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Genotypic Correlation and Path Coefficient for Some Agronomic Traits of Hybrid and Inbred Rice (*Oryza sativa* L.) Cultivars

Jakkrit Seesang, Prapa Sripicchitt, Pornpen Somchit and Tanee Sreewongchai
Department of Agronomy, Faculty of Agriculture, Kasetsart University, Bangkok, 10900, Thailand

Corresponding Author: Tanee Sreewongchai, Department of Agronomy, Faculty of Agriculture, Kasetsart University, Bangkok, Thailand

ABSTRACT

Association of agronomic traits contributed towards grain yield will be an added advantage in aiding the selection process. The objective of this study was to compare genetic variability and relationships among traits between hybrids and inbreds genotypes. Crossing between 2 A-lines and 6 R-lines were done for the experiment. The experiment was performed in Augmented in RCBD with three replications. Broad sense heritability and genetic advance of hybrids were higher than inbreds in number of tillers, number of filled seeds per panicle, plant height and grain yield. Genotypic correlation indicated that grain yield of hybrids had high positive correlation with number of productive tillers, number of filled seeds per panicle, flag leaf length, plant height and harvest index. Inbred had high positive correlation in number of tillers, number of productive tillers and 1000-seed weight. Path coefficient revealed that number of productive tillers, number of seeds per panicle, plant height and harvest index had positive direct effect on grain yield of hybrids. However, number of tillers, number of seeds per panicle, 1000 grain weight and flag leaf length had positive direct effect on grain yield for inbreds genotypes. Hence, number of productive tillers, number of seeds panicle^{-1} and harvest index could be used for selection criteria of hybrid genotype.

Key words: Genotypic correlation, rice, path coefficient, broad sense heritability, genetic advance

INTRODUCTION

Hybrid is a common phenomenon in nature, representing higher vigor in F_1 plants than in their parental lines. It has greatly contributed to agriculture production by increasing yield and broadening adoptability of hybrid varieties (Shull, 1908; Virmani, 1994). The main strategies for breeding hybrid rice combinations with wide adaptability and high yielding potential are to combine the ideal plant type with physiological vigor and to harmonize all the growth traits. Hybrid rice is an F_1 progeny with superiority of yield over both the better parent and the best high yielding inbred varieties (Virmani and Kumar, 2004). Grain yield is a complex character determined by several characters having positive and negative effect on this trait. It is necessary to identify those traits with greatest effect on grain yield in order to practice indirect selection. Heritability and genetic advance of the trait for hybrid rice is important for determining its response to selection in hybrid rice breeding program.

Correlation is a useful tool that provided an indication of the degree of association between two variables indicated by correlation coefficients as the statistics (Dewey and Lu, 1959; El-Badawy and Mehasen, 2012) and path coefficient analysis can be used to partition the relationship between components into direct and indirect effects. In addition, correlation and path analyses could be used in order to understand the complex relationships among traits. Akinwale *et al.* (2011) reported that number of tillers per plant, panicle weight and number of seeds per panicle and number of productive tillers per m^2, biological yield, harvest index and number of filled seeds per panicle was positive correlation to grain yield. In hybrid rice, the correlations on grain yield and it component was reported by Raju *et al.* (2003), the positive correlation to grain yield with number of productive tillers $plant^{-1}$, 100 grain weight, panicle length, Crop Growth Rate (CGR), leaf area index and harvest index. Babu *et al.* (2012) reported number of productive tillers $plant^{-1}$ could be use for selection criteria in high yielding of hybrid rice variety. The previous publication was reported that plant height, productivity day^{-1}, filled grains $panicle^{-1}$, day to 50% flowering and panicle height had a positive association with hybrids rice yield (Bhadru *et al.*, 2011). In japonica×indica, tropical japonica×japonica, indica×indica and indica×japonica type hybrids, revealed that number of productive tillers, number of filled grains $panicle^{-1}$ and 100-grain weight were the important traits to bring to the improvement in yield potential of rice (Gunasekaran *et al.*, 2010). Therefore, the information on association of grain yield and yield components in hybrid rice is a great importance to define selection criteria for hybrid rice breeding program (El-Badawy, 2013; Mahdy *et al.*, 2011).

In this study, an attempt was made study broad sense heritability, genetic advance, direct and indirect effect of some important yield component trait on grain yield by adopting correlation and path coefficient analysis. Inbred genotypes (male parent and check varieties) and hybrids developed by the crossing were used in the study. The result might be used to adopt selecting criteria in hybrid rice breeding program and may increase the selection efficiency.

