00	26.31	26.17	98.95	53.63
TGW	23.13	15.80	26.60	8.48	8.09	90.93	15.89
SPY	14.22	9.01	25.83	27.45	26.71	94.65	53.53

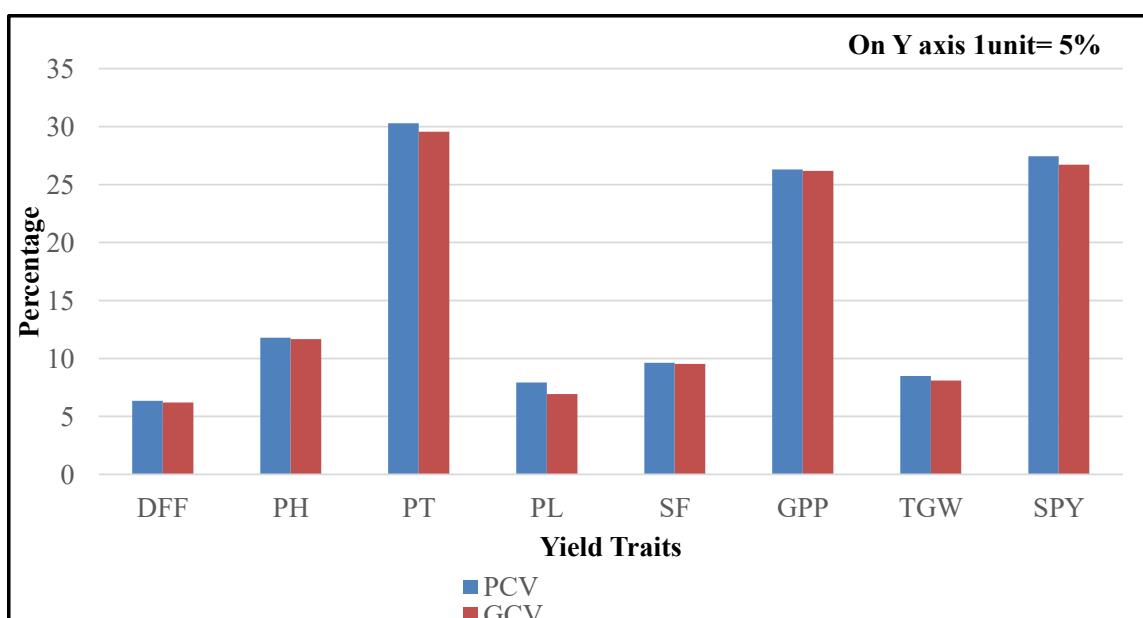
DFF- Days to maximum flowering, PH- Height of plant (cm), PT-Productive tiller number, PL-Length of panicle (cm), SF-Fertility of spikelet (%), GPP- Grain number per panicle, TGW- Weight of 1000 grains (g), SPY- Plant yield(g)

The traits days to maximum flowering, length of panicle, fertility of spikelet and weight of 1000 grains showed high heritability but genetic advance was moderate which limits further improvement through direct selection. Panwar and Mathur (2007) reported similar findings. **Fig. 1 and 2** represents histogram of PCV, GCV, broad sense heritability (h²) and genetic advance as per cent of mean.

Correlation analysis provides information regarding nature and degree of relationship among various traits and decides the component traits, on the basis of which traits can be chosen to improve grain yield genetically. In this study, correlations between eight yield and its related traits namely days to maximum flowering, height of plant, productive tiller number, length of panicle, fertility of

spikelet, grain number per panicle, weight of 1000 grains and plant yield were computed. Correlation coefficient results were represented in **Table 3** which was done by considering plant yield as dependent variable.

The trait days to maximum flowering exhibited significantly positive correlation with height of plant which indicates days to maximum flowering reduces with reduction of height of plant and vice-versa. Similar results were reported by Hema *et al.* (2019). Height of plant showed a significantly positive correlation with productive tiller number, length of panicle and plant yield. It indicates that height of plant plays crucial role in increasing the yield potential in rice as it is positive and significantly associated with productive tiller number, length of panicle

