Correlation and Path Coefficient Analysis for Yield and Yield Components in F2 Segregating Populations of Rice
(Scientific Note)

Atena Hajiaqatabar [1], Ghaffar Kiani✉[1], Seyyed Kamal Kazemitabar[1] and Mohammad Alavi [2]

ABSTRACT

A study was performed to determine the relationship between grain yield and yield components at five F_2 populations in Sari Agricultural Sciences and Natural Resources University in 2014. In this study 10 traits including grain yield, number of panicles per plant, number of filled grains per panicle, 100 grains weight, plant height, grain length, grain width, number of non-filled grains per panicle, grain yield and panicle length were assessed. Results showed that plant height, Panicle length and number of panicles per plant correlated significantly with grain yield while grain yield negatively associated with non-filled grains per panicle. Path coefficient analysis revealed that grain yield was associated with number of filled grains per panicle, number of panicles per plant and plant height with the direct effects of 0.32, 0.30 and 0.29, respectively. Also the greatest indirect effect belonged to total number of grains (0.17) through filled grains per panicle. Stepwise regression analysis showed that 37.2 percent of yield variation could be explained by five characteristics named filled grains per panicle, panicle length, plant height, non-filled grains per panicle and grain width. According to the results obtained in these study traits such as plant height, panicle length, number of panicles per plant and number of filled grains per panicle are suggested as selection indices for grain yield improvement at segregating F_2 populations of rice.

Keywords: Rice, path analysis, correlation, stepwise regression, F2 populations.

INTRODUCTION

Rice is the staple food for 2.5 billion of world's population which may escalate to 4.6 billion by the year 2050 (Mclean et al., 2002). Also it is a staple food for Iranian consumers after wheat. (Nadarajan and Gunasekaran, 2005) Yield enhancement is the major breeding objective in rice breeding programs and knowledge on the nature and magnitude of the genetic variation governing the inheritance of quantitative

Characters like yield and its components are essential for effective genetic improvement (Kishore et al., 2015). Selection of promising genotypes in breeding programs is based on various criteria and most importantly final crop yield and its quality (Kozak et al., 2008). Using trait correlation is so effective on determining the main component which is effective on yield (Acquaah et al., 1992). But correlation relationships do not express the relation between cause and effect. Therefore other methods like path analysis could be used to provide information on internal relation among the investigated characters as well as their effect on certain traits and determine the relation between

[1]Department of Plant Breeding and Biotechnology, Sari Agricultural Sciences and Natural Resources University, Sari, Iran.
[2]Genetics and Agricultural Biotechnology Institute of Tabarestan, Sari, Iran.
✉ ghkiani@gmail.com
Received on 9/6/2015 and Accepted for Publication on 28/10/2015.

traits and direct and indirect effects on yield (Kozak and Kong 2006; Popovic et al., 2006). Path coefficient analysis as to correlation coefficient gives more detailed information on the relations so it is commonly used by plant breeders to determine yield and yield contributing characters (Manik Sarker et al., 2014). The information on relative direct and indirect contribution of each component character toward yield will help breeders to formulate the effective criteria in selecting desirable genotypes in early segregating populations. There has been so many research and investigations about correlation between traits and path analysis in rice varieties (Kumar and Mahadevappa., 1998; Rahim Soroush et al., 2005; Bagheri et al., 2011; Balouchzehi and Kiani, 2013). The relationship between yield and its main economic components in segregating population of rice has been studied by few researchers (Surek and Beser, 2005; Yogameenakshi and Vivekanandan, 2010; Kiani and Nematzadeh, 2012). This present study aimed to determine the relationship between grain yield and yield components at segregating F_2 population of rice to develop selection indices for rice breeding and to provide basis for selection and yield improvement of rice.

