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Research Article

Studies on genetic variability, association and path coefficient analysis in F_2 derivatives of CR 1009 × WP 22-2 for earliness and semi-dwarfism in rice (*Oryza sativa L.*)

T. Hema[1], S. Saravanan[1], R. Kannan[2], D. Shoba[1] and M. Arumugam Pillai[1]*
[1]Department of Plant Breeding and Genetics, Agricultural College and Research Institute, Killikulam -628 252
[2]Department of Plant Pathology, Agricultural College and Research Institute, Killikulam -628 252
***E-Mail:** mapillai1@hotmail.com

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Abstract
The present investigation was conducted in the F_2 population of CR 1009 × WP 22-2 for earliness and semi-dwarfism. The yield contributing traits *viz.*, plant height, days to fifty per cent flowering, number of productive tillers, panicle length, number of grains per panicle, thousand grain weight, grain length, grain breadth, length breadth ratio were interpreted based on their exposition of genetic variability, heritability and genetic advance besides correlation and path coefficient analysis. Negligible values of difference between PCV and GCV were recorded for plant height, number of grains per panicle, grain length and grain breadth suggesting lower environmental influence on the expression of these traits. The results of correlation and path analysis indicated that the number of productive tillers shows significantly positive and highest correlation with single plant yield pursuing selection of this trait is rewarding for grain yield improvement.

Key words
F_2 population, earliness and semi-dwarfism, genetic variability, association and path coefficient analysis

Introduction

Rice (*Oryza sativa* L.) is one of the major cereal grains which serve as staple food for a major part of world's population (FAO, 2017). Thus, the increased and sustained production of rice is fundamental to food security in India and the world. During 2017 and 2018, China was the largest producer of rice with a production of 208.1 million metric tons and 210.3 million metric tons respectively, followed by India with a production of 169.5 million metric tons and 166.5 million metric tons respectively (Statista, 2019). Improving crop yield is one of the important aspects in crop breeding programmes and it would fulfill the requirements of increasing population.

Selection in segregating generation is always focused on to obtain a better yielding plant variety. Variability in a population for yield and its contributing characters are the basic factor to be considered during selection while heritability measures the extent of phenotypic variance caused by the action of genes. Further, correlation helps in understanding the influence of various components on the yield while path analysis is the basic method that enables to draw inferences about causal structure of phenotypic data (Kozak and Kang, 2006). Yield is controlled by polygenes being greatly influenced by environment and thus the knowledge on correlation and path coefficient analysis of yield and its contributing traits is an efficient selection strategy for plant breeders to evolve an economic variety.

Plant height is an important agronomic trait of rice that directly affects the yield of rice crop. The dwarf phenotype is beneficial for non lodging, but if the plants are too short, it will lead to insufficient growth affecting the yield potential of rice. The second green revolution and the breeding of super rice were based on appropriate plant heights (Mooney, 2009 and Palme *et al*. 2014). Earliness is an important agronomic trait in rice which determines the duration of the crop and a plant with earliness judiciously utilizes the input resources.

Most of the semi-dwarf varieties developed around the world have *sd-1*, the 'green revolution gene' as a donor. However, this may lead to narrow down the genetic base reducing further improvement in the plant architecture and hence development of novel sources of semi-dwarf genes is important. WP 22-2, a semi-dwarf and early maturing rice mutant was developed from Improved White Ponni (Medium duration) through gamma irradiation at Department of Plant Breeding and Genetics, Agricultural College and Research Institute, Killikulam and to characterize the semi-dwarfism and earliness in WP 22-2, it was crossed with

CR1009 (long duration) and the F_2 plants evaluated for their influence of plant architecture, yield and its related traits.

