International Journal of Biosciences | IJB |
ISSN: 2220-6655 (Print) 2222-5234 (Online)
http://www.innspub.net
Vol. 3, No. 7, p. 119-125, 2013

RESEARCH PAPER OPEN ACCESS

Study of agronomic traits in a number of promising rice lines by multivariate statistical methods

Seyyed Mohadeseh Mirhoseini[1], Morteza Sam Daliri[1], Mojtaba Neshaee Moghaddam[1], Ali Mohaddesi[2], Abouzar Abbasian[3*]

[1]*Dept of Agronomy, Islamic Azad University, Chalous Branch, Iran*

[2]*Rice Research Station of Tonekabon, Iran*

[3]*Department of Agronomy, Tabriz Branch, Islamic Azad University, Tabriz, Iran*

Key words: Correlation, cluster analysis, path analysis, stepwise regression.

doi: http://dx.doi.org/10.12692/ijb/3.7.119-125 Article published on July 25, 2013

Abstract

The objectives of the experiment were to study the relationships between the agronomic traits and yield components and identify effective traits for the improvement of grain yield in seven promising lines of rice plus two native cultivars (Shiroodi and 843) as control. The experiment was conducted as a randomized complete block design (RCBD) with four replications at Rice Research Station of Tonekabon, Iran in 2011. In this study, 17 traits including plant height, total tiller number, fertile and sterile tiller number, length, width and area of flag leaf, panicle length, total grain, number filled and empty grain, 100-grain weight, length, width and the ratio of length to width of grain and grain yield. The result of correlation showed that the grain yield has a positive and significant correlation with plant height and negative correlation with empty grain. Stepwise regression showed that the effective characters related to grain yield were total number of grain that about 49.48 percent of the regression model variation was allocated to itself. The results of path analysis indicated that number of empty grain and plant height were the most important components of grain yield and they had the most directed effects on grain yield. For synchronizing of these effects on rice lines, cluster analysis was done and results of this method showed that there was 3 classes between these genotypes.

* **Corresponding Author:** Abouzar Abbasian ✉ abouzar.abbasian@gmail.com

Introduction

Rice (*Oryza sativa* L.) is one of the three major food crops of the world. Being grown population, it is the staple food for more than one and a half of the world's population. Rice grain yield is highly influenced by production environments and breeders often determine stability of high yielding genotypes across environments before recommending a stable cultivar for release. Varietal adaptability to environmental fluctuations is important for the stabilization of crop production over both the regions and years. The development of cultivars or varieties, which can be adapted to a wide range of diversified environments, is the ultimate goal of plant breeders in crop improvement program. The adaptability of variety over diverse environments is usually tested by the degree of its interaction with different environments under which it is planted. A variety or genotype is considered to be more adaptive or stable if it has a high mean yield but low degree of fluctuations in yielding ability when grown over diverse environments (Falconer, 1981). Iftekharuddaula *et al.*, (2002) reported the positive correlation between grain yield with plant height, panicle length and harvest index. Luzi-Kihupi, (1998) by studying traits in the rice varieties reported that there are positive and significant correlation between panicle length, number of filled grain and plant height with grain yield and by using of path analysis stated that number of filled grain was most important factor for increasing yield. Honarnezhad, (2003) showed that most direct and positive effects on the grain yield were through filled grain per panicle and total tiller number per plant. Miller *et al.*, (1991) stated that number of fertile tiller depends to environmental constraints and growth conditions and they concluded that number of fertile tiller in flooding culture is most important of density. Furthermore, the power of tillering had significant effect on density panicle. Therefore, the cultivars with high tillering had more panicle. Prasad *et al.*, (2001) with research on traits and path analysis of rice reported that there is positive correlation between numbers of filled grain with grain yield. Also, path analysis showed that this trait is most important factor for increasing of yield.

The purpose of this research is to identify the correlation between some agronomic traits, and to recognize traits with maximum direct and indirect effects on grain yield by making use of path coefficient analysis, so that by using important traits which are related to yield, we can achieve improvement on these breeding goals.