Materials and methods

A field experiment was carried out at research field of Sari University of Agricultural Sciences and Natural Resources during 2014 with geographic location of 39 and minutes 36 degrees north latitude, 53 degrees 4 minutes east, 14 meters above the sea level. The annual rainfall was reported 800 mm. Segregating rice populations were developed from crosses between local and high yielding rice varieties. Seedling preparation was done in the nursery seeding and transplanting was performed in late May in the plots with 20×20 cm planting pattern. Standard agronomic practices compatible to the field were adopted to ensure crop growth. NPK fertilizers were applied at the rate of 200, 100 and 50 Kg/ha, respectively. 100 superior genotypes were studied and selected according to superior morphological characteristics. Then ten important traits included plant height (cm), panicle length (cm), number of grains per panicle, number of filled grains per panicle, number of non-filled grains per panicle, total number of grains, grain length (mm), grain width (mm), 100 grains weight (g) and grain yield (g) were recorded on selected genotypes based on the standard evaluation system (SES) of rice. In order to study the effects of each considered trait on grain yield, stepwise regression and path analysis were done to separate traits correlation coefficient from grain yield to direct and indirect effects. All statistical analysis including pearson coefficient of correlation, stepwise regression and path analysis performed using SPSS version 14 statistical package and infostat.

Results and Discussion

The degree of correlation among characteristics is an important factor which is considered as economic and complex characteristic, such as yield. Direct selection of yield shows low effectiveness. Hence association of selecting was undertaken to determine the direction of selection and number of characteristic to be considered in improving grain yield. Correlation coefficient of studied traits (Table 1) showed that plant height (0.249), panicle length (0.239) and number of panicle per plant (0.240) and number of filled grains per panicle (0.366) statistical level had high significant correlation with grain yield. A strong correlation of grain yield with these traits indicated that simultaneous improvement of these traits is possible. Previous studies have mentioned similar findings (Lanceras et al., 2004; Muhammed et al., 2007; Yadav et al., 2010; Kiani, 2012; Abarshahr et al., 2011). But number of panicles had a significant negative correlation with grain length and number of non- filled grain had a significant negative correlation with yield.

Table 1. correlation coefficient of studied traits in rice

Traits	Plant height (cm)	Panicle length (cm)	Number of panicles	Total grains	Number of filled grains	Number of non-filled grains	Grain length (mm)	Grain width (mm)	100 grain weight (g)	Yield (g)
Plant height	1	0.346**	0.017-.	0.085	0.028	0.012	0.158	0.17-	0.101-	0.249 **
Panicle length		1	0.123-	0.055	**0.326	*0.208-	**0.274	0.006	0.242	0.239*
Number of panicles			1	0.119-	0.051-	0.031-	**-0.277	0.11 -	0.078	0.240*
Total grains				1	**0.573	0.641	0.107-	0.063	0.195	0.014-
Number of filled grains					1	-0.226 **	0.013-	0.115	0.290 **	0.366**
Number of non-filled grains						1	0.104-	0.017-	0.001	-0.377**
Grain length							1	0.096	0.064-	0.005-
Grain width								1	0.009-	0.018
100 grain weight									1	0.072
Yield										1

** and* shows significant at 1 and 5% level respectively.

Path analysis of yield component revealed that filled grains per panicle (0.32) had the highest direct effect (Table 2). Many researchers found that filled grains per panicle were an effective trait with the highest direct effect on grain yield (Ram, 1992; Sandram and Planisamy 1994; Samonte et al., 1998; Bagheri et al., 2011). Sum of direct and indirect effect of number of filled grains per panicle on yield was 0.36 which is due to its direct effect thus it could be a suitable trait for yield improvement. It seems that according to the large capacity provided by storage grains in panicles it can be an advantage for reaching higher yield. Number of panicles per plant (0.30) showed to be the second most important trait. This trait increase yield potentially because, changing number of panicles will enhance the number of storage resource in plants. Results on importance of direct effect of panicles per plant were reported by several researchers (Kumar, 1992; Yadav and Bhuhan, 2001; Madhavilatha et al., 2005; Yogameenakshi and Virekanadan, 2010; Bagheri et al., 2011; Kiani, 2012). Plant height (0.29) was the third trait which had direct effect on yield. This was also reported by Yadave et al. (2010). The direct effect of total number of grains was negative (-0.014) but it showed the highest indirect positive effect on it through number of filled grains (0.17) (Table 2).

