J. Indian Soc. Coastal agric. Res. 34(1): 40-45 (2016)

Correlation and Path Analysis in Inter varietal Crosses in Rice (*Oryza sativa* L.)

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Received: 16. 12. 2014 Accepted: 12.12.2015

An investigation was carried out in rice (*Oryza sativa* L.), at Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal during *kharif*, 2008 to genetically analyse the F_3 generations of five crosses viz., ADT 43 x Vellaichitraikar, ADT 43 x Arupathamkuruvai, ADT 43 x Varappukudaichan, ADT 43 x IPM Rascadam and ADT 43 x IR 66424. Mean, variability, heritability, genetic advance, correlation and path analysis were worked out for seven quantitative traits viz., plant height, panicles per plant, panicle weight, panicle length, grains per panicle, grain weight and grain yield. The F_3 generations of the five crosses were studied along with the check variety, ADT 43 the common female parent that is a popular ruling variety. Among the five crosses, ADT 43 x IPM Rascadam and ADT 43 x IR 66424 were found to be superior crosses to provide good source populations for exercising an effective selection for high yielding plants, as these crosses registered high mean and greater genetic variability for grain yield and three of its most important component traits viz., panicles per plant, panicle weight and grains per panicle. The possibility of isolating superior transgressive segregants in the populations of these two crosses was noted based on wider range along with high mean performance for grain yield and the above yield component traits.

(***Key words:*** *Correlation, F_3 generation, Inter varietal crosses, Path analysis, Rice, Segregating population*)

Rice (*Oryza sativa* L.) is the staple food for more than half of the population in the world, more particularly in Asian countries and therefore "Rice is life" for Asia. In India, current annual growth rate of rice production is 1.27% as against the population growth rate of 1.90% (Reddy *et al*., 2008). If this trend continues, severe food shortage is anticipated in near future. In the absence of feasibility for area expansion, the only option available is to increase the productivity level of rice. Plant breeding is a continuous process of evolving varieties. Thus, it is possible to develop varieties yielding more than the present ruling varieties. Recombination breeding involving hybridization and selection is a time tested effective breeding method widely adopted in self pollinated crops like rice. Recombination breeding involves the creation of variability by hybridisation among the genetically divergent parents.

MATERIALS AND METHODS

Bulk seeds of F_3 generations of five crosses in rice and genetically pure seeds of ADT 43 obtained from the Department of Plant Breeding and Genetics, Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal during *kharif* 2008 were utilised as the experimental material for the present study. In all the five crosses, ADT 43 is the common female parent and it is a popular ruling fine grain variety released from Tamil Nadu Rice Research Institute, Aduthurai. The five male parents involved in the crosses are land races. In the present study, the F_3 generations of five crosses were studied along with the common female parent ADT 43 which was used as the check variety. The details of parents of the crosses studied are given in Table 1. The crosses with parental combinations are listed below.

Table 1. *Details of crosses*

Cross No.	Parental combination
Cross 1	ADT 43 x Vellaichitraikar
Cross 2	ADT 43 x Arupathamkuruvai
Cross 3	ADT 43 x Varappukudainchan
Cross 4	ADT 43 x IPM Rascadam
Cross 5	ADT 43 x IR 66424

The F_3 generations of the five crosses and the check variety, ADT 43 were raised in Randomised Block Design (RBD) with three replications. The twenty five days old seedlings were planted with single seedling per hill by adopting a spacing of 30 cm between rows and 20 cm between plants in a row of 2 m length. The F_3 generation of each cross was planted in 20 rows and the check variety ADT 43 in 10 rows in each replication.

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Thus, a total of 600 F_3 plants per cross and 300 plants in check in the three replications were maintained. Recommended agronomical and plant protection measures were taken up to maintain a healthy crop.

