Available online at http://www.journalcra.com

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

ISSN: 0975-833X

International Journal of Current Research
Vol. 2, pp. 092-095, March, 2010

RESEARCH ARTICLE

CAUSE AND EFFECT RELATIONS OF MORPHO-AGRONOMIC AND PHYSIO-BIOCHEMICAL TRAITS OF IMPORTANT RICE (*ORYZA SATIVA* L.) VARIETIES UNDER SUBTROPICAL CONDITIONS OF JAMMU

Hilal Ahmad B.B., Gupta S.M., Razvi[1] M., Ashraf Bhat[1] S., Najeeb[1], Nawsheeba Wani[1] K. A., Bhat[1] and Mir[2] M.R.

Division of Plant Breeding and Genetics, Main Campus Chatha, Sher-e-Kashmir University of Agricultural Sciences and Technology of JAMMU
[1]Division of Plant Breeding and Genetics, SKUAST (K), Shalimar- 191 121, Srinagar, J&K, INDIA
[2]Department of Botany, Aligarh Muslim University, Aligarh, UP

ARTICLE INFO

Article History:
Received 5th February, 2010
Received in revised form
28th February, 2010
Accepted 15th March, 2010
Published online 25th March, 2010

Key words:
Rice, Genotypic correlation
Phenotypic correlation
Moropho-agronomic
Physio-biochemical
Path analysis

ABSTRACT

The present studies were undertaken to find the selection criteria for higher rice yield which this would also help to select the genotypes possessing plant traits with maximum contribution to grain yield. The experimental material for the study comprised of sixteen genotypes of rice (*Oryza sativa* L.) grown in a randomized complete block design with three replications. The study revealed that genotypes differed significantly among themselves for all the characters viz., morpho-physiological, biochemical, yield and yield attributing traits. The genotypic correlation coefficient was higher than phenotypic correlation coefficient. Grain yield per plant was significantly and positively correlated with average panicle weight, harvest index and α-amylase. Path coefficient analysis revealed that characters like relative growth rate (RGR), net assimilation rate (NAR), leaf area duration (LAD), spikelet fertility, α-amylase, harvest index, peroxidase, flag leaf area, biomass yield, days to 50% flowering, spikelets per panicle and kernel density would be effective in improving the grain yield.

INTRODUCTION

Rice is one of the major food crops of the world and especially of China and India. In India the total area under rice is 44 m ha with a production of 97 m tones of milled rice and a productivity of just 2.2 t ha^{-1} which is just half of productivity of China (4.4 t ha^{-1}). The rice production and productivity status of Jammu region, of Jammu and Kashmir is still grim of just 1.6 t ha^{-1} (Anonymous, 2008) although blessed with wide germplasm base including indigenous landraces and export quality basmati rice. The inheritance of grain yield in a complex phenomena and is being influenced through number of moropho-genetic characters which in turn are made up of other component traits. Improvement in yield directly as well as indirectly through the improvement of its component traits to evolve a biologically superior and physiologically efficient genotype, are of eager need to feed our increasing population and to compete in the international market. Grain yield is the complex and highly variable trait, the expression of which depends upon the action and interactions of various components. Therefore, direct selection for it may not be very effective.

***Corresponding Author:** *mashrafbhat@rediffmail.com*

To understand the structure of yield, one has to prove it through the yield components, since there may or may not be genes for yield *per se* but only for various components which are relatively less complex and simply inherited (Graffins, 1959). Therefore, it is essential to comprehend the inter-relationship of various yield components in an interlinked complex system which probably may again be dependent on the material chosen for the study. In this inherited complex system, selection practiced for a character might subsequently bring about a correlated change in other. Thus, knowledge of association is a must for simultaneous improvement of plant traits. The correlation study among grain yield and its components provide the information about the plant performance traits and their genetic association with one another. Path analysis enables breeders to rank the genetic attributes according to their contribution (Dewey and Lu, 1959). A number of workers have studied the genetic association between moropho-agromonic, physiological and biochemical traits with grain yield. Raisheed et al. (2002); Sharma and Sharma (2007). The present studies were undertaken to find the selection criteria for higher rice yield, this would also help to select the genotypes possessing plant traits with maximum contribution to grain yield.

