The Ecoscan 10(3&4): Supplement on Rice: 419- 426, 2016
AN INTERNATIONAL QUARTERLY JOURNAL OF ENVIRONMENTAL SCIENCES

STUDIES ON GENETIC VARIABILITY AND PATH ANALYSIS IN RICE (*Oryza sativa* L.) GERMPLASM

J. M. PRIYANKA[1], G. M. LAL, RAJESH SINGH[2] AND M. S. SAI REDDY[3]
[1]Department of Genetics and Plant breeding, Sam Higginbottom Institute of Agriculture, Technology and Sciences (Deemed-to-be-University), Allahabad - 211 007, U.P, INDIA.
[2]Department of Agronomy, Sam Higginbottom Institute of Agriculture, Technology and Sciences (Deemed-to-be-University), Allahabad - 211 007, U.P, INDIA.
[3]Department of Entomology,
G. B. Pant University of Agriculture and Technology, Pantnagar - 263 145, Uttarakhand.
e-mail: jmanupriyanka@gmail.com

ABSTRACT

The experiment was conducted with 30 genotypes of rice during *Kharif*-2015 in Randomized Block Design. The data were recorded for 13 quantitative characters to study genetic variability, heritability, genetic advance, correlation and path coefficient analysis. On the basis of mean performance highest seed yield per plant reported in KR-15-01 (43.36) genotype followed by KR-15-05 (39.93). Analysis of variance revealed significant difference among 30 rice genotypes for all characters indicating the existence of variability. High GCV and PCV were observed for biological yield per plant (17.29 & 21.72) and harvest index (16.51 & 23.72). High heritability coupled with high genetic advance as percent of mean was observed for the character test weight (96.30 & 30.05). Correlation coefficient showed panicles per plant (0.49) and biological yield per plant (0.48) exhibited maximum direct effect on seed yield per plant. Path coefficient analysis revealed that tillers per plant (2.41), panicles per plant (2.33), harvest index (0.72) exhibited maximum direct effect on seed yield per plant showed to be the primary yield contributing characters and could be relied upon for selection of genotypes to improve genetic yield potential of rice. Hence, utmost importance should be given to these characters during selection for yield improvement.

KEY WORDS
Variability
Heritability
Genetic advance, Correlation coefficient, Path analysis

Received : 18.02.2016
Revised : 21.04.2016
Accepted : 28.06.2016

***Corresponding author**

INTRODUCTION

Rice (*Oryza sativa* L.) is the most important staple food crop of the world. About 90 percent of world rice is produced and consumed in Asian region. There are two distinct type of domestic rice, *Oryza sativa* L. of Asian origin and second *Oryza glabarrima* L. of African origin. This genus contains 22 wild relatives also. All members of the rice genus have n = 12 chromosome.

Globally it is cultivated in an area of 160.6 m ha with an annual production of about 738.2 million tones and an average productivity of 2.96 t ha-1(FAO, 2015). Among the rice producing countries, India ranks second in total production next to China with an average productivity of 3.09 t/ ha-1(FAO, 2015). More than 8% of our countrymen depend fully or partially on rice as their main cereal food and staple diet.

India has the largest area under rice as 43.95 million hectare with a production of 105.48 million tones. (Directorate of economics and statistics, Department of agriculture and cooperation, Government of India 2015).In Uttar Pradesh area, production and productivity is 5.98million hectare, 14.63 million tonnes, and 2447 kg/ha respectively.(Agricultural statistics at a glance-2014, Department of agriculture and cooperation, ministry of agriculture, Government of India 4th advance estimate).The success of any breeding programme depends on the exploitation of existing variability and therefore, it is desirable to collect, evaluate and utilize the available diversity for crop improvement to suit specific need with regards to specific ecosystem. The nature and relationship between yield and its component traits and also among yield components seems to provide information, which would be of greater value at the time of practicing selection for improved yield. Correlation coefficient measures the relationship between two characters and does not indicate relative importance of each factor, this study was conducted to determine the nature of relationship between seed yield and yield components. Correlation studies provide information about yield contributing characters. This information is useful to plant breeder in selection of elite genotypes from diverse genetic populations (Robinson *et al.*, 1951; Johnson *et al.*, 1955). Simple correlation studies do not provide adequate information about the contribution of each factor towards yield. Therefore, the use of path-coefficient analysis is necessary. Path coefficient analysis partitions into direct and indirect matrix presenting correlation in a more meaningful way. The present investigation was conducted to find out the genetic variability among different characters, direct and indirect contribution of these characters towards yield and to identify better combinations as selection criteria for developing high yielding fine rice genotypes.

