The Ecoscan 10(1&2): 191-195, 2016 (Supplement on Rice)
AN INTERNATIONAL QUARTERLY JOURNAL OF ENVIRONMENTAL SCIENCES
www.theecoscan.com

INTERRELATIONSHIP AND CAUSE-EFFECT ANALYSIS OF BASMATI RICE (*Oryaza sativa* L.) GENOTYPES

UMESH*, H. K. JAISWAL, SHOWKAT A. WAZA, T. SRAVAN AND MUKH RAM
Department of Genetics and Plant Breeding,
Institute of Agricultural Sciences, Banaras Hindu University, Varanasi - 221 005, Uttar Pradesh, INDIA
e-mail: umesh7155@gmail.com

ABSTRACT

A study of interrelationship and cause-effect analysis of grain yield and its component traits was carried out using twenty four rice genotypes. Grain yield per plant had significant positive correlation with spikelets per panicle, effective tillers per plant, flag leaf length, spikelet fertility, main panicle length and it shows negative significant association with plant height. Path analysis revealed that the maximum direct effect for yield was observed for days to 50% flowering followed by effective tillers per plant and spikelets per panicle. Days to 50% flowering and effective tillers per plant had high significant overall effect on yield. There is not a single quality trait significantly contributing to the yield although some traits had positive indirect effect. The overall effect of days to 50% flowering on yield per plant is more than the direct effect. It is due to positive indirect effects via days to maturity, effective tillers per plant and spikelet per panicle. Thus these are important plant traits which should be considered when any breeding program for higher yield in rice is to be planned.

KEY WORDS
Correlation
Path analysis
Direct effect
Indirect effect

Received : 06.06.2015
Revised : 03.03.2016
Accepted : 14.05.2016

*Corresponding author

INTRODUCTION

Rice is the staple food for two thirds of the Indian population. It contributes 43 per cent of caloric requirement and 20-25% of agricultural income. The area grown under rice (45.5 million hectares) in India is the largest among all the rice growing countries and it ranks second in production after China (MOA & FCI, 2011). Keeping in mind the future demand of rice as a food for mankind, there is a continuous need to evolve new varieties, which should exceed the existing varieties in yield. The knowledge of patterns of genetic variation of a crop species in any given region or country is very important for planning future germplasm collection missions and for efficient utilization of collected germplasm in crop improvement programmes (Nagi *et al.*, 2013).The basic objective of most of the crop improvement programs is to realize a marked improvement in crop yield. But yield is a complex character which is controlled by association of various characters. Before placing strong emphasis on breeding for yield improvement, the knowledge on the association between yield and yield attributes will enable the breeder to improvement this trait. The correlation coefficient may also help to identify characters that have little or no importance in the selection programme (Singh *et al.,* 2013). The existence of correlation may be attributed to the presence of linkage or pleiotropic effect of genes or physiological and development relationship or environmental effect or in combination of all (Oad *et al.,* 2002). The information on association of yield attributes and their direct and indirect effects on grain yield are of paramount significance. Hence, path analysis is of much importance in any plant breeding program. Path analysis permits the partitioning of the correlation coefficient into its components, one component being the path coefficient that measures the direct effect of a predict or variable upon its response variable; the second component being the indirect effect (s) of a predictor variable on the response variable through another predictor variable (Deweyand Lu, 1959). In agriculture, path analysis has been used by plant breeders to assist in identifying traits that are useful as selection criteria to improve crop yield (Dhanwani *et al.,* 2013; Surek and Beser, 2003). The present study was conducted to find out the genetic association among different plant traits, direct and indirect contribution of these parameters towards grain yield and to identify better combinations as selection criteria for developing high yielding rice genotypes.

MATERIALS AND METHODS

The present study entitled "Interrelationship and cause-effect analysis in basmati rice (*Oryza sativa* L)" was carried out during *kharif* 2013 at Agricultural Sciences research farm, Banaras Hindu University, Varanasi, Uttar Pradesh. The experiment was laid out in a Randomized Block Design (RBD) with three replications. The experimental material was planted in three blocks. Each block consisted of twenty four genotypes randomized and replicated within each block. Twenty five days old seedlings were transplanted 20 cm apart between rows and 15 cm within the row. All necessary precautions were taken to maintain uniform plant population in each treatment per replication. All the recommended package of practices was followed along with necessary prophylactic plant protection measures to raise a good crop. Observations were recorded and the data was subjected to statistical analysis. Statistical analyses were done following Singh and Chaudhary (1985) for correlation coefficient and Dewey and Lu (1959) for path analysis.

