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Heritability, Phenotypic Correlation and Path Coefficient Studies for Some Agronomic Characters in Landrace Rice Varieties

Seyed Mustafa Sadeghi

Department of Agriculture, Lahijan Branch, Islamic Azad University, Lahijan, Iran

Abstract: For effective selection, information on nature and magnitude of variation in population, association of character with yield among themselves and the extent of environmental influence on the expression of these characters are necessary. This study was conducted to determine variability, heritability and correlations between yield and yield components in 49 landrace rice varieties (*Oryza sativa* L.) for 2 years. Direct and indirect effects of yield components on seed yield per plant were investigated. Broad-sense heritability ranged from 69.21% (Plant height) to 99.53% (Grain width). Grain yield was found to be positively and significantly correlated with grains per panicle, days to maturity, panicle weight, the number of productive tillers, days to flowering, plant height, panicle length, flag leaf width and flag leaf length indicating the importance of these characters for yield improvement in this population. The results of phenotypic path analysis revealed that the number of productive tillers had the highest positive direct effect followed by days to maturity, grains per panicle and 1000-grain weight.

Key words: Rice (*Oryza sativa* L.) · Path coefficient · Correlation · Yield components

INTRODUCTION

For effective selection, information on nature and magnitude of variation in population, association of character with yield and among themselves and the extent of environmental influence on the expression of these characters are necessary. In such situations, correlation and path coefficient analysis could be used as an important tool to bring information about appropriate cause and effective relationship between yield and some yield components [1]. Genetic variation among traits is important for breeding and in selecting desirable types. On the other hand, an analysis of the correlation between seed yield and yield components is essential in determining selection criteria; however, path coefficient analysis helps to determine the direct effect of traits and their indirect effects on other traits. Seed yield is a complex character determined by several characters having positive or negative effects on this trait. It is important to examine the contribution of each of the trait in order to give more attention to those having the greatest influence on seed yield. Therefore, information on the association of traits with seed yield is of great importance to define selection criteria for rape breeding in terms of yield. Generally, correlation coefficients show relationships among independent characteristics and the degree of linear relation between these characteristics. However, path analysis is necessary to clarify relationships between characteristics deeply because correlation coefficients describe relationships in a simple manner [2]. Path coefficient analysis separates the direct effects from the indirect effects through other related characters by partitioning the correlation coefficient [3]. Many breeders were involved in analyzing the path coefficient. Path Analysis was conducted following the procedure developed by Wright [4] and applied by Dewey and Lu [5]. The path coefficient analysis helps the breeders to explain direct and indirect effects and hence has extensively been used in breeding experimentsin different crop species by various researchers [6-10]. The expected response to selection is also called as genetic advance (GA). High genetic advance coupled with high heritability estimates offers the most effective condition for selection [10]. The utility of heritability therefore increases when it is used to calculate genetic advance, which indicates the degree of gain in a character obtained under a particular selection pressure. Thus, genetic advance is yet another important selection parameter that aids breeder in a selection program [11]. Phenotypic and genotypic variance, heritability and genetic advance have

Corresponding Author: Seyed Mustafa Sadeghi, Department of Agriculture, Lahijan Branch, Islamic Azad University, Lahijan, Iran.

been used to assess the magnitude of variance in rice breeding material [12]. Highly significant associations of grain yield were observed with 1000-grain weight and tiller number per plant [13-18], the number of filled grains per panicle [15, 19, 20], biological yield [15,18,21,22] and harvest index [17,18,22,23]. Grain yield has been reported to be influenced by high direct effects of total tillers and days to flowering [24], the number of panicles per plant, the number of filled grains per panicle and 1000-grain weight [25], the number of filled grains per panicle and plant height [26], productive tillers, panicle length and flowering time [28], plant height and tiller number [28], panicle number per plant and spikelet number per panicle [29], the number of effective tillers per plant, grains per panicle and 1000-grain weight [15], grains per panicle and productive tillers [30], the number of filled grains per panicle and 1000-grain weight [21, 29] and biological yield, harvest index and 1000-grain weight [31]. Hasib and Kole. stated that panicles per plant, panicle length and grain weight though had positively non-significant correlation with grain yield also be utilized for improvement of yield [322]. Portioning through path coefficient analysis revealed that grains per panicle played an important role in the improvement of grain yield in rice. Present research was conducted with the following objectives: 1) to evaluate the heritability and genetic advance for grain yield and some of its related components in order to select the more desirable trait which may contribute for the improvement of rice. 2) to study the variation of important agronomic traits and identify the characters of utmost importance which may be used as selection criteria in a rice breeding program and 3) to determine the direct and indirect contributions of important yield components on yield in rice landrace of Iran.