Materials and methods

Experimental design, Plant growth conditions, and sampling

The study is performed in the rice research station of Tonekabon, Iran in 2011. The experiment was conducted in randomized complete blocks design (RCBD) with four replications. The treatments were consisted of 7 rice line plus two native cultivars Shiroodi and 843 (Table 1). The seedlings in nursery were sown on 4 May and transplanted to experimental field on 29 June 2011. The plant distance was 25×25 cm and plot size was 2.25×3.75 m^2. At the time of maturity, the data of each genotype in each replication were recorded for plant height, total tiller number, fertile and sterile tiller, length, width and area of flag leaf, panicle length, total grain, number filled and empty grain, 100-grain weight, length, width and the ratio of length to width of grain and grain yield. For calculating of coefficient correlation, mean of measured traits in each plot were statistically analysis. In order to studying some studied traits on the dependent variable and also for decreasing the number of independent variables and deleting the variables that have little effect on the dependent variable, stepwise regression method was used. Path analysis was grouped the independent traits with grain yield through direct and indirect effects.

Statistical analyses

For grouping of studied genotypes by agronomic traits and dendrogram chart, cluster analysis by method UPGMA was used. All measured and derived data were analyzed by analysis of variance (GLM PROC) using the SAS computer software. Character means were separated by least significant differences (LSD, $p<0.05$) when sources of variation from the

ANOVAs were significant ($p<0.05$). Also, stepwise regression and cluster analysis analyzed by SAS software. Path analysis estimated by using PATH 74.

Results and discussion

Correlation analysis

The results of correlation analysis showed that grain yield has positive and significant correlation with plant height and there is not any significant correlation between grain yield with other traits. Also, a negative correlation was observed between with number of empty grain and grain yield (Table 2).

The positive correlation between grain yield and plant height is showed that a canopy with more height, better ventilation and Co_2 density is higher inside the canopy. Therefore, light absorption and better transport of food materials to grain is increased grain yield per plant. Similar results were reported by Mohaddesi *et al.*, (2010). However, Gholipoor and Zeinali, (1998) stated that grain yield was significant and negative correlation with plant height and length of highest internodes. These differences in results were due to different plant and environmental conditions. Results showed that there is non-significant and negative correlation between total tiller number and grain yield that Agahi *et al.*, (2007) were reported similar results. Grain yield was negative and significant correlation with number of empty grain per panicle. This result was in agreement with findings of Allah Gholipour, (1998) and Honarnezhad, (2003). Chaubey and Singh, (1994) with study on the 20 rice varieties reported that grain yield was correlated positively with plant height and panicle weight. Honarnezhad, (2003) stated that correlation between some rice quantitative traits with grain yield can be considered as a standard for measuring the performance. Also, they observed negative correlation between tiller number per plant and plant height. Dourosti, (2005) with studying on the 64 of rice lines reported that there is significant and higher correlation between grain yield with panicle length and total tiller number. In this research, we observed that there is significant and positive correlation between plant height with flag leaf area. This indicated that with increasing of plant height, leaf area especially flag leaf followed by increasing in light absorption, photosynthesis and chlorophyll production will increase. Therefore, grain yield will increase. A positive and significant correlation was observed between flag leaf area with grain length and number of filled grain. This indicated that with increasing of leaf area or number of green leaf per plant, photosynthetic capacity and chlorophyll content increases in the filling grain stage with more making and better transport of assimilate to grain. This is agreement with report of Rahim Soroush, (2005). A positive and significant correlation was between 100-grain weight with grain length and width. These results are agreement with the research done by Rahim Soroush, (2005). The results of this study are showed that plant height is the best option for increasing of grain yield per plant.

Table 1. Used genotypes.

Genotype	Number line or cultivar	Parent
1	1	107× shiroodi
2	2	A (8948) 64669-153-2-3 IR × Surinam) *(Deylaman
3	47	(37632) A 67015-22-6-2 × IR Amole 3)* (Number 3
4	107	(37632) A 67015-22-6-2 × IR Amole 3)* (Number 3
5	121	(37632) A 67015-22-6-2 × IR Amole 3)* (Number 3
6	126	(37632) A 67015-22-6-2 × IR Amole 3)* (Number 3
7	39	(37632) A 67015-22-6-2 × IR Amole 3)* (Number 3
8	843	native
9	Shiroodi	native

Stepwise regression

The results of regression (Table 3) showed that plant height, total tiller number, flag leaf width, flag leaf area, total number of grain and 100-grain weight as independent variables have determination coefficient 0.0121, 0.0204, 0.1023, 0.0468, 0.4989 and 0.016, respectively with grain yield. Determination coefficient model indicated that 69.65 percent of performance changes can justified by independent variables in model. Among studied traits, total number of grain can justified about 49.89 percent of the grain yield variations. So, this trait is the most important component of grain yield in rice. These findings are in agreement with the work done by Rahim Soroush, (2002) and Gholami Tajany, (1998).