MATERIALS AND METHODS

The experimental material for the study comprised of 16 genotypes selected from diverse areas of Jammu Division which were grown during *Kharif*, 2005 in a randomized block design with three replications at the Research Farm, Division of Plant Breeding & Genetics, SKUAST-Jammu, Main Campus, Chatha. Each plot consisted of three rows of 1.5 m length with inter- and intra row distance of 20 and 15 cm, respectively. Five plants were randomly selected from each plot in each replication for different morpho-physiological traits viz. plant height (cm), number of productive tillers, days to 50% flowering (on plot basis), flag leaf area (cm^2) [FLA], spikelets per panicle, spikelet fertility (%), average panicle weight (g), 1000-grain weight (g), biomass yield (g), crop growth rate (CGR) [mg/g/pl/day], relative growth rate (RGR) [mg/g/pl/day] net assimilation rate (NAR) [mg/dm^2/day], leaf area index (LAI), leaf area duration (LAD), kernel density (ml/g), grain yield per plant (g) and harvest index (%). Biochemical studies were analysed for various characters such as esterases, α-amylase, peroxidase and soluble proteins by the method given by Bemfield (1955). Analysis of variance was done by the procedure described by Panse and Sukhatme (1978). The phenotypic and genotypic correlation coefficients were worked out according to the procedure suggested by Al-Jibouri *et al*. (1958) using variance and covariance components. Path coefficient analysis was utilized by partitioning the genotypic correlation coefficients into direct and indirect effects as per (Dewey and Lu, 1959).

Table 1: Genotypic (G) and phenotypic (P) correlation coefficients among grain yield and yield attributing traits

Characters		Days to 50% flowering	Flag leaf area (cm^2)	No. of productive tillers	Spikelets per panicle	Spikelet fertility (%)	Average panicle weight (g)	Biomass yield (g)	1000-grain weight (g)	Kernel density (ml/g)	Harvest index (%)	Grain yield (g)
Plant height	G	-0.22	0.82**	0.76**	0.49*	0.59*	-0.34	0.53*	-0.16	0.23	-0.51	-0.14
(cm)	P	-0.17	0.73**	0.26	0.32	0.27	-0.21	0.43	-0.16	0.16	0-.42	-0.10
Days to50%	G		0.002	0.38	0.61*	-0.45	0.55*	-0.42	0.99**	0.04	-0.02	-0.27
flowering	P		-0.01	0.94**	-0.67**	-0.34	0.47	-0.31	0.56*	0.03	-0.01	-0.98
Flag leaf	G			0.15	0.37	0.18	-0.31	0.22	-0.11	0.14	-0.50*	-0.39
Area (cm^2)	P			0.66**	0.25	0.18	-0.21	0.20	-0.08	0.08	-0.45	-0.37
No. of productive	G				0.67**	0.17	0.39	0.96**	0.11	-0.87**	-0.77**	-0.41
tillers	P				0.41	0.01	0.02	0.14	0.06	-0.11	-0.66**	-0.13
Spikelets	G					0.09	0.02	0.65**	-0.21	-0.62**	-0.72**	-0.25
per panicle	P					0.10	0.10	0.29	-0.17	-0.30	-0.35	-0.16
Spikelet fertility	G						-0.57*	0.69**	-0.13	0.002	-0.46	0.32
(%)	P						-0.30	0.17	-0.18	-0.002	-0.10	0.24
Average panicle	G							0.18	0.28	-0.12	0.32	0.52*
weight (g)	P							0.05	0.21	0.09	0.17	0.35
Biomass yield	G								0.22	-0.29	-0.59*	0.27
(g)	P								0.18	-0.13	-0.69**	0.16
1000-grain	G									0.46	-0.02	0.18
weight (g)	P									0.34	-0.05	0.12
Kernel density	G										0.37	0.10
(mi/g)	P										0.19	0.06
Harvest index	G											0.61*
(%)	P											0.56*