MATERIALS AND METHODS

The experiment was conducted during *Kharif* - 2015 at the Central Research Farm of the Department of Genetics and Plant breeding, Faculty of Agriculture, Sam Higginbottom Institute of Agriculture, Technology and Sciences, (Deemed to - be University) Allahabad, Uttar Pradesh, India, with 30 rice genotypes sown in a randomized block design with three replications. Twenty five days old seedlings of each genotype were transplanted in a row of 4.0 m length by adopting a spacing of 20 cm between rows and 15 cm between plants within the row. Observations were recorded on five randomly selected plants in each genotype in each replication and the average values were subjected for statistical analysis. Observations were recorded on plant basis for all characters, except days to 50 per cent flowering and days to maturity which were recorded on plot basis. The differences between 30 genotypes for different characters were tested for significance by using Analysis of Variance technique as proposed by Panse and Sukhatme (1967). The genetic parameters genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were calculated by the formula given by Burton (1952), heritability (h^2) by Burton and De Vane (1953) and genetic advance i.e. the expected genetic gain were calculated by using the procedure given by *Johnson et al.* (1955).Correlation coefficient and path coefficient was worked out as method suggested by Al Jibouri *et al.* (1958), Dewey and Lu (1959). The estimated values compared with table values of correlation coefficient to test the significance of correlation coefficient prescribed by Fisher and Yates (1967).

RESULTS AND DISCUSSION

The analysis of variance showed highly significant differences among the various genotypes for the characters under study. It indicated that there is ample scope for selection of different quantitative characters for improvement of rice. These findings are in accordance with the findings of Akinwale *et al* (2011), Mulugeta *et al* (2012) who also observed significant variability for yield and its components traits in rice. The result of analysis of variance is present in the Table1. On the basis of mean performance highest seed yield per plant was exhibited by the genotypes KR-15-01 (43.36) followed by KR-15-05 (39.93), KR-15-03 (37.85), PHB-71 (34.56) and KR-15-09 (33.95). The result of mean performance is given in the table2. The Phenotypic coefficient of variation was higher than genotypic coefficient of variation for all the characters studied. Maximum genotypic coefficient of variation (GCV) and phenotypic coefficient variation (PCV) was observed for biological yield per plant (17.29, 21.72) and harvest index (16.51, 23.72) indicating that these characters could be used as selection for crop improvement. Similar results were also found by Zahid *et al.* (2006). Heritability is classified as high (above 60%), medium (30%-60%) and low (below 30%). High heritability was observed for test weight (96.30), days to maturity (90.60), days to 50% flowering (87.60), number of tillers per plant (65.80), biological yield per plant (63.40), plant height (63.00), number of panicles per plant (62.30), seed yield per plant (62.20). High heritability for test weight, days to 50% flowering, days to maturity was also observed by Ashvani *et al.* (2007) and Warakad *et al*. (2013). High genetic advance was observed for number of spikelets per panicle (19.77). Similar results were also reported by Nayak *et al.,* (2002) and Singh *et al.,* (2011). High genetic advance as percent of mean was observed for test weight (30.05), biological yield per plant (28.37), seed yield per plant (26.58), harvest index (23.69), number of panicles per plant (21.44), number of tillers per plant (20.54). Yadav (2000) reported that seed yield per plant showed high genetic advance as percent of mean. High heritability coupled with high genetic advance as percent of mean was observed for test weight (96.30, 30.05). The result of estimation of components of variance and genetic parameters present in the table3. Correlation studies revealed that panicles per plant (0.49), biological yield per plant (0.48), harvest index (0.43), tillers per plant (0.43), number of spikelets per plant (0.39) and plant height (0.35) showed positive significant association with seed yield per plant at genotypic level. Similar results were reported by Panwar *et al.* (2007), Kole *et al.* (2008), Nandan *et al* (2010), Paul *et al.* (2011),), Pandey *et al.* (2012), Ishwar *et al.*(2012), Sharma *et al.* (2012) and Singh *et al.* (2013) for seed yield at genotypic level. The result of genotypic correlation coefficient between yield and its related traits present in the table4. Harvest index (0.47), biological yield per plant (0.40), tillers per plant (0.40), numbers of panicles