Table 2. Direct and indirect effect of studied traits on grain yield of rice

	Plant height (cm)	Panicle length (cm)	Number of panicles	Total number of grains	Number of filled grains	Number of non-filled grains	Grain length (mm)	Grain width (mm)	100grain weight (g)	Correlation with yield
Plant height	0.29	0.01	-0.03	0.003	0.01	-0.00009	-0.002	-0.04	0.0014	0.249*
Panicle length	0.10	0.02	-0.04	-0.002	0.10	0.05	-0.004	0.0016	-0.0021	0.239*
Number of panicles per plant	-0.03	-0.003	0.3	0.005	-0.02	0.02	0.004	-0.02	-0.0012	0.240*
Number of total grains	0.03	0.0013	-0.04	-0.04	0.17	-0.14	0.002	0.01	-0.0028	-0.014
Number of filled grains	0.01	0.010	-0.02	-0.02	0.32	0.05	0.0003	0.03	-0.004	0.366**
Number of non-filled grains	0.001	-0.01	-0.01	-0.02	-0.07	-0.22	0.0015	-0.0039	0.000002	0.337**
Grain length	0.04	0.01	-0.07	0.004	-0.01	0.02	-0.02	0.02	0.00095	0.05
Grain width	-0.05	0.0002	-0.03	-0.002	0.04	0.004	-0.001	0.22	0.00013	0.18
100 grain weight	-0.03	0.003	0.02	-0.01	0.09	0.000002	0.001	-0.0019	-0.01	0.072

In this study a stepwise regression was used to facilitate the interpretation of grain yield. The result presented in Table 3 indicating that independent variables such as number of filled grains, panicle length, plant height, number of non-filled grains and grain width with R-square percent of 13.6, 20.3, 26.5, 36.6 and 37.2, respectively entered to the model. Number of grains per panicle had the highest R^2 percent and explains 13.6 percent from total variation. Panicle length and plant height, explained 20.3 and 26.5 percent of variance respectively. In the stepwise regression analysis by Bagheri et al. (2011) the number of filled grain and panicle length were entered into the model. Therefore number of filled grains per panicle, number of panicles per plant, plant height and panicle length are good criteria for selecting genotypes with high yield potential.

Table 3. Stepwise regression for grain yield and yield components

	Stepwise regression				
Traits entered model	1	2	3	4	5
Constant	13.20	2.19	-19.14	-12.31	-17.81
Number of filled grains per panicle	0.14	0.14	0.14	0.12	0.11
Panicle length		0.62	0.68	0.66	0.72
Plant height			0.14	0.14	0.16
Number of non-filled grains per panicle				-0.09	-0.09
Grain width					1.01
R-square	13.6	20.3	26.5	32.6	37.2

** *, ns show significant difference at 1 and 5% level and no significant difference.

Conclusions

From the correlation and path study it may be concluded that number of filled grains per panicle, number of panicles per plant, plant height and panicle length are the most important characters that contribute directly to grain yield. According to the above results selection indices should be formulated using these traits for yield improvement at segregating populations of rice.

REFERENCES

Abdus Salam, P. A, Hollington, J. Gorham, R. G. Jones, W. Abarshahr, M., Rabiei, B. and Samizadeh, H. 2011. Genetic variability, correlation and path analysis in rice under optimum and stress irrigation regims. ***Notulae Scientia Biologicae***, 3(1): 134-142.

Acquaah, G., Adams, M.W. and Kelly, J.D. 1992. A factor analysis of plants variables associated with architecture and seed size in dry bean. ***Euphytica***, 60: 171-177.