Materials and Methods

The present investigation was carried out at Agricultural College and Research Institute, Killikulam during 2018-19.The experimental material for the present genetic study consists of 108 F_2 plants derived from a cross CR 1009 × WP 22-2. Biometrical traits *viz.,* plant height (cm),days to fifty percent flowering (days), number of productive tillers, panicle length (cm),number of grains per panicle, hundred seed weight (g), grain length (mm), grain breadth (mm), length breadth ratio and single plant yield (g) were studied for genetic interpretation. The traits of the parents pertaining to the cross are given below.

Parents	Special features
CR1009 (Female parent)	Cross derivative of Pankaj × Jagannath, short bold and long duration type.
WP 22-2 (Male parent)	Gamma rays induced mutant derivative of Improved White Ponni and early duration type.

The parents along with the 108 F_2 plants were sown in raised bed nursery and transplanted to main field. The appropriate agronomic practices and crop protection measures were followed during the crop growth period. The various genetic variability parameters *viz.,* GCV, PCV, heritability and genetic advance as percentage of mean were calculated by adopting the formulae given by Johnson *et al.* (1955). Genotypic correlation co-efficient was calculated by using the formulae given by AL-Jibouri *et al.* (1958). The direct and indirect effects of different components on yield were estimated by path coefficient analysis as suggested by Dewey and Lu (1959). Correlation and path coefficient analyses were performed using TNAUSTAT software (Manivannan, 2014). The correlation chart was prepared using R software (R Core Team, 2019).

Results and Discussion

The values of GCV and PCV are essential to find out the role of environmental effect on different traits (Akinwale *et al.*2011). In the present study, the variability parameters were worked out for different traits and indicated in Table 1. High PCV and GCV were observed for number of productive tillers per plant (27.79 and 27.45 respectively) and number of grains per panicle (29.69 and 29.56 respectively). The high estimates of PCV and GCV for number of productive tillers per plant and number of grains per panicle indicated the presence of high degree of variability and the direct selection of these traits is a better option for crop improvement. Similar high GCV and PCV for number of productive tillers per plant were reported by Bharath *et al.* (2018).

The traits *viz.*, thousand seed weight, grain breadth, length breadth ratio and single plant yield recorded moderate level of PCV and GCV. The low level of PCV and GCV was observed for plant height, days to fifty per cent flowering and grain length suggesting less variability for the traits and selection based on these traits might be unfruitful. Similar results were reported by various authors *viz.,* Devi *et al.* 2017; Konate *et al.* 2016; Abebe *et al.* 2017 and Abilash *et al.* 2018.

Estimates of phenotypic and genotypic coefficients of variation alone are not sufficient enough to assess the heritable variation. High heritability and high genetic gain are considered together for drawing a reliable conclusion (Johnson *et al.* 1955). Heritability of a trait is an index of transmission of characters from the parents to its progeny and it is vital for the selection of breeding programme, where the estimates of heritability helps in selection of elite genotypes (Singh *et al*. 2018).

The traits *viz.,* number of productive tillers per plant, number of grains per panicle, thousand seed weight, grain breadth, length breadth ratio, and single plant yield showed high heritability and genetic advance favouring additive gene action. Bharath *et al.* (2018) reported similar findings for number of productive tillers per plant, number of grains per panicle and thousand seed weight. Hence, simple selection procedures like pedigree selection could be used for the improvement of these traits. High heritability and low genetic advance was recorded for days to fifty per cent flowering indicated the governance of non-additive gene action hence selection of this trait will be ineffective providing effective improvement of the trait by heterosis breeding and similar findings were reported by Abilash *et al.* (2018).

The mutual relationship between various plant characters can be measured and the component traits can be determined using correlation coefficient analysis based on which the selection can be done for genetic improvement of yield. In the present study, association analysis was carried out for different traits and indicated in Table 2. Correlation coefficient analysis was done by taking single plant yield as the dependent variable. The major traits of interest in this study *viz.,* plant height and days to fifty per cent flowering recorded significantly higher positive correlation between them. This suggested that reduction of plant height would reduce days to fifty per cent flowering and *vice-versa.* This combined with observed non-significant correlation between plant height and single plant yield and days to fifty per cent flowering with single plant yield suggested that improvement of these traits could be done with no or little influence on yield. Similar results were reported by Konate *et al*. (2016), Haradari and Hittalmani (2017), Rathod *et al*, (2017) and Abilash *et al.*(2018) on plant height and single plant yield; Konate *et al*,(2016) and Abilash *et al.*(2018) on days to fifty per cent flowering and single plant yield.