RESULTS AND DISCUSSION

Correlation coefficients

The result of simple linear correlation coefficients between all pairs of trait are shown in Tables 1, 2, 3 and 4 at genotypic and phenotypic level for yield and quality trait. Selection based on the detailed knowledge of magnitude and direction of association between yield and its attributes is very important in identifying the key characters, which can beexploited for crop improvement through suitable breeding programme.

Table 1: Estimation of genotypic correlation coefficient among yield and yield trait

	DTF50%	DTM	FLL	FLW	PH	MPL	ET/P	SPP	SPF	100SW	GYP
DTF50%	1.0000	1.0078	0.0451	-0.1434	-0.0425	-0.2004	0.1494	0.1383	-0.2839*	0.1559	0.0295
DTM		1.0000	0.0057	-0.1316	-0.0340	-0.2222	0.1594	0.1438	-0.2979*	0.1825	-0.0030
FLL			1.0000	0.3674**	-0.2214	0.0682	0.1657	0.4407**	0.2624*	-0.1665	0.5110**
FLW				1.0000	-0.4817**	-0.3261**	0.1449	0.4274**	-0.3363**	0.2579	-0.0431
PH					1.0000	0.2897*	-0.1173	-0.5827**	0.2734*	-0.4383**	-0.2820
MPL						1.0000	0.3653**	-0.0002	0.4215**	-0.2721	0.3666**
ET/P							1.0000	0.3399**	0.2006	-0.0900	0.5119**
SPP								1.0000	0.2583*	-0.0626	0.5650**
SPF									1.0000	-0.4122	0.5881**
100SW										1.0000	-0.1751
GYP											1.0000

"* and ** indicate significant at p = 0.1 and 0.05, respectively; Where: DTF50% = Days to 50 % flowering,DTM = Days to maturity,FLL = Flag leaf length,FLW = Flag leaf width,PH = Plant height,MPL = Main panicle length, ET/P = Effective tiller per plant,SPP = Spikelet per panicle, SPF = Spikelet fertility,100SW = 100-seed weight, GY/ P = Grain yield per plant

Table 2: Estimation of phenotypic correlation coefficient among yield and yield trait

	DTF50%	DTM	FLL	FLW	PH	MPL	ET/P	SPP	SPF	100SW	GYP
DTF50%	1.0000	0.9686**	0.0358	-0.0734	-0.0342	-0.1373	0.1314	0.1289	-0.1390	0.1491	0.0175
DTM		1.0000	-0.0077	-0.0633	-0.0327	-0.1645	0.1277	0.1337	-0.0879	0.1694	0.0202
FLL			1.0000	0.1998	-0.2104	0.0957	0.1548	0.3969	0.1187	-0.1564	0.4651**
FLW				1.0000	-0.3054**	-0.2181	0.0760	0.2761*	-0.1061	0.1621	-0.0332
PH					1.0000	0.1843	-0.1143	-0.5770	0.1351	-0.4295**	-0.2776*
MPL						1.0000	0.2500*	0.0237	-0.0302	-0.1921	0.2670*
ET/P							1.0000	0.3261	0.1336	-0.0955	0.4989**
SPP								1.0000	0.1314	-0.0606	0.5344**
SPF									1.0000	-0.2104	0.4008**
100SW										1.0000	-0.1713
GYP											1.0000

* and ** indicate significant at p = 0.1 and 0.05, respectively

Table 3: Estimation of genotypic correlation coefficient among quality traits

	KL	KB	KLAC	ASV	GT	AC
KL	1.000	0.4042**	0.7650**	0.3581**	-0.3320**	0.4080**
KB		1.000	0.6621**	0.3524**	-0.3302**	0.1235
KLAC			1.000	0.6514**	-0.6209**	0.4051**
ASV				1.000	-0.9448**	0.4844**
GT					1.000	-0.5043**
AC						1.000

* and ** indicate significant at p = 0.1 and 0.05, respectively

Table 4: Estimation of phenotypic correlation coefficient among quality traits

	KL	KB	KLAC	ASV	GT	AC
KL	1.000	0.3659**	0.7555**	0.3530**	-0.3105**	0.3977**
KB		1.000	0.6064**	0.3210**	-0.3001*	0.1174
KLAC			1.000	0.6433**	-0.5941**	0.3987**
ASV				1.000	-0.9210**	0.4814**
GT					1.000	-0.4983**
AC						1.000

* and ** indicate significant at p = 0.1 and 0.05, respectively;
Where, KL = Kernel length, KB = Kernel Breadth, KLAC = Kernel length after cooking, ASV = Alkali spread value, GT = Gelatinization temperature, AC = Amylose content.