MATERIALS AND METHODS

Forty nine Iranian landrace rice varieties were grown and evaluated in a lattice squared design with tree replications during two years 2007 and 2008 at Rasht Rice Research Institute. Each plot with size 4.5 m^2 (3x1.5 m) consisted of 4 rows spaced 25 cm apart. The data was taken from 2 middle rows. Ten competitive plants were selected at random from each genotype in each replication. The data were recorded on grain yield, grains per panicle, days to maturity, panicle weight, the number of productive tillers, days to flowering, plant height, panicle length, Grain width, Flag leaf width, Flag leaf length and 1000 grain weight. Correlation coefficient studies were done using SPSS for Windows Version 11.0 (SPSS, Inc., Chicago, IL). Data was log transformed and then standardized prior to analysis. Log-transformation was performed to obtain linear relationships between yield and yield components and standardization was required to calculate path coefficients. Path analysis was carried out according to Dewey and Lu [5]. Grain yield was the dependent variable and grains per panicle, days to maturity; panicle weight, the number of productive tillers, days to flowering, plant height, panicle length, Grain width, Flag leaf width, Flag leaf length and 1000 grain weight were taken as the causal variables. Broad sense heritability (*h2B*) and genetic advance under selection (GA) were estimated in genotypes by partitioning the variance in plant traits into between accessions and within accessions components and applying these in the following function: *h2 B = Vg/Vp, w*here *Vg* genetic variance = (variance between-accessions - variance within-accessions)/*n, Vp* phenotypic variance = [(variance between-accessions – variance within-accessions)/*n*] + variance within-accessions, *n* = number of replications. Genetic advance (GA) = K × (*Vp*) 0.5 × *h2 B*, where K = selection intensity at 5% (2.06), *Vp* = phenotypic variance, *h2 B* = heritability (broad sense).

$$\text{Phenotypic coefficient of variability (PVC)} = \frac{\text{Phenotypic variance (Vp)}}{\text{Mean value of the trait}} \times 100$$

$$\text{Genotypic coefficient of variability (GVC)} = \frac{\text{Genotypic variance (Vp)}}{\text{Mean value of the trait}} \times 100$$

RESULTS AND DISCUSSION

The estimates of phenotypic coefficient of variation (PCV) were higher than those of genotypic coefficient of variation (GCV) for all the traits, which was also, reported earlier [11, 32, 33]. However, the highest PCV and GCV were recorded for the number of productive tillers and lowest for days to flowering, which was at variance from the reports cited above. All the characters showed high heritability, the highest being for Grain width and lowest for Grain yield (Table 1). The estimates of genetic advance (GA) were highest for the number of productive tillers and lowest for flag leaf width. Although these are not realized values, the observations form a good guideline for future planning. Johnson *et al.* suggested that for a more reliable conclusion, heritability and genetic advance should be considered together [34]. In this study, high estimates of heritability and genetic advance were obtained for the number of productive tillers and plant height which supports the results of Sundaram and Palanisamy [30].

Table 1: Mean squares, maximum, minimum, means, genotypic and genotypic coefficient of variability, heritability and genetic advance

characters	Mean squares	Maximum	Minimum	Mean	GCV%	PVC%	h^2B	GA
Days to flowering(d)	41.259**	98.86	83.15	90.39	11.29	20.78	93.3	16.82
Days to maturity(d)	73.638**	127	113	119.47	20.32	32.31	98.90	19.54
Plant height(cm)	123.75**	115.46	88.25	98.74	28.89	39.27	69.21	32.25
Grain length(mm)	1.57**	8.16	5.70	6.830	18.37	25.42	98.66	1.35
Grain width(mm)	0.390**	3.31	2.02	2.42	25.80	28.25	99.53	0.36
Panicle length(cm)	14.387**	30.89	23.06	26.604	16.79	20.42	93.15	9.19
Panicle weight(gr)	0.556**	4.44	1.74	2.56	29.02	38.52	80.09	0.31
Flag leaf width(cm)	0.390**	1.67	0.91	2.42	19.31	25.26	87.500	0.13
Flag leaf length(cm)	47.32**	46.82	21.75	32.82	20.09	24.32	82.41	14.68
The number of productive tillers(m^2)	2576.997**	261.3	156.2	199.244	301.90	427.12	70.02	50.32
Grains per panicle	568.748**	134.4	63.3	85.160	28.00	33.42	83.08	33.20
1000-grain weight	37.68**	37.73	23.72	28.69	41.39	45.42	93.77	14.21
Grain yield(t ha^{-1})	0.852**	4.20	2.15	3.198	28.86	39.25	68.19	0.39