Table1: Analysis of variance for 13 characters in rice germplasm

S.no	Characters	Mean squares		
		Replication(d.f = 2)	Treatments(d.f =29)	Error(d.f = 58)
1	Days to 50% flowering	13.73	313.32**	14.11
2	Plant height	2.49	158.36**	25.92
3	Flag leaf length	1.93	38.69**	9.72
4	Flag leaf width	0.006	0.03**	0.01
5	Numbers of tillers per plant	0.13	7.03**	1.03
6	Number of panicles per plant	0.12	5.95**	1.00
7	Panicle length	1.53	3.68**	1.50
8	Number of spikelets per panicle	108.48	1939.17**	917.61
9	Days to maturity	12.57	279.15**	9.32
10	Biological yield per plant	84.66	387.29**	62.52
11	Harvest index	11.04	267.63**	70.02
12	Test weight	0.18	29.05**	0.36
13	Seed yield per plant	24.83	79.51**	13.37

** Significant at 1% probability level.

Table 2: Mean performance of 30 rice genotypes for 13 characters during Kharif-2015

S.no	Characters	Days to 50% flowering	Plant height (cm)	Flag leaf length (cm)	Flag leaf width (cm)	No. of tillers /plant	No. of panicles /plant	Panicle length (cm)	No. of spikelets /plant	Days to maturity	Biological yield / plant (gm)	Harvest index (%)	Test weight (gm)	Seed yield /plant (gm)
1.	KR-15-01	85.66	119.60	37.66	1.30	14.45	11.93	24.20	253.21	115.66	83.74	52.24	23.36	43.36
2.	KR-15-03	86.33	112.13	35.86	1.50	11.86	10.48	25.53	248.11	116.33	76.15	50.27	22.16	37.85
3.	KR-15-05	88.00	113.60	34.80	1.56	12.02	10.66	24.46	233.44	119.66	74.98	53.77	19.66	39.93
4.	KR-15-07	87.33	105.73	38.46	1.70	12.17	10.40	22.86	229.99	117.33	56.20	52.37	24.30	29.12
5.	KR-15-09	115.33	107.86	34.26	1.71	9.86	7.84	22.00	236.11	145.33	70.19	48.38	18.51	33.95
6.	KR-15-11	107.66	99.06	35.00	1.70	11.28	8.68	24.46	227.66	137.66	52.66	49.95	14.70	26.20
7.	KR-15-13	107.33	97.26	37.73	1.48	9.80	8.34	22.60	216.88	137.66	63.06	46.49	21.62	29.08
8.	KR-15-15	116.00	99.26	31.53	1.45	11.57	10.46	23.00	233.66	146.00	50.94	65.59	21.50	31.96
9.	KR-15-16	91.00	122.33	44.26	1.53	9.94	8.26	24.80	263.77	122.00	56.45	44.08	14.20	24.92
10.	KR-15-17	104.33	103.26	37.93	1.44	10.66	9.00	23.60	227.10	134.33	50.85	50.10	20.37	25.49
11.	KR-15-18	90.33	116.00	46.93	1.56	9.40	8.20	21.93	247.77	121.33	54.00	48.30	20.54	26.06
12.	KR-15-20	105.66	109.06	37.66	1.56	11.13	9.14	24.86	219.55	135.66	67.00	44.32	20.36	29.27
13.	KR-15-21	106.33	95.40	36.86	1.50	11.71	10.06	24.80	243.22	136.33	62.86	37.23	18.46	22.93
14.	KR-15-23	99.66	99.80	32.73	1.47	12.68	10.17	22.93	189.66	129.66	47.80	67.74	18.96	32.06
15.	KR-15-24	115.33	102.73	30.60	1.54	11.93	10.13	24.93	233.66	142.66	82.66	29.97	21.49	24.87
16.	KR-15-25	106.00	107.60	37.06	1.52	8.26	7.93	23.53	231.55	136.00	73.46	32.37	21.60	23.50
17.	KR-15-26	104.33	108.86	37.53	1.35	11.17	10.04	25.00	246.11	134.33	50.14	44.47	26.10	22.22
18.	KR-15-27	106.33	89.80	28.06	1.39	11.42	9.89	23.86	210.44	136.33	58.86	51.42	18.50	29.93