Table 5: Direct (diagonal) and indirect effect of component traits contributing to yield in basmati genotype at phenotypic level.

Character	DTF50%	DTM	FLL	FLW	PH	MPL	ET/P	SPP	SPF	100SW	KL	KB	KLAC	ASV	GT	AC	GYP	R value
DTF50%	0.408	-0.445	0.010	0.005	0.002	0.000	0.041	0.040	-0.032	-0.048	-0.008	-0.018	0.135	-0.173	0.087	0.012	0.017	0.0071
DTM	0.395	-0.459	-0.002	0.004	0.002	0.000	0.040	0.041	-0.020	-0.055	-0.009	-0.024	0.129	-0.156	0.081	0.012	-0.020	0.0093
FLL	0.015	0.004	0.287	-0.014	0.012	0.000	0.049	0.122	0.028	0.050	-0.014	0.008	-0.015	-0.185	0.131	-0.012	0.465	0.1335
FLW	-0.030	0.029	0.057	-0.070	0.017	-0.001	0.024	0.085	-0.025	-0.052	0.006	-0.006	0.008	-0.200	0.152	-0.028	-0.033	0.0023
PH	-0.014	0.015	-0.060	0.021	-0.057	0.000	-0.036	-0.178	0.031	0.138	-0.023	0.021	-0.226	0.323	-0.287	0.052	-0.278	0.0157
MPL	-0.056	0.075	0.027	0.015	-0.010	0.002	0.078	0.007	-0.007	0.062	0.004	0.015	-0.001	0.031	0.014	0.009	0.267	0.0006
ET/P	0.054	-0.059	0.044	-0.005	0.006	0.001	0.314	0.100	0.031	0.031	-0.026	0.024	-0.027	-0.005	0.001	0.014	0.499	0.1565
SPP	0.053	-0.061	0.114	-0.019	0.033	0.000	0.102	0.308	0.031	0.019	-0.037	-0.016	0.057	-0.257	0.218	-0.008	0.534	0.1644
SPF	-0.057	0.040	0.034	0.007	-0.008	0.000	0.042	0.040	0.232	0.068	-0.016	-0.008	-0.041	0.102	-0.050	0.015	0.401	0.0931
100SW	0.061	-0.078	-0.045	-0.011	0.024	0.000	-0.030	-0.019	-0.049	-0.322	0.073	-0.097	0.431	-0.256	0.183	-0.037	-0.171	0.0551
KL	-0.029	0.038	-0.037	-0.004	0.012	0.000	-0.074	-0.106	-0.035	-0.216	0.108	-0.057	0.460	-0.205	0.140	-0.045	-0.051	-0.0055
KB	0.046	-0.070	-0.014	-0.003	0.008	0.000	-0.047	0.031	0.012	-0.199	0.039	-0.157	0.369	-0.187	0.135	-0.013	-0.050	0.0078
KLAC	0.090	-0.097	-0.007	-0.001	0.021	0.000	-0.014	0.029	-0.016	-0.228	0.082	-0.095	0.609	-0.374	0.268	-0.045	0.222	0.1351
ASV	0.121	-0.123	0.092	-0.024	0.031	0.000	0.003	0.136	-0.041	-0.142	0.038	-0.050	0.392	-0.581	0.415	-0.054	0.212	-0.1235
GT	-0.079	0.083	-0.084	0.023	-0.036	0.000	-0.001	-0.149	0.026	0.130	-0.034	0.047	-0.362	0.535	-0.451	0.056	-0.293	0.1323
AC	-0.044	0.049	0.031	-0.018	0.026	0.000	-0.039	0.023	-0.030	-0.104	0.043	-0.018	0.243	-0.280	0.225	-0.113	-0.007	0.0008

R Square = 0.8637; Residual Effect = 0.3692

Table 6: Direct (diagonal)and indirect effect of component traits contributing to yield in basmati genotype at genotypic level.