MATERIALS AND METHODS

Twelve rice hybrids, six male parent line and five check varieties were laid out in Augmented design in RCBD with three replications in the department of Agronomy, Faculty of Agriculture, Kasetsart University, during 2009/2010 cropping season. Seed sown in the nursery were transplanted after twenty days. Spacing of 25×25 cm included sixteen plants per plot. The data were sampling four plant per plot and recorded on grain yield, number of tillers, number of productive tillers, number of seeds per panicle, number of filled seeds per panicle, 1000-seed weight, flag leaf length, plant height, panicle length and harvest index.

Statistical analysis: Correlation coefficient and analysis of variance were done by using GENRES version 8.0 and test significant by t-test. Broad-sense heritability was calculated as the ratio of the genetic variance to the phenotypic variance using the formula according to Allard (1960) and genetic advance was calculated at twenty percent of selection intensity ($i = 1.4$).

RESULTS AND DISCUSSION

The analysis of variance revealed significant differences among genotypes for all the traits examined in hybrids. Similarly in inbred genotypes, significant differences were observed for all trails except panicle length (data not showed), Therefore, panicle length was not used in inbred genotypes for correlation analysis. Estimate of broad-sense heritability is the relative magnitude of genotypic and phenotypic variances and it is used as a predictive role in selection procedures (Allard, 1960). The heritability of the yield and its component was estimated in hybrid and inbred genotypes (Table 1). Which, heritability of hybrid were high to moderate heritance almost traits. It ranged between 0.53 to 0.84 for flag leaf length and number of filled seeds per panicle. Inbred

Table 1: Comparison of broad sense heritability and genetic advance of hybrid and inbred genotypes in yield and its components (20% selection intensity, i = 1.4)

	Broad-sense heritability		Genetic advance	
Traits	Hybrids	Inbred	Hybrids	Inbred
No. of tillers	0.82	0.64	12.92	3.02
No. of productive tillers	0.57	0.62	4.94	2.87
No. of seeds per panicle	0.75	0.84	60.19	70.57
No. of filled seeds per panicle	0.84	0.70	82.59	45.68
1000 seed weight	0.71	0.76	2.88	3.90
Flag leaf length	0.53	0.60	10.65	9.52
Plant height	0.72	0.47	32.35	12.84
Panicle length	0.70	NA	6.73	NA
Harvest index	0.80	NA	0.22	NA
Grain yield	0.59	0.43	13.49	7.26

NA: Non-available data

varieties had highest heritability in the number of seeds per panicle and the lowest in grain yield, has 0.84 and 0.43, respectively. As compared to inbred genotypes, hybrid had higher heritability for number of tillers, number of filled seeds per panicle, plant height, panicle length, harvest index and grain yield. However, heritability values for number of productive tillers, number of seeds per panicle, 1000-seed weight and flag leaf length were lower. This indicates the difference in the expression of genetic effect in hybrid and inbred genotypes. High to moderate heritability of hybrid genotypes reported for different quantitative traits studied in rice. Mulugeta *et al.* (2012) revealed that day to 50% flowering, day to 85% maturity, plant height, panicle length, spikelet per panicle and 1000-seed weight exhibited high heritability in inbred genotypes. Moreover, hybrid genotypes showed high heritability for day to 50% flowering, plant height, panicle length, effective tillers per plants, total number of filled spikelet per panicle, spikelet per panicle, spikelet fertility percentage, 100-seed weight and harvest index (Bisne *et al.*, 2009). However, high heritability do not always indicates high genetic advance, heritability with genetic advance considered together should be used in predicting ultimate effect for selecting superior varieties (Ali *et al.*, 2002). Hybrid genotypes showed high heritability and genetic advance for the number of seeds per panicle, number of filled seeds per panicle and plant height indicated that selection for these traits can be achieved through their phenotypic performance. Whereas, inbred genotypes had high heritability and genetic advance for number of seeds per panicle and number of filled seeds per panicle. The previous study reported high to moderate heritability and genetic advance for number of seeds per panicle, grain yield, panicle weight and number of panicles per plant (Akinwale *et al.*, 2011).