19.	KR-15-28	89.00	104.20	37.93	1.39	10.62	8.26	23.33	177.55	119.66	42.21	59.85	20.09	24.88
20.	KR-15-29	108.00	109.33	39.60	1.55	12.93	12.01	22.63	215.55	138.00	77.80	36.03	15.61	27.99
21.	KR-15-30	91.66	104.33	36.00	1.32	10.08	7.93	23.60	221.99	121.66	60.62	48.54	17.69	29.06
22.	KR-15-31	86.33	102.13	38.46	1.44	13.26	10.66	23.00	233.33	116.33	55.22	52.37	23.45	28.67
23.	KR-15-32	105.00	105.93	37.80	1.46	11.42	9.73	24.60	213.77	135.00	55.94	44.99	22.41	24.90
24.	KR-15-34	91.00	99.06	37.33	1.46	14.44	12.04	24.73	208.11	121.00	65.19	44.16	22.28	28.49
25.	KR-15-35	87.33	113.40	38.33	1.56	12.56	9.18	24.73	195.44	117.33	51.40	48.40	21.45	24.94
26.	KR-15-37	90.00	102.26	35.46	1.52	9.46	7.80	23.20	214.21	120.00	47.54	47.58	22.82	22.54
27.	KR-15-39	91.00	99.80	34.00	1.43	12.06	10.67	26.00	204.44	121.00	66.23	45.19	27.90	29.78
28.	KR-15-41	103.66	102.06	34.40	1.33	14.50	12.80	25.66	175.33	133.66	46.64	61.56	17.57	28.46
29.	KR-15-43	98.00	97.63	36.06	1.40	10.29	8.40	22.80	202.24	131.00	54.93	44.30	24.23	24.21
30.	PHB-71	82.00	107.80	38.73	1.54	12.00	11.00	25.06	298.53	119.33	48.66	71.86	22.13	34.56
	Mean	98.20	105.24	36.63	1.49	11.50	9.73	23.95	225.08	128.61	60.14	49.13	20.80	28.71
	Range highest	116.00	122.33	46.93	1.71	14.50	12.80	26.00	298.53	146.00	83.74	71.86	27.90	43.36
	Range lowest	82.00	89.80	28.06	1.30	8.26	7.80	21.93	175.33	115.66	42.21	29.97	14.20	22.22
	C.D. (5%)	6.13	8.32	5.09	0.19	1.66	1.63	2.00	49.50	4.99	12.92	13.67	0.98	5.97
	C.V.	3.82	4.83	8.50	7.98	8.85	10.26	5.12	13.45	2.37	13.14	17.03	2.90	12.73

Table 3: Estimation of components of variance and genetic parameters for 13 characters in rice germplasm

characters	Vg	V_p	Coefficient of variation		h^2 (bs)(%)	GA	GA as (%)
			PCV (%)	GCV (%)			
Days to 50% flowering	99.73	113.85	10.86	10.17	87.60	19.25	19.60
Plant height	44.14	70.06	7.95	6.31	63.00	10.86	10.32
Flag leaf length	9.65	19.37	12.01	8.48	49.80	4.52	12.33
Flag leaf width	0.006	0.02	9.60	5.33	30.90	0.09	6.11
Numbers of tillers per plant	1.99	3.03	15.14	12.29	65.80	2.36	20.54
Number of panicles per plant	1.65	2.65	16.71	13.19	62.30	2.08	21.44
Panicle length	0.72	2.23	6.23	3.55	32.50	1.00	4.17
Number of spikelets per panicle	340.52	1258.13	15.75	8.19	27.10	19.77	8.78
Days to maturity	89.94	99.26	7.74	7.37	90.60	18.59	14.45
Biological yield per plant	108.25	170.78	21.72	17.29	63.40	17.06	28.37
Harvest index	65.86	135.89	23.72	16.51	48.50	11.64	23.69
Test weight	9.56	9.92	15.14	14.86	96.30	6.25	30.05
Seed yield per plant	22.04	35.42	20.73	16.35	62.20	7.63	26.58

V_g = genotypic variation, v_p = phenotypic variation, GCV = Genotypic co-efficient of variation, PCV = Phenotypic co-efficient of variation, h^2 = heritability, GA = Genetic advance.