The traits number of productive tillers, panicle length, number of grains per panicle and thousand seed weight exhibited high and positively significant correlation with single plant yield. Improvement of these traits may ultimately increase the yield. Hajiaqatabar *et al.* (2016), Kahani and Hittalmani (2016), Haradari and Hittalmani (2017), Priya *et al.* (2017), Rathod *et al.* (2017) and Abilash *et al.* (2018) also reported such positive correlation with yield. The Chart of correlation matrix between different traits is represented diagrammatically in Fig 1. The chart implied that the distribution of yield and yield contributing traits are shown on the diagonal, and then on the bottom of the diagonal the bivariate scatter plots with a fitted line are displayed and on the top of the diagonal the value of the correlation plus the significant levels are mentioned.

Path coefficient analysis is a statistical method to partition the association into direct and indirect effects through other dependent variables (Wright, 1921). In the present study, path coefficient analysis was carried out for different traits and indicated in Table 3. Number of productive tillers (0.743) and thousand grain weight (0.396) showed high positive direct effect on single plant yield. While the correlation between plant height and single plant yield was non-significant, path analysis showed low negative direct effect (-0.120) on single plant yield. Similarly, negative indirect effects of plant height on single plant yield was observed through grain length (-0.022) and grain breadth (-0.001). Plant height had positive indirect effect on single plant yield through days to fifty per cent flowering (0.040), number of productive tillers (0.202), panicle length (0.003), number of grains per panicle (0.010), thousand seed weight (0.034) and length-breadth ratio (0.021).

Days to fifty percent flowering and panicle length displayed very low positive direct effect of 0.045 and 0.028 respectively on single plant yield. Days to fifty per cent flowering showed negative indirect effect on single plant yield through plant height (-0.110) and grain length (-0.022). Days to fifty per cent flowering showed positive indirect effect on single plant yield through number of productive tillers per plant (0.139), panicle length (0.001), number of grains per panicle (0.012), thousand seed weight (0.032), grain breadth (0.014) and length breadth ratio (0.005). The number of productive tillers displayed higher positive direct effect on single plant yield which implicated that direct selection of this trait would be rewarding for grain yield improvement.

The overall conclusion is that reduction of plant height and days to fifty per cent flowering is important to achieve lodging resistance and earliness. The correlation analysis and path co-efficient studies combined with variability parameter studies suggested a possibility of improvement in the plant architecture of CR1009 through crossing with WP 22-2 without reduction in yield. WP 22-2 could also be used as a potential donor parent for introducing earliness and semi-dwarfism in rice genotypes.

References

Abebe, T. Alamerew, S and Tulu, L. 2017. Genetic variability, heritability and genetic advance for yield and yield related traits in rain fed lowland rice (*Oryza sativa* L.) genotypes at fogera and Pawe, Ethiopia. *Advances in Crop Science and Technology,* **5(2):** 1-8.

Abilash, R. Thirumurugan, T. Sassikumar, D and Chitra, S. 2018. Genetic studies in F_2 for biometrical traits in Rice (*Oryza sativa* L.). *Electronic journal of Plant Breeding,* **9**(3) : 1067 – 1076.

Akinwale, M.G. Gregorio, G. Nwilene,F. Akinyele,B.O. Ogunbayo, S.A and Odiy, A.C. 2011. Heritability and correlation coefficient analysis for yield and its components in rice (*Oryza sativa L*). *African Journal of Plant Science,* **5:** 207-212.