Table 2. Correlation analysis of some studied traits on grain yield.

Traits	Grain yield	Grain width	Grain length	100-grain weight	Empty grain	Filled grain	Panicle length	Flag leaf area	Fertile tiller	Total tiller
Plant height to maturity	0.32*	-0.14	0.25	-0.14	0.31	0.21	0.15	0.6**	-0.04	0.04
Total tiller	-0.03	0.26	-0.04	-0.28	0.26	-0.59**	0.45**	-0.32	0.89**	
Fertile tiller	-0.12	0.39*	0.02	-0.24	0.28	-0.65**	0.41*	-0.35*		
Flag leaf area	0.11	-0.22	0.42*	0.06	0.43**	0.46**	0.06			
Panicle length	0.11	0.37*	0.07	0.06	0.22	-0.21				
Filled grain	-0.01	-0.42*	-0.27	-0.13	-0.15					
Empty grain	-0.37*	0.01	0.44**	-0.11						
100-grain weight	0.17	0.51**	0.48**							
Grain length	0.16	0.35*								
Grain width	0.07									

*, ** significant at the 0.05 and 0.01probability level, respectively.

Table 3. Regression analysis of some studied traits on grain yield.

Steps	Independent variable	Standard error	F	Incomplete R^2	Total R^2
1	Plant height to maturity	0.25916	3.87	0.0121	0.9121
2	Total tiller	0.21032	5.91*	0.0204	0.8999
3	Leaf width	0.36892	24.01**	0.1023	0.8721
4	Flag leaf area	0.01756	6.31*	0.0468	0.7698
5	Total grain	1.07775	32.86**	0.4989	0.4989
6	100-grain weight	5.29767	4.14	0.016	0.8881

*, ** significant at the 0.05 and 0.01probability level, respectively.

Path analysis

The results of path analysis (Table 4) was showed that highest and lowest positive and direct effect on grain yield was plant height (0.38) and panicle length (0.154). The highest indirect and positive effect belongs to panicle length through total tiller (0.12) and lowest positive and indirect effect belonged to number of empty grain through 100-grain weight (0.001). The highest negative and indirect effect belonged to number of empty grain (-0.737) and lowest negative and indirect effect belonged to 100- grain weight (-0.017).

The 100-grain weight trait because of positive and non-significant correlation with grain yield and negative and indirect effect cannot be selection for improving of yield. These findings are in agreement with the work done by Rahim Soroush, (2005). The highest negative and indirect effect was observed in number of empty grain (-0.737) and also positive and indirect effects were at 100- grain weight (0.001), filled grain (0.024), panicle length (0.033), total tiller number (0.069) and plant height (0.117). Number of empty grain was correlated negatively and significantly with grain yield. Therefore, we can select cultivars based on number of empty grain per plant to increase grain yield. This result is in agreement with the findings of Honarnezhad, (2003). The number of filled grain because of a non-significant and negative correlation with grain yield cannot consider to heading option for improvement yield. However, Nourbakhshian and

Rezaei, (2004) and Mehetre *et al.*, (1996) reported that number of filled grain per panicle is the most important component of the grain yield in rice that can used for selection varieties and high yielding lines of rice. Panicle length showed positive and non-significant correlation with grain yield. Gravois and McNew, (1993) in their studies by path analysis showed that the panicle length is one of the effective traits on the grain yield. Mehetre *et al.*, (1996) suggested that this trait is an important morphological trait in improvement yield. Total tiller number was positive and direct effect (0.267) and negative and indirect effect through empty grain (-0.192). This trait was correlated non-significantly and negatively with grain yield. So, that cannot be used in breeding programs to increase grain yield per plant. Allah Gholipour *et al.*, (2001) reported that total tiller number has the highest direct effect on the grain yield. Plant height has positive and significant correlation with grain yield that means more plant height will increase grain yield.

Table 4. Path analysis of some studied traits on grain yield.