*, ** Significant at 5% and 1% respectively

Table 2: Phenotypic correlation coefficients between different traits in rice

characters	Days to flowering(d)	Days to maturity(d)	Plant height(cm)	Grain length(mm)	Grain width(mm)	Panicle length(cm)	Panicle weight(gr)	Flag leaf width(cm)	leaf length (Flag cm)	The number of productive tillers(m^2)	Grains per panicle	1000-grain weight	Grain yield(t ha^{-1})
Days to flowering(d)	1	0.635**	-0.052	0.034	-0.139*	0.058	0.281**	0.081	0.094	0.049	0.264**	-0.165*	**0.338
Days to maturity(d)		1	0.244**	-0.015	-0.126	0.380**	0.398**	-0.018	0.279**	0.095	0.394**	-0.169*	**0.541
Plant height(cm)			1	-0.109	0.100	0.226**	0.232**	0.317**	0.447**	0.050	0.141*	0.051	0.236**
Grain length(mm)				1	-0.769**	0.400**	0.068	-0.371**	0.158*	-0.055	0.267**	-0.351*	-0.014
Grain width(mm)					1	-0.116	0.017	0.298**	-0.065	-0.228**	-0.402**	0.765**	-0.201**
Panicle length(cm)						1	0.506**	-0.049	0.386**	-0.161*	0.316**	0.085	0.223**
Panicle weight(gr)							1	0.232**	0.493**	-0.101	0.762**	0.067	0.449**
Flag leaf width(cm)								1	0.380**	0.103	0.115	0.206**	0.230**
Flag leaf length(cm)									1	-0.025	0.360**	0.065	0.280**
The number of productive tillers(m^2)										1	0.144*	-0.372**	0.412**
Grains per panicle											1	-0.393**	0.557**
1000-grain weight												1	0.086
Grain yield(t ha^{-1})													1

*, ** Significant at 5% and 1% respectively

Table 3: Path analysis of yield component on grain yield

characters	Days to flowering(d)	Days to maturity(d)	Plant height(cm)	Grain length (mm)	Grain width (mm)	Panicle length(cm)	Panicle weight(gr)	Flag leaf width (cm)	leaf length (Flag cm)	The number of productive tillers(m^2)	Grains per panicle	1000-grain weight
Days to flowering(d)	0.260**	0.184	0.014	0.016	-0.008	0.028	0.083	-0.030	0.074	0.012	0.058	-0.024
Days to maturity(d)	-0.063	-0.087	0.095	-0.054	0.02	0.023	-0.035	0.004	-0.025	-0.009	-0.036	0.014
Plant height(cm)	0.020	0.013	0.055	-0.030	0.005	0.012	0.032	0.017	0.024	0.024	0.007	0.002
Grain length(mm)	-0.005	-0.008	0.004	-0.038	-0.006	-0.013	-0.001	0.015	-0.002	-0.007	-0.002	0.012
Grain width(mm)	-0.058	-0.001	0.034	0.009	0.005	-0.041	0.004	0.012	-0.012	0.002	-0.003	0.034
Panicle length(cm)	0.053	0.038	0.033	0.04	0.046	0.10	0.05	-0.005	0.038	-0.017	0.031	-0.051
Panicle weight(gr)	0.037	0.127	-0.051	0.029	0.002	0.077	0.153	0.034	0.065	-0.024	0.121	0.008
Flag leaf width(cm)	-0.001	0.006	0.010	-0.04	0.042	-0.016	0.024	0.127	0.044	0.012	0.014	0.033
Flag leaf length(cm)	0.008	-0.002	-0.034	0.023	-0.003	0.008	0.011	0.018	0.022	-0.001	0.008	0.032
The number of productive tillers(m^2)	0.016	0.139	0.024	-0.019	-0.067	0.038	-0.03	0.03	-0.008	0.292**	0.045	-0.109
Grains per panicle												
1000-grain weight	0.052	0.136	0.028	0.055	-0.081	0.083	0.173	0.053	0.075	0.028	0.230**	-0.092
	0.019	0.001	0.024	0.075	-0.166	-0.019	-0.015	-0.045	-0.015	0.08	0.084	0.210**
Phenotypic correlation coefficient with yield	0.338**	0.541**	0.236**	-0.014	-0.201**	0.223**	0.449**	0.230**	0.280**	0.412**	0.557**	0.086

Residual=0.11, Diagonal values represents the direct effect, ** Significant at 1%

Similar observations were reported for plant height [32, 35] and grains per panicle [35]. At the phenotypic level, correlations of grain yield with grains per panicle, days to maturity (d), Panicle weight, the number of productive tillers and days to flowering were significantly positive (Table 2). These observations support the earlier findings [11, 32, 35]. The usefulness of conducting experiments in large number of environments is proved through the present study. The results reported here, particularly on grains per panicle and the number of productive tillers, may provide useful information for rice improvement programmers, especially for developing better quality types. Among all the yield traits, the number of productive tillers, days to flowering and grains per panicle showed the highest direct effect on grain yield per plant. The results are in conformity with Nayak *et al.* [36]. for the number of productive tillers and grain number Hasib and Kole [32]. for grain number and days to flowering and Khedikar ***et al.*** [12]. for the number of productive tillers and days to flowering. Positive correlation of a particular trait with yield does not necessarily mean a direct, positive effect of that trait on yield. From path analysis, Jangale ***et al.*** [14] also reported that days to flowering and grains per panicle were the most important traits contributing to grain yield. The present findings support this conclusion. The direct effects of the remaining traits in the present study were either positive or negative although comparatively lower in magnitude than mentioned in the earlier reports. The indirect effects were also either positive or negative but lower in magnitude, except those contributing via panicle weight. However, it may be emphasized that direct effect of days to maturity was negative and very low but indirect effect of this traits via the number of productive tiller and grains per panicle was as high as its genotypic correlation with grain yield (0.541). Thus, greater importance of the number of productive tiller and grains per panicle in breeding involving the present set of varieties is suggested.

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