Table 4: Estimation of Genotypic correlation coefficient between yield and its related traits in 30 rice genotypes

S.no Characters	Days to 50% flowering	Plant height	Flag leaf length	Flag leaf width	Tillers/ plant	Panicles/ plant	Panicle length	No.of spikelets /panicle	Days to maturity	Biological yield / plant	Harvest index	Test weight	Seed yield / plant
1. Days to 50% flowering	1.00	-0.41*	-0.47*	0.23**	-0.23*	-0.11	-0.15	-0.20*	0.99**	0.14	-0.36*	-0.30*	-0.31
2. Plant height		1.00	0.69**	0.13	0.005	0.007	0.05	0.62**	-0.42*	0.36**	-0.08	-0.08	0.35
3. Flag leaf length			1.00	0.05	-0.22*	-0.25*	-0.39*	0.38**	-0.45*	-0.10	-0.22*	-0.06	-0.25
4. Flag leaf width				1.00	-0.31*	-0.32*	-0.71*	0.37**	0.24**	0.19	-0.31*	-0.33*	-0.10
5. Tillers /plant					1.00	0.95**	0.60**	-0.29*	-0.26*	0.12	0.32**	0.09	0.43
6. Panicles/plant						1.00	0.62**	-0.11	-0.12	0.27**	0.25*	0.15	0.49
7. Panicle length							1.00	0.06	-0.17	0.23**	-0.27*	0.19	0.001
8. No. of spikelets /panicle								1.00	-0.13	0.34**	-0.01	0.06	0.39
9. Days to maturity									1.00	0.10	-0.30*	-0.30*	-0.30
10. Biological yield /plant										1.00	-0.56*	0.01	0.48
11. Harvest index											1.00	-0.002	0.43
12. Test weight												1.00	0.04

Table 5: Estimation of Phenotypic correlation coefficient between yield and its related traits in 30 rice genotypes

S.no	Characters	Days to 50% flowering	Plant height	Flag leaf length	Flag leaf width	Tillers/ plant	Panicles/ plant	Panicle length	No.of spikelets /panicle	Days to maturity	Biological yield / plant	Harvest index	Test weight	Seed yield / plant
1.	Days to 50% flowering	1.00	-0.41*	-0.39*	0.03	-0.18	-0.13	-0.18	-0.13	0.98**	0.12	-0.27*	-0.26*	-0.24
2.	Plant height		1.00	0.58**	0.16	-0.07	-0.05	0.11	0.30**	-0.40*	0.15	-0.01	-0.08	0.20
3.	Flag leaf length			1.00	0.23**	-0.16	-0.11	0.004	0.29**	-0.36*	-0.15	-0.02	-0.07	-0.12
4.	Flag leaf width				1.00	-0.19	-0.21*	0.08	0.17	0.05	0.05	-0.02	-0.17	0.02
5.	Tillers /plant					1.00	0.86**	0.22**	-0.05	-0.19	0.14	0.23**	0.08	0.40
6.	Panicles/plant						1.00	0.25**	0.07	-0.12	0.17	0.19	0.10	0.37
7.	Panicle length							1.00	0.09	-0.18	0.01	0.11	0.05	0.12
8.	No. of spikelets /panicle								1.00	-0.09	0.20	-0.008	-0.01	0.19
9.	Days to maturity									1.00	0.08	-0.21*	-0.27*	-0.22
10.	Biological yield /plant										1.00	-0.57*	0.02	0.40
11.	Harvest index											1.00	-0.01	0.47
12.	Test weight												1.00	0.03

Table 6: Estimation of direct and indirect effects of yield related traits on seed yield in 30 rice genotypes at phenotypic level