Traits	100-grain weight	Empty grain	Filled grain	Panicle length	Total tiller	Plant height	Grain yield
100-grain weight	-0.017	0.081	0.021	0.009	-0.076	-0.054	0.17
Empty grain	0.001	-0.737	0.024	0.033	0.069	0.117	-0.37*
Filled grain	0.002	0.011	-0.165	-0.033	-0.159	0.079	-0.01*
Panicle length	-0.001	-0.163	0.034	0.154	0.12	0.057	0.11
Total tiller	0.004	-0.192	0.097	0.069	0.267	0.015	-0.03
Plant height	0.002	-0.229	-0.035	0.023	0.01	0.38	0.32*

*: significant at the 0.05 probability level

underlying numbers are indicative of direct effects

Remaining effects = $\sqrt{1-R^2} = 0.71$

determination coefficient = 69.65

Table 5. Mean of studied traits in the cluster analysis.

Genotype	Plant height 45 day after transplanting	Plant height to maturity	Total tiller	Fertile tiller	Sterile tiller	Leaf length	Leaf width	Flag leaf area
7 & 843	67.7	110.73	25.19	19.06	6.13	33.46	1.31	31.93
5	70.96	117.015	24.02	18.81	5.21	33.95	1.41	36.13
Shiroodi, 1, 2, 3, 4, 6	72.71	112.18	21.52	16.97	4.52	31.58	1.21	28.51
Total average	69.11	111.75	24.25	18.57	5.67	33.76	1.29	31.36

Grouping genotypes by cluster analysis

Results of cluster analysis for studied traits showed that there were genotypes in 3 clusters (Fig. 1). Present genotypes in the same cluster were more genetic affinities and uniform properties than genotypes in different clusters. Therefore, using of this method can help to select the best lines. Cluster 1 was including lines of 843 and 7 that traits of plant height after 45 days of transplanting, plant height to maturity, 100-grain weight and grain yield were higher than total average (Table 5). Cluster 2 was including 5 lines that traits of plant height after 45 days of transplanting, plant height to maturity, number of fertile tiller, length, width and area of flag leaf, panicle length, total grain, filled and empty grain and 100-grain weight were higher than of total average (Table 5). Cluster 3 was including cultivar shiroodi and 1, 2, 3, 4 and 6 lines that traits of total tiller number, fertile and sterile tiller number, length, width and area of flag leaf, panicle length, total grain, empty grain, length, width and the ratio of length to width of grain were higher than of total average (Table 5).

Table 6. continued. Mean of studied traits in the cluster analysis.

Genotype	Panicle length	Filled grain	Empty grain	Total grain	100-grain weight	Grain length	Grain width	Ratio of length to grain width	Grain yield
7 & 843	31.61	119.16	39.04	158.08	2.9	11.5	2.09	23.89	6243.63
5	31.48	126.87	46.45	173.32	2.93	11.43	2.05	23.46	5755.8
Shiroodi,1, 2, 3, 4, 6	30.06	120.23	11.54	131.77	2.96	11.49	2.06	23.7	7021.65
Total average	31.27	120.26	33.75	153.93	2.92	11.49	2.08	23.8	6362.3

The study of Table 5 showed that results of cluster grouping including total tiller number, fertile and sterile tiller, length, width and area of flag leaf and other traits was lower than total average. However, in clusters 2 and 3, the lower parameters of total average were 6 and 6 cases were similar of some traits. Although, cluster 1 was much difference with clusters 2 and 3 but it seems that clusters 2 and 3 have important differences and these differences caused this grouping. The cluster analysis showed that some of the genotypes have the more uniform and genetic affinities and also similar genetic properties and uniform were due to genetic purity that is placed in one cluster. These affinities and genetic purity can help to select the best lines for improving and then choosing them. According to the results of path analysis, some important and effective characteristics of genetic can be used to these indicators for in order to identify and selecting the best lines.

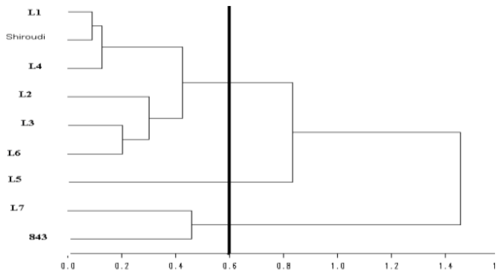

Fig. 1. Grouping genotypes of the cluster analysis in studied traits.