Characters studied

Out of 200 plants per cross and 100 plants per check variety maintained in each replication, 50 plants were tagged randomly before flowering. Thus, a total of 150 plants were randomly selected in three replications for each of the five crosses as well as for the check variety. Observations on plant height (cm), panicles per plant, panicle length (cm), panicle weight (g), grains per panicle, 100 grain weight (g), grain yield per plant (g) were recorded on these 150 individual single plants for each cross and check variety.

RESULTS AND DISCUSSION

In F_3 generations of five rice crosses involving popular ruling variety, ADT 43 as common female parent and five different land races *viz*., Vellaichitraikar, Arupathamkuruvai, Varappukudaichan, IPM Rascadam and IR 66424 as male parents, observations were recorded for plant height, panicles per plants, panicle weight, panicle length, grains per panicle, grain weight and grain yield. The data were analysed statistically and the results are presented below.

Association analysis

In the F_3 generations of all the five crosses, phenotypic correlation coefficients between yield contributing traits and grain yield were worked out along with the intercorrelation coefficients between yield component traits. The results are presented cross wise.

Cross 4 (ADT 43 x IPM Rascadam)

Correlation of component traits with grain yield

Panicles per plant (0.6721), panicle weight (0.7326), grains per panicle (0.3983) and panicle length (0.2459) showed significant positive correlations with grain yield. Plant height (0.0649) and grain weight (0.0084) recorded only meager positive correlation with grain yield (Table 2 and Fig.1)

Intercorrelation among component traits

Plant height had negative significant association with panicle length (-0.2585) and grains per panicle (-0.2389). Panicles per plant registered significant positive association with panicle weight (0.8321), panicle length (0.2681) and grains per panicle (0.4579). Significant positive correlation was established by panicle weight with panicle per plant (0.8321), panicle length (0.2496) and grains per panicle (0.3926). Panicle length had positive significant correlation with panicle weight (0.2496) and grains per panicle (0.2602) but negative significant correlation with plant height (-0.2585) and grain weight (-0.2967) (Table 2 and Fig.1). Grains per panicle recorded significant positive

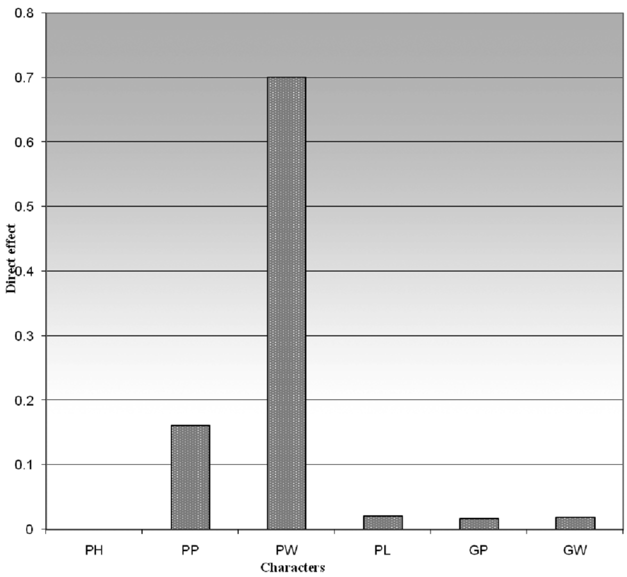

Fig. 1. *Direct effect of component traits on grain yield in F_3 generation of cross 4 (ADT 43 x IPM Racadam)*

Table 2. *Phenotypic correlations among different traits in F_3 generation of cross 4 (ADT 43 x IPM Rascadam)*

Characters	Plant height	Panicles per plant	Panicle weight	Panicle length	Grains per panicle	Grain weight	Grain yield
Plant height	1.0000	-0.0471	0.1508	-0.2585*	-0.2389*	0.1741	0.0649
Panicles per plant		1.0000	0.8321**	0.2681*	0.4579**	0.0086	0.6721**
Panicle weight			1.0000	0.2496*	0.3926**	-0.0264	0.7326**
Panicle length				1.0000	0.2602*	0.2967**	0.2459*
Grains per panicle					1.0000	-0.1914	0.3983**
Grain weight						1.0000	0.0084
Grain yield							1.0000

**Significant at 1 per cent level * Significant at 5 per cent level correlation with panicles per plant (0.4579), panicle weight (0.3926) and panicle length (0.2602) and significant negative correlation with plant height (-0.2389). Positive significant correlation was not exhibited by grain weight with any other component traits but negative significant correlation with panicle length (-0.2967).