Character	DTF50%	DTM	FLL	FLW	PH	MPL	ET/P	SPP	SPF	100SW	KL	KB	KLAC	ASV	GT	AC	GYP	R value
DTF50%	0.065	0.093	0.008	-0.057	0.023	-0.070	-0.007	-0.036	-0.188	-0.006	0.034	-0.061	0.281	-0.033	-0.041	0.026	0.030	0.0019
DTM	0.065	0.093	0.001	-0.053	0.018	-0.078	-0.008	-0.038	-0.198	-0.008	0.048	-0.086	0.279	-0.031	-0.036	0.028	-0.003	-0.0003
FLL	0.003	0.001	0.175	0.147	0.120	0.024	-0.008	-0.115	0.174	0.007	0.077	0.041	-0.017	-0.036	-0.057	-0.024	0.511	0.0892
FLW	-0.009	-0.012	0.064	0.399	0.262	-0.115	-0.007	-0.112	-0.223	-0.011	-0.039	-0.029	0.031	-0.055	-0.106	-0.081	-0.043	-0.0172
PH	-0.003	-0.003	-0.039	-0.192	-0.544	0.102	0.006	0.152	0.182	0.018	0.120	0.090	-0.460	0.060	0.126	0.103	-0.282	0.1533
MPL	-0.013	-0.021	0.012	-0.130	-0.158	0.352	-0.017	0.000	0.280	0.011	-0.052	0.078	-0.013	0.009	0.002	0.028	0.367	0.1289
ET/P	0.010	0.015	0.029	0.058	0.064	0.128	-0.048	-0.089	0.133	0.004	0.139	0.110	-0.065	-0.002	-0.002	0.028	0.512	-0.0244
SPP	0.009	0.013	0.077	0.171	0.317	0.000	-0.016	-0.261	0.171	0.003	0.201	-0.066	0.108	-0.048	-0.097	-0.017	0.565	-0.1477
SPF	-0.018	-0.028	0.046	-0.134	-0.149	0.148	-0.010	-0.068	0.664	0.017	0.190	-0.037	-0.167	0.034	0.045	0.054	0.588	0.3905
100SW	0.010	0.017	-0.029	0.103	0.238	-0.096	0.004	0.016	-0.274	-0.042	-0.387	-0.424	0.890	-0.048	-0.083	-0.073	-0.175	0.0073
KL	-0.004	-0.008	-0.024	0.028	0.117	0.033	0.012	0.094	-0.225	-0.029	-0.559	-0.247	0.939	-0.038	-0.064	-0.090	-0.065	0.0362
KB	0.006	0.013	-0.012	0.019	0.080	-0.045	0.009	-0.028	0.040	-0.029	-0.226	-0.610	0.813	-0.038	-0.063	-0.027	-0.098	0.0597
KLAC	0.015	0.021	-0.002	0.010	0.204	-0.004	0.003	-0.023	-0.090	-0.030	-0.428	-0.404	1.228	-0.070	-0.119	-0.090	0.220	0.2702
ASV	0.020	0.027	0.058	0.207	0.305	-0.029	-0.001	-0.118	-0.212	-0.019	-0.200	-0.215	0.800	-0.107	-0.181	-0.107	0.227	-0.0243
GT	-0.014	-0.017	-0.052	-0.220	-0.356	0.004	0.000	0.132	0.156	0.018	0.186	0.201	-0.762	0.101	0.192	0.111	-0.321	-0.0616
AC	-0.008	-0.012	0.019	0.146	0.255	-0.044	0.006	-0.020	-0.162	-0.014	-0.228	-0.075	0.497	-0.052	-0.097	-0.221	-0.009	0.0021