AL-Jibouri, H.A. Miller, P.A and Robinson, H.F. 1958. Genotypic and environmental variances in upland cotton crosses of inter specific origin. *Agronomy Journal,* **50:** 633-636.

Bharath, M.S. Madhan Mohan, M. Vanniyarajan, C. Veravan, A.G.V. Senthil, N. 2018. Genetic variability studies in ADT 43/Seeraga samba cross derivatives of rice (*Oryza sativa* L.). *Electronic Journal of Plant Breeding,* **9(4):** 1450-1460.

Devi, K. R. Chandra, B. S. Lingaiah, N. Hari, Y and Venkanna, V. 2017. Analysis of variability, correlation and path coefficient studies for yield and quality traits in rice (*Oryza sativa* L.). *Agricultural Science Digest,* **37(1):** 1 – 9.

Dewey, D.R and Lu, K.H. 1959. A correlation and path coefficient analysis of components of crested wheat grass seed production**.** *Agronomy Journal,* **51**: 515-518.

FAO (Food and Agriculture Organization of the United Nations). 2017. Retrieved from http://www.fao.org/faostat

Hajiaqatabar, A. Kiani, G. Kazemitabar, S.K. Alavi, M. 2016. Correlation and Path Coefficient Analysis for Yield and Yield Components in F_2 Segregating Population of Rice. *Jordan Journal of Agriculturl Sciences,* **12(3).**

Haradari, C and Hittalmani, S. 2017. Trait association and construction of selection indices in rice (*Oryza sativa* L.) under aerobic condition. *International Journal of Agriculture Sciences,* **9(3)**:4416–4421.

Johnson, H.W. Robinson, H.F and Comstock, R.E. 1955. Estimate of genetic and environmental variability in Soybeans. *Agronomy journal,* **47**(7):314 – 318

Kahani, F and Hittalmani, S. 2016. Identification of F_2 and F_3 segregants of fifteen rice crosses suitable for cultivation under aerobic situation. *SABRAO Journal of Breeding and Genetics,* **48**(2) : 219–229.

Konate, A. K. Zongo, A. Kam, H. Sanni, A and Audebert, A. 2016. Genetic variability and correlation analysis of rice (*Oryza sativa* L.) inbred lines based on agro-morphological traits. *African Journal of Agricultural Research*. Academic Journals, **11(35):** 3340–3346.

Kozak, M and Kang, M.S. 2006. Note on modern path analysis in application to crop science. *Communications in Biometry and Crop Science,* **1**: 32-34
.

Manivannan, N. 2014. TNAUSTAT-Statistical package. Retrieved from https://sites.google.com/site/tnaustat.

Mooney, B. P. 2009. The second green revolution: Production of plant-based biodegradable plastics. *Biochemical Journal,* **418**: 219–232.

Palme, K. Li, X and Teale, W. D. 2014. Towards second green revolution: engineering nitrogen use efficiency. *Journal of Genetics and Genomics,* **41**: 315–316.

Priya, C. S. Suneetha, Y. Ratna Babu, D. Srinivasa Rao, V. 2017. Inter relationship and path analysis for yield and quality characters in rice (*Oryza sativa* L.). *International Journal of Science, Environment and Technology*, **6(1):** 381–390.

Rathod, Ramya, D. Sanjeeva, B. V and Bharathi, M. 2017.Correlation and Path Coefficient Analysis for Yield, Yield Attributing and Nutritional Traits in Rice (*Oryza sativa* L.), *International Journal of Current Microbiology and Applied Sciences*. **6(11):** 183-188.

R Core Team. 2019. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. https://www.R-project.org/.