*Significant at 5% level, ** Significant at 1% level

Table 2: Genotypic (G) and phenotypic (P) correlation coefficients among grain yield, physiological and biochemical traits

Characters		RGR (mg/g/pl/day)	NAR (mg/dm^2/day)	LAI	LAD	Esterase	α- amylase	Peroxidase	Soluble proteins	Grain yield (g)
CGR	G	0.94**	0.04	0.03	0.03	-0.21	0.46	0.20	-0.22	0.36
(mg/pl/day)	P	0.88**	0.002	0.001	0.08	-0.08	0.35	0.14	0.10	0.18
RGR	G		-0.01	-0.12	-0.11	0.0008	0.49*	0.22	0.01	0.39
(mg/g/pl/day)	P		-0.21	-0.01	-0.01	0.07	0.33	0.15	0.03	0.18
NAR	G			-0.83**	-0.83**	-0.49*	0.47	-0.79**	-0.42	0.32
mg/dm²/day)	P			-0.62**	-0.62**	-0.33	0.36	-0.52*	-0.28	0.24
LAI	G				1.00	-0.21	-0.51*	0.60*	-0.07	-0.37
	P				0.99**	0.17	-0.50*	0.56*	-0.05	-0.40
LAD	G					0.21	-0.51*	0.59*	-0.07	-0.39
	P					0.16	-0.50*	0.55*	-0.05	-0.37
Esterase	G						-0.10	-0.02	-0.19	0.34
	P						-0.10	-0.003	.-0.10	0.30
α-- amylase	G							-0.52*	-0.22	0.73**
	P							-0.50*	-0.22	0.65**
Peroxidase	G								0.19	-0.39
	P								0.18	-0.36
Soluble	G									-0.42
proteins	P									-0.39

* Significant at 5% level, ** Significant at 1% level, CGR = crop growth rate, RGR = relative growth rate, NAR = net assimilation rate, LAI = leaf area index, LAD = leaf area duration

RESULTS

The results revealed that the genotypic correlations were slightly higher than their respective phenotypic correlations for most of the traits (Table 1 and 2). This indicated that there is strong inherent association between the various traits, suggesting that the phenotypic expression of correlation is reduced under the influence of environment. In some cases, however, the genotypic correlation coefficients were lower than their phenotypic correlation coefficient. The present investigation revealed that grain yield showed positive significant correlation with average panicle weight, harvest index and α-amylase (Tables 1 and 2). Present results further revealed highly significant correlation of spikelets per panicle with biomass yield (genotypic level) and negative significant correlation with kernel density and harvest index (genotypic level). Spikelet fertility exhibited highly significant association with biomass yield (genotypic level) and negative significant correlation with average panicle weight (genotypic level).

Plant height showed positive significant correlation with flag leaf area (both at phenotypic and genotypic level) and number of productive tillers, spikelets per panicle, spikelet fertility and biomass yield (genotypic level). Days to 50% flowering showed highly positive correlation with 1000-grain weight (both at genotypic and phenotypic levels) and spikelet per panicle, average panicle weight (genotypic level) and negative significant correlation with spikelets per panicle (phenotypic level). Flag leaf area exhibited high positive significant correlation with number of productive tillers (phenotypic level) and negative significant correlation with harvest index (genotypic level). Number of productive tillers showed positive significant correlation with spikelets per panicle (both genotypic and phenotypic levels) and biomass yield (genotypic level) and negative significant correlation with harvest index and kernel density (phenotypic level). The interrelationship of physio-biochemical traits in the present study revealed positive and significant association of grain yield with α-amylase and in turn α-amylase depicted negative significant association with peroxidase. CGR showed highly positive significant correlation with RGR. RGR exhibited positive significant correlation with α-amylase. NAR exhibited highly negative significant genotypic and phenotypic associations with LAI, LAD, peroxidase and genotypic correlation with esterase. LAD and peroxidase showed positive and significant association (genotypic and phenotypic levels) with LAI, however, LAD in turn depicted positive and significant correlation (genotypic and phenotypic) with peroxidase and negative and significant correlation with α-amylase.