R Square = 0.8637; Residual Effect = 0.3692

Phenotypic and genotypic correlations between yield and yield components *viz.,* days to 50 per cent flowering, plant height, flag leaf length, flag leaf width, panicle length, number of panicles per plant, number of spikelet's per panicleand 100 grains weight were computed separately for rice genotypes. The results are presented in Table 1. The result revealed that the estimates of genotypic coefficients were higherthan phenotypic correlation coefficients for most of the characters under study which indicated strong inherentassociation between the characters which might be due tomasking or modifying effects of environment.Days to 50 per cent flowering registered strong and positivesignificant correlation with number of spikelets per panicle,days to maturity and grain yield per hill, while negativeassociation with number of tillers per hill and number ofpanicles per hill.This corroborates with the findings of Reddy *et al.* (2008), Babu *et al.* (2006) and Saravanan and Sabesan(2009) for days to maturity.The association expressed by plantheight with flag leaf length, flag leaf width, number of spikelets per panicle and panicle length wassignificant and positive at both levels (Table 1 and 2). It suggests that,priority should be given to these traits while making selectionfor yield improvement. A similar result for plant heightassociation with panicle length was reported by Eradasappa *et al.* (2007) and Jayasudha and Sharma (2010). Thecorrelation of number of spikelets per panicle exhibitedpositiveand significant association with panicle length andbiological yield per hill. Similar results were reported bySeyoum *et al.* (2012). Plant height, number of spikelets perpanicle, panicle length and flag leaf length had strong and positivesignificant association with grain yield per plant. It indicatedthat grain yield can be increased whenever there is an increasein characters that showed positive and significant associationwith grain yield. Hence, these characters can be consideredas criteria for selection for higher yield as these were mutuallyand directly associated with yield. Chakraborty and Chakraborty (2010), HossainandHoque (2003), Singh *et al.* (2002) and Biswas *et al.* (2000) reported positive significant association of paniclelength with grain yield per plant. The positive significant of number of spikelets per panicle with yield was supported by Mustafa and Elsheikh (2007). Grain yield per plant recorded significant and negative correlation with plant height, where as it show non significant and negative correlation with 100 seed weight and flag leaf width both at genotypic and phenotypic levels. Similar negative correlation was also reported by Kole *et al.* (2008). The genetic reasons for this type of negative association may be linkage or pleiotropy. According to Ne Wall and Eberhart (1961) when two characters show negative phenotypic and genotypic correlation it would be difficult to exercise simultaneous selection for these characters in the development of a variety.Hence, under such situations, judicious selection programmemight be formulated for simultaneous improvement of suchimportant developmental and component characters.

Among quality traits amylose content showed significant positive association with kernel length, kernel length after cooking, alkali spreading value and showed significant negative association with gelatinization temperature at both genotypic and phenotypic levels (Table 3 and 4). Kernel length is such a quality trait that decides market price of rice so it was important to know its interaction with other quality traits. Kernel length shows significant positive correlation with kernel breadth, kernel length after cooking, alkali spreading value, amylose content and showed significant negative association with gelatinization temperature at both levels (Table 3&4).

Path coefficients

Simple correlation does not provide the true contribution of the characters towards the yield; the genotypic correlationswere partitioned into direct and indirect effects through pathcoefficient analysis. It allows separating the direct effect andtheir indirect effects through other attributes by apportioningthe correlations (Wright, 1921) for better interpretation of causeand effect relationship. Maximum direct effect for yield was observed for days to 50% flowering followed by effective tillers per plant and spikelets per panicle. Days to 50% flowering and effective tillers per plant had high significant overall effect on yield. Spikelet fertility had significant overall effect on yield. However, there is no single quality trait significantly contributing to the yield although some traits had positive indirect effect.Positive direct effects of the traits on grain yield indicatedtheir importance in determining this complex character and therefore, should be kept in mind while practicing selection aimed at the improvement of grain yield. These findings werealso corroborated by Koleet *al.,* (2008)and Sarawgi *et al.* (2000). The indirect expressions of panicle length on grain yield through all the foresaid characters werenegative except number of panicles per hill which was positive. The highest indirectexpression of number of spikelets per panicle on grain yieldper plant through plant height, flag leaf length had a positive effect. Based on the studies on path-coefficientanalysis, it may be concluded that, Direct and indirect effects of component traits contributed to yield at phenotypic andgenotypic levels (Tables 5&6). As residual effect was low at both phenotypic and genotypic levels it infers that maximum important characters were taken for analysis.

The overall effect of days to 50 per cent flowering on yield per plant is more than the direct effect due to positive indirect effects via days to maturity, effective tillers per plant and spikelet per panicle. At genotypic level, along with spikelet fertility, flag leaf length, flag leaf width, main panicle length, kernel length after cooking and gelatinization temperature also show significant overall effect on yield. Hence, utmost importance should be given to thesecharacters during selection for single plant yield improvement.Similar results had been reported by Ekka *et al.* (2011).Selection of plants on the basis of these traits wouldcertainly lead to improvement in grain yield.