Singh, A.K. Nandan, R. and Singh, P. K. 2018. Genetic variability and association analysis in rice germplasm under rainfed conditions. *Crop Research,* **47**(1): 2

Statista, 2019. Retrived from https://www.statista.com/statistics/255937/leading-rice-producers-worldwide/

Wright, S. 1921. Correlation and causation. *Journal of Agricultural Research,* **20**: 557-585

Table 1. Variability parameters in F_2 derivatives of CR 1009 × WP 22-2

Characters	PCV (%)	GCV (%)	(h^2) (%)	GAM (%)
Plant height	8.36	8.33	**99.37**	17.11
Days to 50% flowering	2.64	2.24	**71.94**	3.91
Number of productive tillers	**27.79**	**27.45**	**97.51**	**55.83**
Panicle length	11.37	9.62	**71.59**	16.77
Number of grains per panicle	**29.69**	**29.56**	**99.10**	**60.62**
Thousand seed weight	19.14	17.12	**79.95**	**31.53**
Grain length	7.48	7.47	**99.76**	15.38
Grain breadth	13.26	13.24	**99.79**	**27.25**
Length breadth ratio	17.48	17.45	**99.66**	**35.89**
Single Plant yield	16.7	16.23	**94.44**	**32.49**

Table 2. Correlation coefficients among yield components in F_2 derivatives of CR 1009 × WP 22-2

Characters	Plant height (cm)	Days to 50% flowering	Number of productive tillers	Panicle length (cm)	Number of grains per panicle	Thousand seed weight (g)	Grain length (cm)	Grain breadth (cm)	Length breadth ratio	Single Plant yield (g)
Plant height (cm)	1									
Days to 50% flowering	**0.915****	1								
Number of productive tillers	**0.272****	0.187	1							
Panicle length (cm)	0.107	0.048	**0.232***	1						
Number of grains/panicle	0.036	0.045	0.091	**0.688****	1					
Thousand seed weight (g)	0.085	0.081	0.167	0.168	0.097	1				
Grain length (cm)	0.138	0.129	0.049	-0.072	0.017	-0.020	1			
Grain breadth (cm)	-0.005	0.051	-0.120	0.090	-0.006	0.191*	**-0.221***	1		
Length breadth ratio	0.055	0.012	0.121	-0.099	0.019	-0.180	**0.579****	**-0.916****	1	
Single Plant yield (g)	0.166	0.117	**0.823****	**0.442****	**0.399****	**0.530****	0.023	-0.060	0.063	1

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

Table 3. Direct and indirect effects of different traits on yield in F_2 derivatives of CR 1009 × WP 22-2

Characters	Plant height (cm)	Days to 50% flowering	Number of productive tillers	Panicle length (cm)	Number of grains per panicle	Thousand seed weight (g)	Grain length (cm)	Grain breadth (cm)	Length breadth ratio	Single Plant yield (g)
Plant height (cm)	**-0.121**	0.041	0.202	0.003	0.010	0.034	-0.022	-0.001	0.021	0.166
Days to 50% flowering	-0.110	**0.045**	0.139	0.001	0.012	0.032	-0.021	0.014	0.005	0.117
Number of productive tillers	-0.033	0.008	**0.743**	0.007	0.025	0.066	-0.008	-0.032	0.046	0.823
Panicle length (cm)	-0.013	0.002	0.173	**0.028**	0.188	0.066	0.012	0.024	-0.038	0.442
Number of grains/panicle	-0.004	0.002	0.068	0.019	**0.273**	0.038	-0.003	-0.002	0.007	0.399
Thousand seed weight (g)	-0.010	0.004	0.124	0.005	0.027	**0.396**	0.003	0.051	-0.069	0.530
Grain length (cm)	-0.017	0.006	0.037	-0.002	0.005	-0.008	**-0.162**	-0.059	0.223	0.023
Grain breadth (cm)	0.001	0.002	-0.089	0.003	-0.002	0.076	0.036	**0.266**	-0.352	-0.060
Length breadth ratio	-0.007	0.001	0.090	-0.003	0.005	-0.071	-0.094	-0.243	**0.385**	0.063