When more variables are considered in the correlation studies, the association becomes more complex, less obvious and sometimes confusing. At this point it would appear appropriate to employ path analysis which takes into account the knowledge that we have with regard to the causal relation between the characters of correlation. The knowledge of direct and indirect effect of yield contributing characters on the ultimate end product i.e. grain yield, in any crop is of prime importance in selecting high yielding genotypes.

Path coefficient analysis revealed that RGR, NAR, LAD, spikelet fertility, α-amylase, harvest index, average panicle weight, peroxidase, LAI, flag leaf area, biomass yield, days to 50% flowering, spikelets per panicle and kernel density had direct positive effects towards the grain yield, whereas, characters like CGR, plant height, 1000-grain weight, number of productive tillers, esterases and soluble proteins had negative direct effects towards grain yield (Tables 3 and 4). Path coefficient analysis of physio-biochemical traits (Table 4) revealed that high direct effect of α-amylase was realized in the form of positive and significant correlation coefficient with grain yield. It also had high positive indirect effect via RGR and NAR.

Table 3: Path coefficient analysis showing direct and indirect effect of yield attributing traits on grain yield in rice

Characters	Plant height (cm)	Days to 50% flowering (No.)	Flag leaf area (cm^2)	No. of productive tillers	Spikelets per panicle (No.)	Spikelet fertility (%)	Average Panicle weight (g)	Biomass yield (g)	1000-grain weight (g)	Kernel density (ml/g)	Harvest index (%)
Plant height (cm)	-0.8091	-0.0895	0.5517	-0.1921	0.0332	0.9086	-0.3063	0.2346	0.0644	0.0055	-0.5409
Days to 50% flowering (No.)	0.1780	0.4075	0.0013	-0.0961	0.0414	0.6930	0.4955	-0.1859	-0.3984	0.0010	-0.0212
Flag leaf area (cm^2)	-0.6635	0.0008	0.6728	-0.0379	0.0251	0.2772	-0.2793	0.0974	0.0443	0.0033	-0.5303
No. of productive tillers	-0.6149	0.1548	0.1009	-0.2528	0.0454	0.2618	0.3514	0.4250	-0.0443	-0.0207	-0.8166
Spikelets per panicle (No.)	-0.3965	0.2486	0.2489	-0.1694	0.0678	0.1386	0.0180	0.2878	0.0845	-0.0148	-0.7636
Spikelet fertility (%)	-0.4774	-0.1834	0.1211	-0.0430	0.0061	1.5401	-0.5135	0.3055	0.0523	0.0000	-0.4878
Average Panicle weight (g)	0.2751	0.2241	-0.2086	-0.0986	0.0014	-0.8778	0.9009	0.0797	-0.1127	-0.0029	0.3394
Biomass yield (g)	-0.4288	-0.1711	0.1480	-0.2427	0.0183	1.0626	0.1622	0.4427	-0.0885	-0.0069	-0.6257
1000-grain weight (g)	0.1295	0.4034	-0.0740	-0.0278	0.0122	-0.2002	0.2523	0.0974	-0.4025	0.0110	-0.0212
Kernel density	-0.1861	0.0163	0.0942	0.2200	-0.0420	0.0031	-0.1081	-0.1284	-0.1851	0.0238	0.3924
Harvest index (%)	0.4127	-0.0081	-0.3364	0.1947	-0.0488	-0.7084	0.2883	-0.2612	0.0080	0.0088	1.0605

Residual = -0.4853

4. Efficient analysis showing direct and indirect effect of various physiological and biochemical traits on grain yield in rice