Cross 5 (ADT 43 x IR 66424)

Grain yield recorded significant positive association with panicles per plant (0.6462), panicle weight (0.8118) and grains per panicle (0.3876). Plant height registered significant negative correlation with grain yield (-0.2858), while panicle length and grain weight had insignificant negative correlations with grain yield (Table 3 and Fig. 2). Plant height had no significant correlation with any other component traits. Significant positive correlation was recorded by panicles per plant only with panicle weight (0.6383) and with the other traits it had no significant association. The associations of panicle weight with panicles per plant (0.6383) and grains per panicle (0.4020) were significant positive. Panicle length showed positive significant association with grains per panicle (0.2603) and grain weight (0.2481) (Table 3 and Fig. 2). Intercorrelation of grains per panicle were positive significant with panicle weight (0.4020) and panicle length (0.2603). Grain weight registered only one significant association and it was positive with panicle length (0.2481).

Path coefficient analysis

The direct and indirect effects of the component traits on grain yield were worked out and are presented below cross wise. High positive indirect effects by panicles per plant (0.3229) and grains per panicle (0.3047) and low magnitude of positive indirect effect by grain weight (0.1105) were recorded through panicle weight. Panicle length exerted low negative indirect effect (-0.1527) with grain yield through panicle weight. All the other indirect effects noticed in the cross were of meager amount.

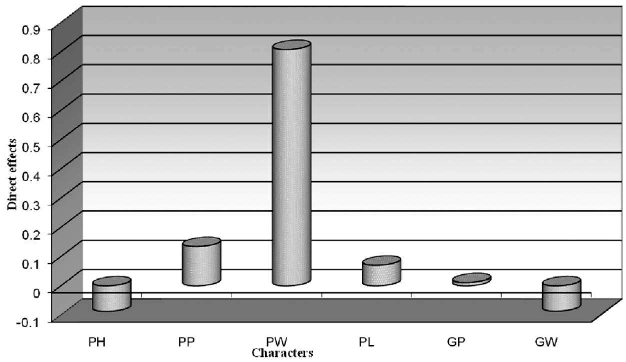

Fig. 2. *Direct effect of component traits on grain yield in F_3 generation of cross 5 (ADT 43 x IR 66424)*

Cross 4 (ADT 43 x IPM Rascadam)

The high positive direct effect with grain yield was recorded only by panicle weight (0.7003), while panicles per plant recorded low positive direct effect (0.1615) with grain yield. The remaining four component traits *viz*., plant height, panicle length, grains per panicle and grain weight exhibited only negligible positive direct effects with grain yield. High positive indirect effects by panicles per plant (0.5346) and grains per panicle (0.3031) were recorded with grain yield through panicle weight. Through panicle weight, plant height (0.1164) and panicle length (0.1927) also recorded low positive indirect effects with grain yield. All the other indirect effects noticed in the cross were of meager amount. The high positive direct effect with grain yield was recorded only by panicle weight (0.8078). Panicles per plant also registered low magnitude of positive direct effect (0.1342) with grain yield. The remaining four traits exerted only negligible direct effects with grain yield. Among those traits, plant height, grains per panicle and grain weight recorded negative effect, while grains per panicle positive effect (Table 2 and Fig.1). Except grain weight, all the other five component traits registered considerable indirect effects with grain yield through panicle weight. High positive indirect effects were

Table 3. *Direct and indirect effects of yield components on grain yield in F_3 generation of cross 5 (ADT 43 x IR 66424)*