REFERENCES

Babu S., Yoggameenakshi P., Sheeba A., Anbumalarmathi, J. and Rangasamy, R. 2006. Path analysis in hybrid rice (*Oryza sativa* L.) over salt environment *Oryza*. **43(3):** 238-240.

Biswas, P. S., Prashad, B. and Dewan, S. B. A. 2000. Variability, character association and path analysis in rice (*Oryza sativa* L.). *Bangladesh J. Plant Breed.Genet.* **13(1):** 19-25.

Chakraborty, R. and Chakraborty, S. 2010. Genetic variability and correlation of some morphometric traits with grain yield in bold grained rice (*Oryza sativa*) gene pool of Barak Valley. *Am-Eurasian J. Sus. Agric.* **4(1):** 26-29.

Dewery, D. R. and Lu, K. H. 1959. A correlation and path analysis of components of crested wheat grass and seed production.*Agron. J.* **51:** 515-18.

Dhanwani, R. K., Sarawgi, A. K., Solanki, A. and Tiwari, J. K. 2013.Genetic variability analysis for various yieldattributing and quality traits in rice (o. sativa l.). *The Bioscan*. **8(4):** 1403-1407.

Ekka, R. E., Sarawgi, A. K. and Kanwar, R. R. 2011. Correlation and Path Analysis in Traditional Rice Accessions of Chhattisgarh. *J. Rice Res*. **4(2):**11-18.

Eradasappa, E., Nadarajan, N., Ganapathy, K. N., Shanthala, J. and Satish, R. G. 2007. Correlation and path analysis for yield and itsattributing traits in rice (*Oryza sativa* L.). *Crop Res.* **34:**156-159.

Hossain M.A. and Haque M.E. 2003.Genetic variability and path analysis in rice genotype. *Bangladesh J. Pl. Breed.Genet.* **16(1):** 33-37.

Jayasudha, S. and Sharma, D. 2010. Genetic parameters of variability,correlation and path-coefficient for grain yield and physiological traits in rice (*Oryza sativa* L.) under shallow lowland situation. *Electronic J. Plant Breed.* **1(5):** 33-38.

Kole, P. C., Chakraborty, N. R. and Bhat, J. S. 2008. Analysis of variability, correlation and path coefficient in induced mutants of aromatic non basmati rice. *Tropical Agric. Res. & Ext.* p. 11.

MOA & FCI. 2011. Ministry of Agriculture and Food Corporation of India*, 2011-12*. pp. 10-11.

Mustafa, M. A. and Elsheikh, M. A. Y. 2007. Variability, correlation and path coefficient analysis for yield and its components in rice. *Afr.Crop Sci. J.* **15:** 183-189.

Nagi, K., Sharma, R. N., Nandah, C. and Kanwer, S. S. 2013. Genetic variability and association studies among yield attributes in Pigeon Pea (*Cajanuscajan*(L.) Millsp.)accessions of Bastar. *The Ecoscan.Special* **IV:** 267-271.

NeWall, L. C. and Eberhart, S. A. 1961. Clone and progeny evaluation in the improvement of switch grass (*Panicumvirgatum*L.). *Crop Sci.* **1:** 117-121.

Oad, F. C., Samo, M. A., Hassan, Z. U., Pompe, S. C. and Oad, N. L. 2002. Correlation and Path Analysis of Quantitative Characters of RiceRatoon Cultivars and Advance Lines, *Int. J. Agri. Biol.* **4(2):** 204-207.

Reddy, Y. M., Yadav, S. C., Reddy, S., Lavanya, G. R. and Suresh, B. G. 2008. Character association and component analysis in rice.*Oryza*. **45(3):** 239-241.

Sarawgi, A. K., Rastogi, N. K. and Sani, D. K. 2000. Studies on some quality parameters of indigenous rice in Madhya Pradesh. *Ann. of Agric. Res*. **21:**2, 258-261.

Seyoum, M., Alamerew, S. and Bantte, K. 2012. Genetic variability,heritability, correlation coefficient and path analysis for yield and yield related traits in upland rice (*Oryza sativa* L.). *J. Pl. Sci.* **7(1):** 13-22.