**** Significant at 1% level; * Significant at 5% level**
Residual effect: 0.26

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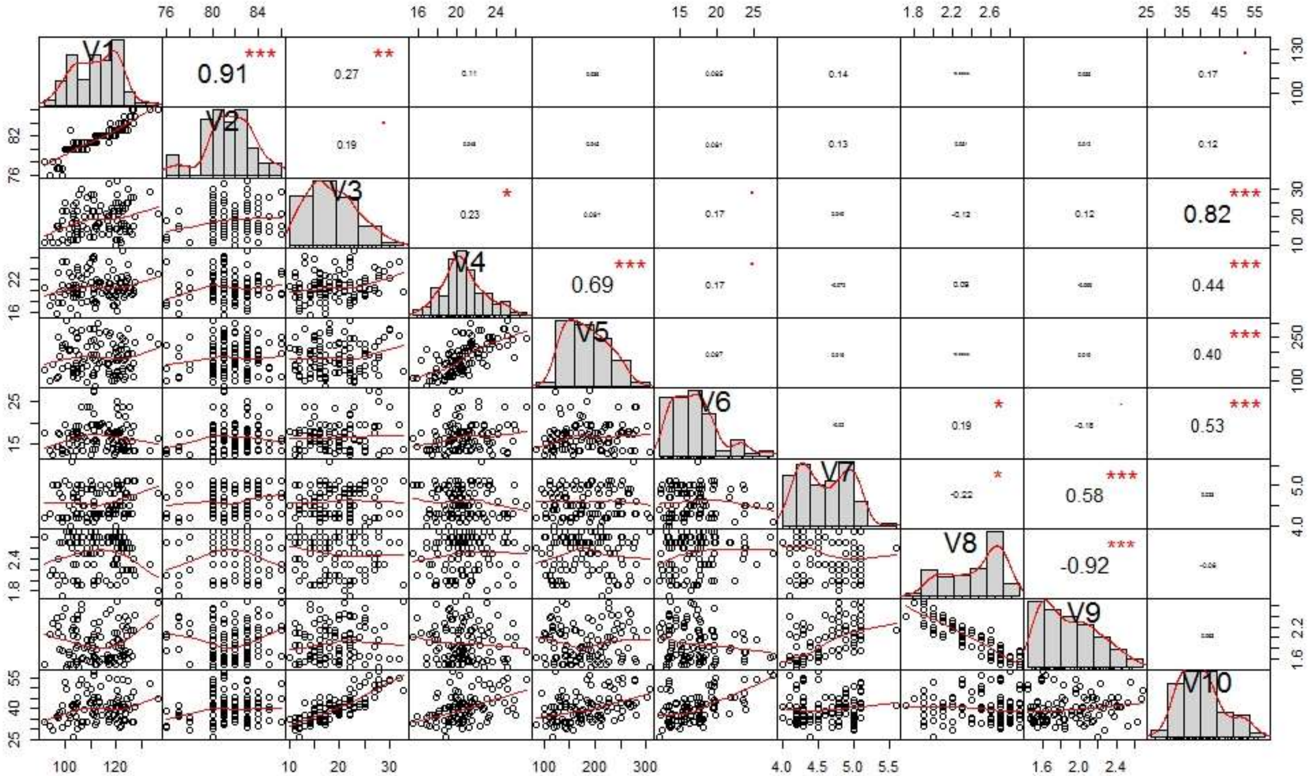

Fig 1. Chart of correlation matrix between different traits in F_2 derivatives of CR 1009 × WP 22-2

V1 - Plant height (cm), V2 - Days to fifty per cent flowering, V3 - Number of productive tillers per plant, V4 - Panicle length (cm), V5 - Number of grains per panicle, V6 - 1000 seed weight (g), V7 - Grain length (mm), V8 - grain breadth (mm), V9 - length breadth ratio, V10 - Single Plant Yield (g).
***Significant at 0.001 level, **Significant at 0.01 level, *Significant at 0.05 level

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