Bagheri, N. A., Babaeian-Jelodar, N. A. and Pasha, A. 2011. Path coefficient analysis for yield and yield components in diverse rice (*Oryza sativa* L.) genotypes. ***Biharean Biologist***, 5(1): 32-35.

Balouchzehi, A. B. and Kiani Gh. 2013. Determination of selection criteria for yield component in rice through path analysis. ***Journal of Crop Breeding***, 12:75-84. (In Persian).

Hossienzadeh Fashalemi, N., Seyed Kazemitabar K., BabaeianJelodar, N. A., Zamani, P. and Allahgholipour, M. 2009. A study of genetic diversity among different rice (*Oriza sativa* L.) genotypes using multivariate methods. ***Iranian Journal of Field Crop Science***, 40(1): 45-54.

Kiani, G. 2012. Character association and path coefficient analysis of yield components in rice varieties. ***Research on Crops***, 13 (2): 552-555.

Kiani, Gh. and Nematzadeh, Gh. 2012. Correlation and path coefficient studies in F_2 population of rice. ***Notulae Scientia Biologicae***, 4(2): 124-127.

Kishore, N.S., Srinivas ,T., Nagabhushanam, U., Pallavi, M and Sameera, S.K. 2015. Gentic 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.

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

Kozak, M., Bocianowski, J. and Rybinski, W. 2008. Selection of promising genotypes based on path and

cluster analyses. ***Journal of Agricultural Science***, 146: 85-92.

Kumar, C. R. A. 1992. Variability and character association studies in upland rice. ***Oryza***, 29: 31-34.

Kumar, G. S. and Mahadevappa, M. 1998. Studies on genetic variability, correlation and path analysis in rice during winter across the location. ***Journal of Agricultural Science***, 11 (1): 73-77.

Lanceras, J.C., Griengrai, P., Boonrat, J. and Theerayut, T. 2004. Quantitative trait loci associated with drought tolerance at reproductive stage in rice. ***Plant Physiology***, 135: 84-399.

Maclean, J. L., Dawe, D. C., Hardy, B. and Hettel, G. P. 2002. Rice Almanac. Los Baños: International Rice Research Institute, Bouake; Ivory Coast: West Africa Rice Development Association; Cali: International Center for Tropical Agriculture; **Rome: Food and Agriculture Organization**, 92(5): 739.

Madhavilatha , L., Reddi Sekhar, M ., Suneetha , Y. and Srinivas, T. 2005. Genetic variability, correlation and path analysis for yield and quality traits in rice (*Oryza sativa* L.). ***Research on Crops***, 6 (3):527-534.

Muhammed, B., Asif, AK., Anjuman, A., Yusuf, Z. and Muhammad, A. 2007. Path analysis of some leaf and panicle traits affecting grain yield in doubled haploid lines of rice (*Oryza sativa* L.). ***Journal of Agricultural Research***, 45:248-252.

Popovic, S., Cupic, T. and Grljusic, M. 2006. Use of variability and path analysis in determining yield and quality of alfalfa. In proc of XXVI Meeting of EUCARPIA Fodder Crops and Amenity Grasses Section. Perugia, Italy., 95-99.

Rahim Souroush, H., Mesbah, M. and Hossainzadeh, A. H. 2005. A study of relationship between grain yield and yield components in rice. ***Journal of Agricultural Science,*** 35: 983-993. (In Persian).

Ram, T. 1992. Character association and path coefficient analysis in rice hybrids and their parents. ***Journal of the Andaman Science Association,*** 8(1): 26-29.

Samonte, S. O., Wilson, L.T. and McClung, A. 1998. Path analysis of yield and yield-related traits of fifteen diverse rice genotypes. *Crop Science*, 38:1130-1136.

Sandram, T. and Palanisamy, S. 1994. Path analysis in early rice (*Oriza sativa* L.). ***Madras Journal of Agriculture***, 81(1): 28-29.