Singh, C. M., Babu, G. S., Kumar, B. and Mehandi, S. 2013.Analysis of quantitative variation and selection criteria for yield improvement in exotic germplasm of upland rice (Oryza sativa L.). *The Bioscan.* **8(2):** 485-492.

Singh, P. K., Mishra, M. N., Hore, D. K. and Panwar, A. S. 2002. Genetic variability in some indigenous low land rice genotypes ofNorth East India. *Indian J. Hill Farming.* **15(1):** 113-115.

Singh, R. K. and Choudhary, B. D. 1985. Biometrical Methods in Quantitative Genetic Analysis. *Kalyani Publishers,* New Delhi. **pp.**318.

Surek, H. and Beser, N. 2003. Correlation and path coefficient analysis for some yield-related traits in rice (Oryza sativa L.) under thrace conditions. *Turk. J. Agric. For.* **27:** 77-83.

Wright and Sewall 1921. Correlation and causation. *J. Agric. Res*. **20:** 557-585.

INSTRUCTION TO AUTHORS

The Ecoscan

An International Biannual Journal of Environmental Science

THE JOURNAL

The Ecoscan is an international quarterly journal of environmental sciences with international editorial board. The journal is online and details can be seen (downloaded from the site. www.thebioscan.in). For any query e-mail at m_psinha@yahoo.com & dr.mp.sinha@gmail.com can be used.

AIM & SCOPE

The journal aims to publish original peerly reviewed/ refereed research papers/reviews on all aspects of environmental sciences.

SUBMISSION OF MANUSCRIPT

Only original research papers are considered for publication. The authors may be asked to declare that the manuscript has not been submitted to any other journal for consideration at the same time. Two hard copies of manuscript and one soft copy, complete in all respects should be submitted. The soft copy can also be sent by e-mail as an attachment file for quick processing of the paper.

FORMAT OF MANUSCRIPT

All manuscripts must be written in English and should be typed double-spaced with wide margins on all sides of good quality A4 paper.

First page of the paper should be headed with the title page, (in capital, font size 16), the names of the authors (in capitals, font size 12) and full address of the institution where the work was carried out including e-mail address. A short running title should be given at the end of the title page and 3-5 key words or phrases for indexing.

The main portion of the paper should be divided into Abstract, Introduction, Materials and Methods, Results, Discussion (or result and discussion together), Acknowledgements (if any) References and legends.

Abstract should be limited to 200 words and convey the main points of the paper-outline, results and conclusion or the significance of the results.

Introduction should give the reasons for doing the work. Detailed review of the literature is not necessary. The introduction should preferably conclude with a final paragraph stating concisely and clearly the aims and objectives of your investigation.

Materials and Methods should include a brief technical description of the methodology adopted while a detailed description is required if the methods are new.

Results should contain observations on experiment done illustrated by tables and figures. Use well known statistical tests in preference to obscure ones.

Discussion must not recapitulate results but should relate the author's experiments to other work on the subject and give their conclusions.

All tables and figures must be cited sequentially in the text. Figures should be abbreviated to Fig., except in the beginning of a sentence when the word Figure should be written out in full.

The figures should be drawn on a good quality tracing/ white paper with black ink with the legends provided on a separate sheet. Photographs should be black and white on a glossy sheet with sufficient contrast.

References should be kept to a minimum and listed in alphabetical order. Personal communication and unpublished data should not be included in the reference list. Unpublished papers accepted for publication may be included in the list by designating the journal followed by "in press" in parentheses in the reference list. The list of reference at the end of the text should be in the following format.

1. **Witkamp, M. and Olson, J. S. 1963.** Breakdown of confined and non-confined Oak Litter.*Oikos*. **14**:138-147.
2. **Odum, E.P. 1971.** *Fundamentals of Ecology*. W. B. Sauder Co. Publ. Philadelphia.p.28.
3. **Macfadyen, A.1963.** The contribution of microfauna to total soil metabolism. In:*Soil organism*, J. Doeksen and J. Van Der Drift (Eds). North Holland Publ. Comp., pp 3-16.

References in the text should be quoted by the **author's name and year** in parenthesis and presented in year order. When there are more than two authors the reference should be quoted as: first author followed by *et al.,* throughout the text. Where more than one paper with the same senior author has appeared in on year the references should

Cont. .... P. 212