Conclusions

The results of this study showed that plant height is the best option for increasing of yield, because of it had the highest significant and positive correlation with grain yield. Also, plant height is not so much to make lodging and this trait is important than other traits that can be suggest to heading index for increasing yield. Also, lines of 7 and 843 were known as best lines that they have the highest grain yield and they can be used in breeding programs of rice.

References

Agahi K, Fotokian MH, Farshadfar E. 2007. Correlation and path coefficient analysis for some yield-related traits in rice genotypes (*Oryza sativa* L.). Asian Journal of Plant Sciences **6(3)**, 513-517.
http://dx.doi.org/10.3923/ajps.2007.513.517

Allah Gholipour M, Mohammad Salehi MS, Tavazoe M. 2001. Study of genetic diversity and classification of different rice cultivars. Rice Research Institute Publications, Rasht, Iran.

Allah Gholipour M. 1998. Study of correlation between some agronomic traits and grain yield using Path analysis in rice. M.Sc. thesis, Agricultural University of Tehran, Iran.

Chaubey PK, Singh R. 1994. Genetic variability, correlation and path analysis of yield components of rice. The Madras Agricultural Journal **81(9),** 468-470.

Dourosti H. 2005**.** Assessment of genetic diversity based on agronomic properties of rice promising lines. M.Sc. thesis, Islamic Azad University, Karaj Branch, Iran.

Falconer DS. 1981. Introduction to Quantitative Genetics. 2ed. Longman Group Limited, New York. 340 p.

Gholami Tajany M. 1998. Study of grain yield and yield Components of rice using path analysis. M.Sc. thesis, Islamic Azad University, Ardebill Branch, Iran.

Gholipoor M, Zeinali H. 1998. Study of correlation between yield and some important agronomic traits using path analysis in rice. Iranian Journal of Agricultural Science **29(3)**, 627-638. (In Persian)

Gravois KA, McNew RW. 1993. Genetic relationship among and selection for rice yield and yield component. Crop Science **33(2)**, 249-252**.** http://dx.doi.org/10.2135/cropsci1993.0011183X003300020006x

Honarnezhad R. 2003. Study of correlation between some quantitative traits of rice (*Oryza sativa* L.) and grain yield using Path analysis. Iranian Journal of Crop Science **4(1),** 25-33**.** (In Persian)

Iftekharuddaula KM, Akter K, Hassan MS, Fatema K, Badshah A. 2002. Genetic divergence, character association and selection criteria in irrigated rice. Journal of Biological Sciences **2(4),** 243-246**.** http://dx.doi.org/10.3923/jbs.2002.243.246

Luzi-Kihupi A. 1998. Inter-relationship between yield and some selected agronomic characters in rice. African Crop Science Journal **6(3),** 323-328.

Mehetre SS, Patil PA, Mahajan CR, Shinde RB. 1996. Variability, heritability, characrer association and genetic divergence studies in m_2 generation of gamma Irradiated upland paddy. Crop Research **12(2),** 155-161.

Miller BC, Hill JE, Roberts SR. 1991. Plant population effects on growth and yield in water-seeded rice. Agronomy Journal **83(2),** 291-297. http://dx.doi.org/10.2134/agronj1991.00021962008300020006x

Mohaddesi A, Abbasian A, Bakhshipoor S, Mohammad salehi M. 2010. Study of effects of nitrogen fertilizer and planting distance on yield and yield components of promising rice line (843 numbers). Journal of crop Ecophysiology **2(3),** 198-203. (In Persian)

Nourbakhshian J, Rezaei A. 2004. Investigation of traits correlations and path analysis of grain yield in rice (*Oryza sativa* L.). Iranian Journal of Crop Science **1(4)**, 55-65 (In Persian)

Prasad B, Patwary AK, Biswas PS. 2001. Genetic variability and selection criteria in fine rice (*Oryza sativa* L.). Pakistan Journal of Biological Sciences **4(10),** 1188-1190. http://dx.doi.org/10.3923/pjbs.2001.1188.1190

Rahim Soroush H. 2002. Assessment of Genetic Diversity a Number of Rice Promising Lines by Multivariate Statistical Methods. M.Sc. thesis. Islamic Azad University, Karaj Branch, Iran.

Rahim Soroush H. 2005. Study of grain yield stability in rice (*Oryza sativa* L.) promising genotypes. Iranian Journal of Crop Science **7(2),** 112-122. (In Persian)