Characters	CGR (mg/pl/day)	RGR (mg/g/pl/day)	NAR ($mg/dm^2/day$)	LAI	LAD	Esterase	α-amylase	Peroxidase	Soluble proteins
CGR (mg/pl/day	-4.5367	3.9443	0.1071	0.0217	0.0561	0.0269	0.5628	0.1636	0.0141
RGR (mg/g/pl/day)	-4.2645	4.1961	-0.0268	-0.0869	-0.2057	-0.0010	0.5996	0.1799	-0.0006
NAR ($mg/dm^2/day$)	-0.1815	-0.0420	2.6780	-0.6014	-1.5519	0.0627	0.5751	-0.6461	0.0270
LAI	-0.1361	-0.5035	-2.2227	0.7245	1.8698	0.0269	-0.6240	0.4907	0.0045
LAD	-0.1361	-0.4616	-2.2227	0.7245	1.8698	-0.0269	-0.6240	0.4825	0.0045
Esterase	0.9527	0.0336	-1.3122	-0.1521	0.3927	-0.1281	-0.1224	-0.0164	0.0122
α-amylase	-2.0869	2.0561	1.2587	-0.3695	-0.9536	0.0128	1.2236	-0.4253	0.0141
Peroxidase	-0.9073	0.9231	-2.1156	0.4347	1.1032	0.0026	-0.6363	0.8178	-0.0122
Soluble proteins	0.9981	0.0420	-1.1248	-0.0507	-0.1309	0.0243	-0.2692	0.1554	-0.0642

Residual = 0.4923

CGR = crop growth rate, RGR = relative growth rate, NAR = net assimilation rate, LAI = leaf area index, LAD = leaf area duration

CGR had negative direct effect on the grain yield but indirect effect via RGR counterbalanced it. RGR and NAR had both high direct effects with grain yield but were dissipated through RGR and LAD respectively. LAI and LAD showed direct positive effects but negative correlation coefficient because effect was counterbalanced through NAR. Peroxidases showed positive direct effect on the grain yield and also contributed indirectly via LAI and LAD. Soluble proteins exhibited negative direct effect on the grain yield, but its indirect effects via CGR and peroxidases counterbalanced the effect.

DISCUSSION

The results revealed that the genotypic correlations were slightly higher than their respective phenotypic correlations for most of the traits. Shrivastava *et al.* (1983) and Katiyar and Singh (1974) also observed higher genotypic correlation coefficients than the corresponding phenotypic ones of morpho-agronomic traits. These findings are in close conformity with the observations of Vachhani and Rao (1965) and Ahmad and Rao (1967). Important grain yielding attribute i.e. 1000-grain weight exhibited positive non-significant correlation with kernel density and grain yield. Soga and Nozaki (1957) and Mutsushima (1970) reported 1000-grain weight may effect grain yield to some extent but rarely becomes limiting factor under most conditions, because grain size is rigidly controlled by the hull size and under most conditions is a very stable varietal character. Vaisc *et al*. (2001). Used various ideas of selection for improvement of grain yield. The conventional path analysis or one carried out in the present study suffers from the limitations of dependence of predictor variables often leading to high multicallinearity. In fact (Samonte *et al*., 1998). Prepared a sectional path analysis which is based on minimizing multicollinearity due to complex interaction of yield component traits and delineates the importance of mediator variables into various orders based in their direct effects. Thus multiple regression based path analysis can be improved by stepwise regression analysis by sequentially remaining the non significant predictor variables from analysis besides more and more traits can be included in the path analysis in order to reduce the residual effect.

Plant height had high negative direct effect on grain yield. This negative effect was counter balanced by indirect effects via flag leaf area, spikelet fertility, biomass yield and thus revealed small negative non-significant correlation with grain yield. Days to 50% flowering and flag leaf area had high positive direct effect but that did not correspond to their non-significant and negative association with grain yield. Flag leaf area had high positive direct effect on grain yield and it contributed indirectly via spikelet fertility, days to 50% flowering, spikelets per panicle, biomass yield, 1000-grain weight and kernel density. Direct effects of average panicle weight and harvest index where in conformity with the significant and positive correlation coefficients with grain yield, however, there was not a close correspondence between their direct effects and grain yield, in fact, were counter balanced by the negative indirect effect via spikelet fertility. These results were in agreement with the findings of Li *et al.* (1991).