Characters	Plant height	Panicles per plant	Panicle weight	Panicle length	Grains per panicle	Grain weight	Grain yield
Plant height	-0.0873	-0.0187	-0.2002	0.0067	0.0038	0.0099	0.2858**
Panicles per plant	0.0192	0.1342	0.4851	-0.0137	0.0143	0.0070	0.6462**
Panicle weight	0.0044	0.0037	0.8078	-0.0147	0.0074	0.0034	0.8118**
Panicle length	-0.0082	-0.0167	-0.1116	0.0704	0.0287	-0.0265	-0.0639
Grains per panicle	0.0032	0.0030	0.3849	-0.0188	0.0111	0.0042	0.3876**
Grain weight	0.0086	-0.0055	-0.0913	0.0175	0.0162	-0.0864	-0.1409

** Significant at 1 per cent level r_p: Phenotypic correlation coefficient Residual Effects: 0.1784 recorded by panicles per plant (0.4851) and grains per panicle (0.3849) through this trait, while plant height (-0.2002) and panicle length (-0.1116) showed moderate and low negative indirect effects through panicle weight, respectively. All the other indirect effects noticed in the cross were of meager amount.

Association of Characters

The ultimate aim of plant breeding is to achieve a higher level of yield, which is a complex trait determined by the interaction of many component traits. Therefore, direct selection for yield is not advisable in a large population and indirect selection for yield by exercising selection for yield contributing component traits is the practical preposition that can be followed in a segregating population. These yield determining traits could be identified by correlation study and path analysis.

Correlation study

The knowledge on the strength and direction of correlation of different component traits with yield and intercorrelation among themselves would enable the breeder in formulating effective selection parameters for improvement of yield (Breese and Haywards, 1972). Therefore, the F_3 generations of the five crosses were investigated for correlations among the seven traits studied to identify characters or combination of characters, which may be useful as indicators of high yield. Three component traits studied *viz*., panicles per plant, panicle weight and grains per panicle registered significant positive correlations with grain yield in all the five crosses. Among these three traits, panicle weight established the highest positive association with grain yield in all the five crosses, indicating its very high influence on grain yield. Therefore, in a selection programme for yield improvement in the F_3 populations of all the five crosses under study, panicle weight needs greater emphasis. Establishment of high positive correlation of panicle weight with grain yield was reported by many earlier workers (Janardhanam *et al.,* 2001; Surek and Beser, 2003; Raju *et al.,* 2004; Panwar, 2006) in their studies with segregating populations in rice. Next to panicle weight, panicles per plant and grains per panicle in all the crosses exhibited the second and third highest positive correlation with grain yield. In the earlier studies, Zahid *et al*. (2006), Kishore *et al*. (2007), Anbumalarmathi and Nadarajan (2006) and Reddy *et al*. (2008) also recorded strong positive correlation of panicles per plant and grains per panicle with grain yield in the segregating populations of rice. These results reveal that while selecting plants for higher yield in the populations of the five crosses under study, next to panicle weight, panicles per plant and grains per panicle should be given importance. Only in the two crosses *viz*., cross 3 and 4, panicle length recorded significant positive association with grain yield. In the other three crosses, this component trait had no relationship with grain yield. Similarly, plant height exerted strong negative correlation in the crosses 3 and 5 and had no association with grain yield in the other three crosses. In the previous studies, Karad and Pol (2008) and Kishor *et al*. (2008) observed strong positive correlation of panicle length with grain yield. Venkataramana and Hittalamani (2003) reported significant negative association of plant height with grain yield. Thus, in a selection program for yield improvement in the population of cross 3, plants with long panicles and shorter stature may be selected, besides giving consideration for panicle weight, panicles per plant and grains per panicle. Whereas, panicle length in cross 4 and shorter plants in cross 5 may be given due weightage in such a selection scheme. Efficiency of selection for a character depends upon the magnitude of variability available for that character in the population under investigation. In the present study, only three component traits, *viz.,* panicle weight, panicles per plant and grains per panicles had greater genetic variability in the F_3 generations of all the five crosses as well as their strength of positive associations were strong with grain yield in these crosses. Whereas, though panicle length had strong positive association with grain yield in crosses 3 and 4, the extent of variability realized for this trait was low to moderate. A similar trend was noticed for plant height, which had strong negative correlation in crosses 3 and 5, but had only limited variability in these crosses. These results indicate that yield improvement in F_3 populations of all the five crosses could be achieved only by exercising selection for panicle weight, panicles per plant and grains per panicle. Perusal of intercorrelation among component traits indicated that the above three traits also established strong positive interrelationships among themselves in cross 4, while in the other crosses high magnitude of positive intercorrelation was found between panicle weight and panicles per plant. Such a high positive intercorrelation among panicle weight, panicles per plant and grains per panicle was also noted earlier by Janardhanam *et al.* (2001) and Venkataramana and Hittalamani (2003). The above findings strongly suggest that in F_3 populations of five crosses under study, the grain yield was primarily decided by panicle weight, panicles per plant and grains per panicle. Selection for any one of these trait would lead to simultaneous improvement of both the traits along with the improvement in grain yield.