The relationship at genotypic level or genotypic correlation, involves the genetic effect of the traits (Sughroue and Hallauer, 1997). In hybrid rice, genotypic correlation of grain yield with number of filled seeds per panicle, flag leaf length and harvest index was significant, however it had positives correlation in most traits except number of tillers (Table 2). For inbred genotypes had highly significant positive correlation for number of tillers, number of productive tillers and 1000-seed weight, however, plant height had positive correlation with grain yield per plant, indicated that differences important traits for hybrid and inbred genotypes. Genotypic correlation among the traits for hybrid genotypes had significant genotypic correlation between number of tillers with number of productive tillers (0.784**), number of seeds per panicle with number filled

Table 2: Comparison of genotypic correlation among yield and its components between hybrids and inbred genotypes. (The residual effect of hybrid genotypes = 0.135, R^2 = 0.977 and inbred genotypes = 0.122, R^2 = 0.971)

Traits	Genotypes	No. of tillers	No. of effective tillers	No. of seeds per panicle	No. of filled seeds per panicle	1000 seed weight	Flag leaf length	Plant height	Panicle length	Harvest index	Grain yield
No. of tillers	Hybrid	1	0.784**	-0.523^{ns}	-0.52^{ns}	0.506^{ns}	0.206^{ns}	0.346^{ns}	0.281^{ns}	-0.294^{ns}	-0.042^{ns}
	Inbred	1	1.000**	-0.366^{ns}	-0.301^{ns}	0.616**	-0.621**	-0.168^{ns}	NA	0.436^{ns}	0.858**
No. of productive tillers	Hybrid		1	-0.39^{ns}	-0.24^{ns}	0.43^{ns}	0.325^{ns}	0.134^{ns}	0.328^{ns}	0.190^{ns}	0.484^{ns}
	Inbred		1	-0.322^{ns}	-0.26^{ns}	0.683**	-0.608**	-0.119^{ns}	NA	0.392^{ns}	0.881**
No. of seeds per panicle	Hybrid			1	0.762**	-0.299^{ns}	0.274^{ns}	0.134^{ns}	0.093^{ns}	0.383^{ns}	0.315^{ns}
	Inbred			1	0.996**	-0.442^{ns}	0.880**	0.474*	NA	-0.064^{ns}	-0.387^{ns}
No. of filled	Hybrid				1	0.183^{ns}	0.136^{ns}	0.017^{ns}	-0.142^{ns}	0.513^{ns}	0.675**
seeds per panicle	Inbred				1	-0.477^{ns}	0.761**	0.381^{ns}	NA	0.044^{ns}	-0.373^{ns}
1000-seed weight	Hybrid					1	0.124^{ns}	0.119^{ns}	-0.016^{ns}	0.22^{ns}	0.42^{ns}
	Inbred					1	-0.241^{ns}	0.376^{ns}	NA	-0.252^{ns}	0.934**
Flag leaf length	Hybrid						1	0.967**	0.936**	0.591*	0.537**
	Inbred						1	0.915**	NA	-0.986**	-0.298^{ns}
Plant height	Hybrid							1	0.926**	0.452^{ns}	0.487^{ns}
	Inbred							1	NA	-0.686^{ns}	0.291^{ns}
Panicle length	Hybrid								1	0.565*	0.449^{ns}
	Inbred								1	NA	NA
Harvest index	Hybrid									1	0.863**
	Inbred									1	-0.125^{ns}

*: Significant at $p<0.05$; **: Significant at $p<0.01$; ns: Non significant; NA: non-available data

seeds per panicle (0.762**), plant height with panicle length (0.926**) and panicle length with harvest index (0.565*). Beside, flag leaf length showed significant correlation with plant height (90.967**), panicle length (0.936**) and harvest index (0.591*). Inbred genotypes had significant genotypic correlation between number of tillers with number of productive tillers, 1000-seed weight and flag leaf length with value 1**, 0.616** and -0.621**, respectively. Number of productive tillers also showed significant correlation with 1000-seed weight and flag leaf length with coefficient of 0.683** and -0.608**, respectively. Similarly, the correlation coefficient of number of seeds per panicle with number of filled seeds per panicle, flag leaf length and plant height were 0.996**, 0.88** and 0.474*, respectively. That of number of filled seed per panicle with flag leaf length was 0.761**. Flag leaf length had significant correlation with plant height and harvest index (0.915** and -0.986**, respectively). It indicates that these traits could be exploited by breeders in the selection of superior genotypes on the basis of phenotypic performance.