**Fig. 1. Histogram of Phenotypic Coefficient of Variation and Genotypic Coefficient of Variation.**

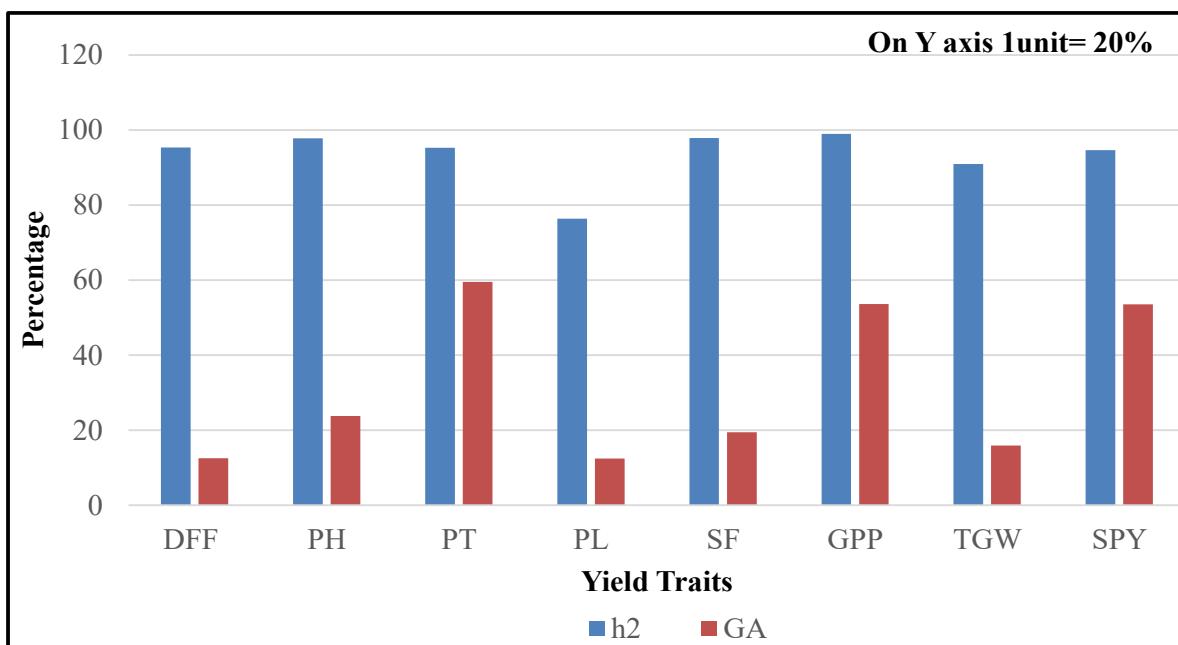


Fig. 2. Histogram of h^2 (broad sense) and Genetic advance as per cent of mean.

Table 3. Correlation analysis among yield and related traits in F_2 population of AR 9-18 × YPK 198.

Traits	DFF	PH	PT	PL	SF	GPP	TGW	SPY
DFF	1.0000	0.3123**	0.0832	0.0091	-0.0283	-0.0935	0.0934	0.0862
PH		1.0000	0.1564*	0.4036**	-0.0348	0.0513	0.1140	0.3793**
PT			1.0000	0.0926	-0.2023**	0.0354	-0.1433*	0.6856**
PL				1.0000	0.0580	0.1969**	0.0865	0.2492**
SF					1.0000	0.2109**	0.0458	-0.1072
GPP						1.0000	-0.1417*	0.3223**
TGW							1.0000	-0.0348
SPY								1.0000

** Significant at 1% level * Significant at 5% level

DFD- Days to maximum flowering, PH- Height of plant (cm), PT-Productive tiller number, PL- Length of panicle (cm), SF- Fertility of spikelet (%), GPP- Grain number per panicle, TGW- Weight of 1000 grains (g), SPY- Plant yield (g)

and plant yield. Similar results were given for height of plant by Panigrahi *et al.* (2018). Productive tiller number showed a significantly positive correlation with plant yield and negative correlation with fertility of spikelet and weight of 1000 grains. Earlier researchers, Abhilash *et al.* (2018) and Seneega *et al.* (2019) reported similar positive association between productive tiller number and plant yield. Length of panicle exhibited a significantly positive correlation with grain number per panicle and plant yield which indicates improvement in length of panicle would improve grain number per panicle and plant yield. Significantly Positive correlation was observed between fertility of spikelet and grain number per panicle. Bhadru *et al.* (2012) manifested similar results.

The trait grain number per panicle exhibited a positively significant association with length of panicle, fertility of spikelet, plant yield hence it can be considered as significant component for realizing good yields and it exhibited a negatively significant association with weight of 1000 grains. Panigrahi *et al.* (2018) reported similar results. The traits height of plant, productive tiller number, length of panicle and grain number per panicle exhibited significant and positive association with plant yield. This suggests that ultimate increase in yield may be due to improvement of these traits. Nayak (2008) and Seneega *et al.* (2019) reported such positive correlation with yield. Correlation measures the relation between two variables only, as path coefficient analysis explains the direct and

Table 4. Phenotypic path coefficient analysis representing direct and indirect effects on single plant yield by its related traits in F_2 population of AR 9-18 × YPK 198.

Traits	UFF	PH	PT	PL	SF	GPP	TGW	SPY
UFF	-0.0259	-0.0081	-0.0022	-0.0002	0.0007	0.0024	-0.0024	0.0862
PH	0.0788	0.2524	0.0395	0.1019	-0.0088	0.0129	0.0288	0.3793
PT	0.0531	0.0998	0.6380	0.0591	-0.1291	0.0226	-0.0915	0.6856
PL	0.0002	0.0104	0.0024	0.0259	0.0015	0.0051	0.0022	0.2492
SF	0.0011	0.0013	0.0076	-0.0022	-0.0376	-0.0079	-0.0017	-0.1072
GPP	-0.0278	0.0153	0.0106	0.0586	0.0627	0.2974	-0.0422	0.3224
TGW	0.0067	0.0082	-0.0103	0.0062	0.0033	-0.0102	0.0719	-0.0349