S.No	Characters	Days to 50% flowering	Plant Height (cm)	Flag Leaf length (cm)	Flag Leaf width (cm)	Tillers/ plant	Panicle/ plant	Panicle length (cm)	Spikelets/ panicle	Days to Maturity	Biological Yield (gm)	Harvest Index (%)	Test Weight (gm)	Seed yield/ plant(gm)
1.	Days to 50% flowering	0.04	-0.02	-0.01	0.001	-0.008	-0.006	-0.009	-0.006	0.04	0.006	-0.01	-0.01	-0.24
2.	Plant Height (cm)	-0.01	0.04	0.02	0.007	-0.003	-0.002	0.005	0.01	-0.01	0.006	-0.0006	-0.003	0.20
3.	Flag Leaf length (cm)	-0.001	0.002	0.004	0.001	-0.0007	-0.0005	0.00	0.001	-0.001	-0.0006	-0.0001	-0.0003	-0.12
4.	Flag Leaf width (cm)	0.00	0.00	0.00	-0.0001	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
5.	Tillers/ plant	-0.009	-0.003	-0.008	-0.009	0.04	0.04	0.01	-0.002	-0.009	0.007	0.01	0.004	0.40
6.	Panicle/ plant	0.006	0.002	0.005	0.01	-0.04	0.04	-0.01	-0.003	0.006	-0.008	-0.009	-0.005	0.37
7.	Panicle length (cm)	0.005	-0.003	-0.0001	-0.002	-0.006	-0.007	-0.02	-0.002	0.005	-0.0004	-0.003	-0.001	0.12
8.	Spikelets/ panicle	0.001	-0.002	-0.002	-0.001	0.0004	-0.0005	-0.0006	0.007	0.0006	-0.001	0.0001	0.0001	0.19
9.	Days to Maturity	-0.117	0.04	0.04	-0.006	0.02	0.01	0.02	0.01	-0.12	-0.01	0.02	0.03	-0.22
10.	Biological Yield (gm)	0.12	0.15	-0.15	0.05	0.14	0.17	0.01	0.20	0.08	1.006	-0.57	0.02	0.40
11.	Harvest Index (%)	-0.28	-0.01	-0.02	-0.02	0.24	0.20	0.12	-0.008	-0.22	-0.59	1.04	-0.01	0.47
12.	Test Weight (gm)	-0.003	-0.001	-0.001	-0.002	0.001	0.001	0.0007	-0.0002	-0.003	0.0003	-0.0002	0.01	0.03

R SQUARE = 0.9109 RESIDUAL EFFECT = 0.2986

Table 7: Estimates of direct and indirect effects of yield related traits on seed yield in 30 rice genotypes at genotypic level.

S.No	Characters	Days to 50% flowering	Plant Height (cm)	Flag Leaf length (cm)	Flag Leaf width (cm)	Tillers/ plant	Panicle/ plant	Panicle length (cm)	Spikelets/ panicle	Days to Maturity	Biological Yield (gm)	Harvest Index (%)	Test Weight (gm)	Seed yield/plant (gm)
1.	Days to 50% flowering	1.09	-0.45	-0.51	0.25	-0.25	-0.12	-0.17	-0.22	1.09	0.15	-0.40	-0.33	-0.31
2.	Plant Height (cm)	-0.21	0.52	0.36	0.07	0.002	0.003	0.02	0.32	-0.22	0.19	-0.04	-0.04	0.35
3.	Flag Leaf length (cm)	0.24	-0.35	-0.51	-0.02	0.11	0.13	0.20	-0.20	0.23	0.05	0.11	0.03	-0.25
4.	Flag Leaf width (cm)	0.06	0.03	0.01	0.27	-0.08	-0.09	-0.19	0.10	0.06	0.05	-0.08	-0.09	-0.10
5.	Tillers/ plant	0.56	-0.01	0.54	0.75	2.41	-2.29	-1.47	0.70	0.64	-0.29	-0.77	-0.22	0.43
6.	Panicle/ plant	-0.26	0.01	-0.59	-0.77	2.22	2.33	1.46	-0.26	-0.29	0.64	0.59	0.37	0.49
7.	Panicle length (cm)	-0.002	0.0007	-0.005	-0.009	0.008	0.008	0.01	0.0009	-0.002	-0.003	-0.003	0.002	0.001
8.	Spikelets/ panicle	0.08	-0.24	-0.15	-0.14	0.11	0.04	-0.02	0.38	0.05	-0.13	0.006	-0.02	0.39
9.	Days to Maturity	-1.74	0.74	0.80	-0.42	0.46	0.21	0.29	0.22	-1.75	-0.17	0.53	0.53	-0.30
10.	Biological Yield (gm)	0.05	0.14	-0.04	0.07	0.04	0.11	0.09	0.13	0.04	0.40	-0.22	0.006	0.48
11.	Harvest Index (%)	-0.26	-0.06	-0.16	-0.22	0.23	0.18	-0.19	-0.01	-0.21	-0.40	0.72	-0.002	0.43
12.	Test Weight (gm)	0.05	0.01	0.01	0.06	-0.01	-0.03	-0.03	-0.01	0.05	-0.003	0.0005	-0.18	0.04