Genotypic correlation coefficients were partitioned by using method of path analysis to find out the direct and indirect effects of yield contributing traits toward the grain yield. The path analysis of hybrid genotypes (Table 3) revealed that number of seeds per panicle, number of productive tillers, plant height and harvest index had high positive direct effect on grain yield per plant (1.011, 3.995 and 2.369, respectively). The direct effect of number of tillers per plants, number of filled seeds per panicle, 1000-seed weight, flag leaf length and panicle length were negative. In inbred genotypes, traits which had high positive direct effect to grain yield were number of tillers, number of seeds per panicle (0.899 and 3.417, respectively) and trait with low positive and negative direct effect were number of productive tillers, number of filled seeds per panicle, 1000 seed weight, flag leaf length, plant height and harvest index. Number of tillers showed the

Table 3: Comparison of path coefficients (diagonal), direct effects (upper diagonal) and indirect effect (lower diagonal) of yield components on grain yield between hybrid and inbred genotypes

Traits		No. of tillers	No. of effective tillers	No. of seeds per panicle	No. of filled seeds per panicle	1000-seed weight	Flag leaf length	Plant height	Panicle length	Harvest index
No. of tillers	Hybrid	-0.159	0.451	-0.529	0.905	-0.023	-0.231	1.368	-1.139	-0.696
	Inbred	0.899	0.900	-0.329	-0.271	0.554	-0.558	-0.151	NA	0.392
No. of effective tillers	Hybrid	-0.125	0.575	-0.394	0.418	-0.020	-0.364	0.530	-1.330	0.450
	Inbred	0.899	0.032	-0.010	-0.008	0.022	-0.020	-0.004	NA	0.013
No. of seeds per panicle	Hybrid	0.083	-0.224	1.011	-1.326	0.014	-0.307	0.530	-0.377	0.907
	Inbred	-0.012	-0.010	3.417	3.403	-1.510	3.007	1.620	NA	-0.219
No. of filled seeds per panicle	Hybrid	0.083	-0.138	0.770	-1.740	-0.008	-0.152	0.067	0.576	1.215
	Inbred	-1.029	-0.888	3.403	-3.476	1.658	-2.645	-1.324	NA	-0.153
1000-seed weight	Hybrid	-0.080	0.247	-0.302	-0.318	-0.046	-0.139	0.471	0.065	0.521
	Inbred	-2.141	-2.374	1.536	1.658	0.395	-0.095	0.149	NA	-0.100
Flag leaf length	Hybrid	-0.033	0.187	0.277	-0.237	-0.006	-1.120	3.824	-3.795	1.400
	Inbred	-0.245	-0.240	0.348	0.301	-0.095	0.320	0.293	NA	-0.316
Plant height	Hybrid	-0.055	0.077	0.135	-0.030	-0.005	-1.083	3.995	-3.755	1.071
	Inbred	-0.054	-0.038	0.152	0.122	0.120	0.293	-0.213	NA	0.146
Panicle length	Hybrid	-0.045	0.189	0.094	0.247	0.001	-1.048	3.662	-4.055	1.338
	Inbred	NA	NA	NA	NA	NA	NA	NA	NA	NA
Harvest index	Hybrid	0.047	0.109	0.387	-0.893	-0.010	-0.662	1.788	-2.291	2.369
	Inbred	-0.093	-0.083	0.014	-0.009	0.054	0.210	0.146	NA	0.113

NA: Non-available data

high positive direct effect and genotypic correlation with grain yield per plant in inbred genotypes; whereas harvest index showed the high positive direct effect and genotypic correlation in hybrid genotypes. Base on the direct effect of traits exerted on grain yield per plant, number of tillers, number of seed per panicle, 1000-seed weight and flag leaf length could be used for selection criteria of high yielding inbred genotypes. Similarly in hybrid genotypes, number of productive tillers, number of seed per panicle, plant height and harvest index could be used as selection criteria as they had high direct effect to grain yield. On the other hand, plant height had negative correlation with lodging resistance. So that could be used number of productive tillers, number of seed per panicle and harvest index for selection criteria of superior hybrid genotypes. In other hand, revealed that number of productive tillers per plant (Babu *et al*., 2012), plant height, productivity per day, number of filled grain per panicle, day to 50% flowering and panicle height (Bhadru *et al*., 2011) could be used for selection criteria for high yielding hybrid genotypes.

The residual effect of hybrid and inbred genotypes were 0.135 and 0.122, respectively. This indicates that the contribution of the nine yield component traits on grain yield were 86.5 and 87.8%, respectively. The rest were the contribution of other factors.

CONCLUSION

Knowledge on contribution of each agronomic trait to grain yield in hybrid rice genotypes will be useful to assist rice breeders in the indirect selection of grain yield in hybrid rice program. The study showed different effect of traits on grain yield between hybrids and inbred genotypes. Number of tillers per plant, number of seeds per panicle and 1000-seed weight could be used in indirect selection for increasing grain yield in hybrid rice in Thailand.

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