The biomass yield has high direct positive effective on grain yield, it also contributed considerably via spikelet fertility, flag leaf area and average panicle weight. Whileas 1000-grain weight had negative direct effect on grain yield, but was counterbalanced by its indirect effects via plant height, days to 50% flowering and average panicle weight. These findings were also reported by Surek *et al.* (1998). The results are in contrast to the study of Sharma and Mani (1997). Thus path analysis study suggested that characters like RGR, NAR, LAD, spikelet fertility, α-amylase, harvest index, peroxidase, flag leaf area, biomass yield, days to 50% flowering and spikelets per panicle are effective in improving the grain yield through selection.

REFERENCES

Ahmad, M. K and Rao, R.S. 1967. Studies in the correlation between yield and yield components in hybrid rice. *Indian J. Agron.* 12:34-36.

Al-Jibouri, H.A, Miller, P.A and Robinsen, H.F. 1958. Genotypic and environmental variances and covariances in an upland cotton cross of interspecific origin. *Agron. J.* 50 :633-636.

Anonymous, 2007. Statistical Digest. Directorate of Economics and Statistics, Government of Jammu and Kashmir.

Bemfield, P. 1955. In: Methods Enzymol. Academic press, New York, pp. 1-149.

Dewey, D. R and Lu, K. H. 1959. A correlation and path coefficient analysis of components of crusted wheat grass and seed production. *Agronomy J.* 51: 515-518.

Grafins, J. E. 1959. Heterosis in barley. *Agronomy J.* 51: 551-554.

Katiyar, R. P and Singh, B. 1974. Interrelationship among yield and its components in Indian mustard. *Indian J. Agric. Sci.* 44:287-289.

Li, Q.L, Li, V. T, Gou, G. Z, Jiang, G and Zhu, Y. 1991. Study on high yield breeding and genetic analysis of yield components of main rice cultivars in Jilin, China. *Heredita-Beijing*. 13: 3-6.

Matsushima, S. 1970. In *"Crop Science in Rice"*. Fuji Publishing Company Limited, Tokyo, Japan. pp. 25-60.

Panse, V. G and Sukhatme, P. V. 1978. Statistical methods for agricultural workers. ICAR, New Delhi. pp. 97-123.

Rasheed, M.S, Sadaqat, H.A and Baber, M. 2002. Interrelationship among grain quality traits of rice (*Oryza sativa* L.). *Asian J. of Plant Sci.* 3: 245-247.

Sharma, A. K and Sharma, R.N. 2007. Genetic variability and character association in early maturing rice. *Oryza* 44: 300-303.

Sharma, J. P and Mani, S. C. 1997. Analysis of biochemical parameters at boot stages in rice (*Oryza sativa* L.). *Indian J. Genet*. 57: 238-242.

Soga, Y and Nozaki, M. 1957. Studies on the relation between seasonal changes of carbohydrates accumulated and the ripening stage of generative growth in rice plant. *Proceeding Crop Sciences Society Japan,* 26: 105-108.

Srivastava, L. S, Wani, S. A and Dixit, R. K. 1983. Genetic association in Indian mustard. *Indian J. Agric. Sci.* 53: 778-781.

Surek, H, Korkut, Z. K and Bilgin, O. 1998. Correlation and path analysis for yield and yield components in rice in a 8-parent half diallel set of crosses.*Oryza*. 35: 15-18.

Vachhani, M. V and Rao, M.V. 1965. Relative efficacy of nitrogenous fertilizers for rice in rice. *Rice News Lett.* 13: 71-76.

Samonte, S.G., Wilson, L.T. and Mcclung, A. 1998. Path analysis of yield and yield related traits of 15 rice genotypes. *Crop Sci.* 38: 1130-1136.

Vasic, N, Ivcnovic, M, Jockovic, D, Stojakovic, M and Bocanksi, J. 2001. Genetic relationship between grain yield and its components in a synthetic maize population and their implecation in selection. *Acta Agron. Flumg*. 49(4): 337-342.

****