Direct effects are represented in bold values

Residual effect: 0.6043

UFF- Days to maximum flowering, PH- Height of plant (cm), PT-Productive tiller number, PL-Length of panicle (cm), SF- Fertility of spikelet (%), GPP- Grain number per panicle, TGW- Weight of 1000 grains (g), SPY- Plant yield (g)

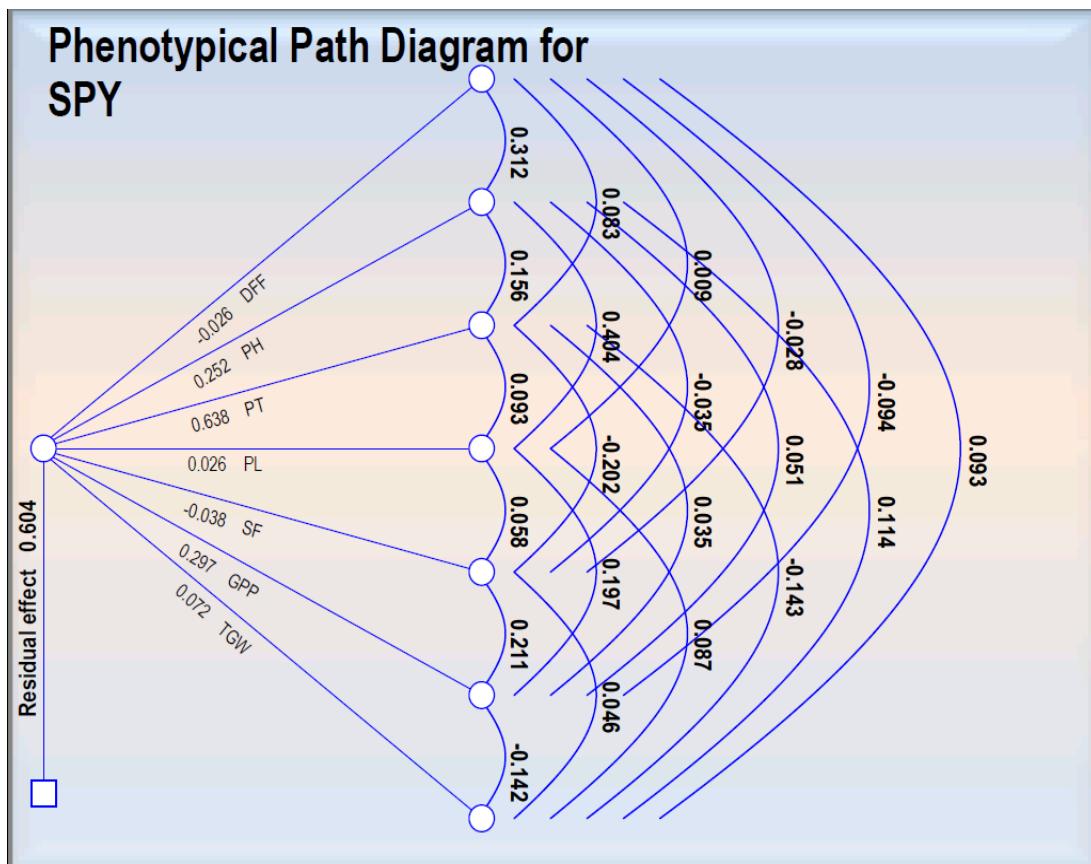


Fig. 3. Phenotypical path diagram

indirect causes of association using other attributes by dividing the correlations for explaining the cause-and-effect relationship clearly (Wright, 1921). **Table 4** depicts the path coefficient analysis estimates for yield and its related traits. Productive tiller number (0.6380) exerted

maximum positive direct effect on plant yield followed by grain number per panicle (0.2974), height of plant (0.2524), weight of 1000 grains (0.0719) and length of panicle (0.0259) indicates yield improvement is directly associated with these traits. Similar results of direct

positive effect on plant yield were reported by Nandeshwar *et al.* (2010) and Kalaiselvan *et al.* (2019).

In contrast to positive direct effect, negative direct effect on plant yield was exhibited by days to maximum flowering and fertility of spikelet. Similar results of negative direct results were reported by Ravindra Babu *et al.* (2012) for days to maximum flowering and Kalaiselvan *et al.* (2019) for fertility of spikelet. At phenotypic level the residual effect was 0.6043. The trait productive tiller number exhibited maximum positive direct effect among all the yield contributing traits. Hence, it can be considered as major contributor to plant yield. Phenotypical path diagram for plant yield was represented in **Fig. 3**.

PCV and GCV estimates were high for the traits productive tiller number, grain number per panicle and plant yield implying that direct selection of these traits may lead to genetic improvement. It was observed that height of plant, productive tiller number, grain number per panicle and plant yield showed high genetic advance as per cent of mean and high heritability which signifies predominance of additive gene action in their genetic control. So, for improvement of these traits simple selection would be productive. Analysis of correlation and path coefficient together revealed that among the yield traits studied, productive tiller number, height of plant and grain number per panicle were considered as most critical ones as they exhibited higher correlation coefficients and direct effects in association to plant yield.

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