Path Analysis

The interdependence of the component traits often affects their direct relationship with yield thereby making the correlation coefficients as unreliable selection indices. Path analysis permits the partitioning of a correlation coefficient of a character with yield into direct effect and indirect effects through the other traits (Dewey and Lu, 1959). This would help to pinpoint with certainly the component traits to be relied upon as selection criteria to improve yield. Such an attempt was made in the present investigation to formulate suitable selection criteria for yield improvement in the populations of five crosses under study. The results of path analysis revealed that in the populations of all the five crosses, only panicle weight exhibited high magnitude of positive direct effect on grain yield, besides showing the highest amount of positive correlation with grain yield in these crosses. All the remaining component traits had only negligible to low direct influence on grain yield in all the crosses. Similar high positive direct effect of panicle weight on grain yield was also recorded by Swain and Reddy (2006) in segregating populations. The strong positive association established by panicle weight with grain yield in all the crosses was mostly contributed by its direct influence and its indirect effects through the other traits were only negligible. This shows that grain yield in the populations of the crosses under study is mostly directly determined by panicle weight. The significant positive correlations recorded with grain yield by the other component traits, panicles per plant and grains per panicle in all the five crosses and panicle length in crosses 3 and 4 were mainly because of their moderate to high positive indirect effects with grain yield registered through the panicle weight. This evidently suggests that selection for panicle weight would produce simultaneous improvement of the other component traits in addition to directly improving the yield in the populations of all the five crosses. From the foregoing discussion on correlation and path analysis, it could be concluded that while exercising selection for superior plants with high yield potential in the populations of the five crosses under study, panicle weight could be used as the selection criterion. From correlation study, panicle weight, panicles per plant and grains per panicle were identified as yield contributing traits. Based on path analysis, panicle weight was identified as the most important selection index for yield improvement in the populations of crosses under study. It is further suggested that the five land races used as male parents in the crosses under study are known for their drought tolerance (Yogameenakshi *et al.*, 2003; Anandkumar and Vinothini, 2006, Anbumalarmathi and Nadarajan, 2006). Since the present study involved the F_3 generations of the crosses, creation of drought condition in such a large population under field condition is not possible and recording of drought related traits in large number of plants is not practically feasible. Hence, the present study was restricted with the analysis of yield and its component traits in the F_3 populations in comparison with the check variety, ADT 43. Limited number of lines developed through selection for yield in the subsequent generations may be tested in the later stage for the drought related traits to evolve breeding lines superior over ADT 43 for both yield potential and drought tolerance. Such lines would be more stable than ADT 43.