Sarker, M., Hassan, L., Islam M.M., Rashid, M. and Seraj, S. 2014. Correlation and path analysis of some exotic early maturing rice (*Oryza sativa* L.) lines. ***Journal of Bioscience and Agriculture Research***, 1 (1):1-7.

Siahsar, B. and Rezai, A. 1999. Genetic and phenotypic and factor analysis for morphological phonological traits in soy bean. ***Journal of Science and Technology of Agriculture and Natural Resources***, 3(3): 61-74. (In Persian).

Surek, H. and Beser, N. 2005. Selection for grain yield and its components in early generation in rice (*Oryza sativa* L.). ***Trakia Journal of Science***, 6:51-58.

Yadav, S. K., Suresh, B. G., Pandy, P. and Kumar, B. 2010. Assessment of genetic variability, correlation and path association in rice (*Oriza Sativa* L.). ***Journal of BioSciences***, 18: 1-8.

Yogameenakshi, P. and Vivekanandan, P. 2010. Association analysis in F_1 and F_2 generations of rice under reproductive stage drought stress. ***Electronic Journal of Plant Breeding***, 1(4): 890-898.

معامل تحليل الارتباط و المسار للمحصول و مكوناته في الجيل الثاني F2 المعزول الصفات من نبات الارز

اتينا هاجكابتر[1]، الغفار كياني ✉[1]، سيد كمال كازيمتابر[1] ومحمد الفي[2]

ملخص

تم إجراء دراسة لتحديد العلاقة بين محصول الحبوب ومكوناته في خمسة اجيال من الجيل الثاني F2 لنبات الأرز في جامعة ساري للعلوم الزراعية والموارد الطبيعية في عام 2014. في هذه الدراسة 10 صفات تم تقييمها بما في ذلك محصول الحبوب، عدد العناقيد في النبات، عدد الحبوب الممتلئة لكل عنقود وزن 100 حبة من الحبوب، ارتفاع النبات، طول الحبوب، عرض الحبوب، وعدد من الحبوب غير الممتلئة لكل عنفود و محصول الحبوب وطول العنقود. وأظهرت النتائج أن ارتفاع النبات، طول العنقود وعدد العناقيد لكل نبات يرتبط بشكل كبير مع محصول الحبوب في حين محصول الحبوب يرتبط سلبا مع الحبوب غير الممتلئة لكل عنقود. وكشف تحليل معامل المسار أن محصول الحبوب كان مرتبطا مع عدد الحبوب الممتلئة في كل عنقود، عدد العناقيد للنبات وطول النبات كان لها تأثير مباشر بقيمة 0.32، 0.30 و 0.29 على التوالي. أيضا كان أكبر تاثير غير مباشر لمجموع عدد الحبوب الممتلئة (0.17). وأظهر تحليل الانحدار المتدرج أن 37.2 في المئة من الاختلاف في عائد المحصول يمكن تفسيره من خلال خمس خصائص المسماه الحبوب الممتلئة لكل عنقود، طول العنقود، ارتفاع النبات، و الحبوب الممتلئة لكل عنقود وعرض الحبوب. وفقا لهذه النتائج التي تم الحصول عليها في هذه الدراسة فان الصفات مثل ارتفاع النبات، طول العنقود، عدد العناقيد للنبات وعدد الحبوب الممتلئة لكل عنقود قد تم اقتراحها كمؤشرات لاختيار تحسين المحصول العائد من الحبوب في مرحلة عزل صفات الجيل الثاني F2 من الأرز.

الكلمات الدالة: الأرز، تحليل المسار، الارتباط، الانحدار التدريجي، الجيل الثاني F2.

[1]. قسم تربية النباتات والتكنولوجيا الحيوية، جامعة ساري للعلوم الزراعية و الموارد الطبيعية، ساري، ايران.

[2]. معهد تابريستان للتكنولوجيا الحيوية الزراعية ، ساري، ايران.

✉ghkiani@gmail.com

تاريخ استلام البحث 2015/6/9 وتاريخ قبوله 2015/10/28.