CONCLUSION

High mean performance was observed in F_3 populations of crosses 4 and 5 for grain yield, panicles per plant, panicle weight and grains per panicle indicating the superiority of these two crosses for exercising selection for improving these traits. High mean values in desirable direction observed for plant height and panicle length in crosses 4 and 5 suggested the suitability of their populations for selecting semi dwarf plants with fine grain types. Populations of crosses 1 and 2 showed lower mean values for grain yield, panicles per plant, panicle weight and grains per panicle, revealing unsuitability of these populations for an effective selection for yield improvement. Comparison of range along with mean performance of crosses and check revealed the possibility of selecting transgressive segregants superior over the check variety in the populations of crosses 4 and 5. Higher amount of genetic variability was observed for grain yield and its three important component traits, panicles per plant, panicle weight and grains per panicle in F_3 populations of all the five crosses, implying that the populations of these five crosses could serve as potential source material for selection for grain yield and the three component traits.

REFERENCES

Anandkumar, C. R. and Vinothini, S. (2006). Variability in drought tolerant rice. *The Andhra Agriculture Journal* **53**: 114-115.

Anbumalarmathi. J. and Nadarajan, N. (2006). Evaluation of genetic potential of land races and improved varieties for drought tolerance in rice (*Oryza sativa* L.). *The Indian Journal of Genetics and Plant breeding* **66** (3): 196-199.

Breese, E. L. and Haywards, M. O. (1972). The genetic basis of present breeding methods in forage crops. *Euphytica* **21**: 324-336.

Dewey, J. R and Ku, K. H. (1959). Correlation and path coefficient analysis of components of crested wheat grass seed production. *Agronomy Journal* **51**: 515-518.

Janardhanam, V., Nadarajan, N and Jebaraj, S. (2001). Correlation and path analysis in rice (*Oryza sativa* L). *Madras Agricultural Journal* **88**: 719-720.

Karad, S. R. and Pol, K. M. (2008). Character association, genetic variability and path coefficient analysis in rice (*Oryza sativa* L.). *International Journal of Agricultural Sciences* **4** (2): 663-666.

Kishore, N. S., Srinivas, Nagabhushanam, T. U., Pallavi, M. and Sameera, S. K. (2007). Genetic variability, correlation and path analysis for yield and yield components in promising rice (*oryza sativa* l.) genotypes, *SAARC Journal of Agriculture* **13**(1): 99-108.

Kishor, C, Prasad Y, Haider, ZA, Kumar, R., Kumar, K. (2008). Quantitative analysis of upland rice. *Oryza* **45**(4): 268-274.

Panwar, L. L. (2006). Character association and path analysis in rice (*Oryza sativa* L.). *Annals Agricultural Reserch New series* **27**(3): 257-260.

Raju, C. S., Rao, M. V. B. and Sudarshanam, A. (2004). Genetic analysis and character association in F_2 generation of rice. *Madras Agricuture Journal* **91**(1-3): 66-69.

Reddy, R., Yadav, M. S. C., B., Reddy, S., Lavanya, G. R. and Suresh, G. (2008). Character association and component analysis in rice. *Oryza* **45**(3): 239-241.

Surek, H. and Beser, N. (2003). Correlation and path analysis for some yield related traits in rice (*Oryza sativa* L.) under terrace conditions. *Turkish Journal of Agriculture* **27**: 77-83.

Swain, B. and Reddy, J. N. (2006). Correlation and path analysis of yield and its components in rainfed lowland rice genotypes under normal and delayed planting conditions. *Oryza*, **43**(1): 58- 61.

Venkataramana, R. and Hittalmani, S. (2003). Path analysis in F_2 segregating populations of rice (*Oryza sativa* L.). *Crop Res*earch **20**: 206-208.

Yogameenakshi, P., Nadarajan, N. and Sheeba, A. (2003). Evaluation of varieties and land races for drought tolerance in rice (*Oryza sativa* L.). *Indian Journal of Genetics* **63**: 299-303.

Zahid, M. A., Akther, M., Sabar, M. and Awan, Z. M. T. (2006). Correlation and path analysis Studies of quality and economic traits in Basmati rice (*Oryza sativa* L.). *Journal of Plant Science* **5**: 643-645.