R SQUARE = 0.9260; RESIDUAL EFFECT = 0.2721

per plant (0.37) were found significant and positive association with seed yield per plant at phenotypic level. Bhadru *et al.* (2011), Paul *et al.* (2011), Datt *et al.* (2012) and pandey *et al.* (2012) were reported that there is positive significant correlation between biological yield per plant and harvest index with seed yield at phenotypic level. The result of phenotypic correlation coefficient between yield and its related traits present in the table5. In the present investigation path coefficient analysis has been conducted for seed yield per plant. Harvest index (1.04), biological yield per plant (1.006), number of tillers per plant (0.04), number of panicles per plant (0.04), plant height (0.04), days to 50% flowering (0.04), test weight (0.01), number of spikelets per panicle (0.007) and flag leaf length (0.004) were found significant and positive association with seed yield at phenotypic level. The result of direct and indirect effects of yield related traits on seed yield at phenotypic level present in table6. Number of tillers per plant (2.41), number of panicles per plant (2.33), days to 50% flowering (1.09), harvest index (0.72), plant height (0.52), biological yield per plant (0.40), number of spikelets per panicle (0.38), flag leaf width (0.27) and panicle length (0.01) showed positive and significant association with seed yield per plant at genotypic level. Similar result was also reported by Ishwar *et al.* (2012) and Neha and Lal (2012). The result of direct and indirect effects of yield related traits on seed yield at genotypic level present in table7. These traits contributed maximum to higher seed yield compared to other characters, thus, selection for these characters helps in selection of superior fine genotypes.

REFERENCES

Akinwale, M. G., Gregorio, G., Nwilene, F., Akinyele, B. O., Ogunbayo, S. A and Odiyi, A. C. 2011. Heritability and correlation coefficient analysis for yield and its components in rice (*Oryza sativa L.*). *African J. Plant Science*. **5(3):** 207-212.

Al Jibouri, H. A., Miller, P. A. and Robinson, H. F. 1958. Genotypic and environmental variation and co-variation in an upland rice crop of inter specific origin. *Agronomic J.* **50:** 626-636.

Alok Kumar, N. R. Rangare and Vidyapati Vidyakar 2013. Study of genetic variability of Indian and exotic rice germplasm in Allahabad agroclimate. *The Bioscan.* **8(4):** 1445-1451.

Ashvani, P., Dhaka, R. P. S and Kumar, V. 2007. Genetic variability and heritability studies in rice (*Oryza sativa* L.). *Advances in Plant Sciences*. **20(1):** 47-49.

Bhadru, D., Reddy, L. and Ramesh, M. S. 2011. Correlation and Path coefficient analysis of yield and yield contributing traits in rice hybrids and their parental lines. *Electronic J. Plant Breeding*. **2(1):** 112-116.

Burton, G. W. 1952. Quantitative inheritance of grasses. *Progress 6Th International Grassland Congress*. **1:** 277-283.

Burton, G. W. and De Vane 1953. Estimating heritability in tall Fescus from replicated clonal material. *Agronomic J.* **45:** 474-481.

Datt, I. Mehla, B. S., Goyat, B. and Kaliramana, R. S. 2012. Variability and correlation coefficient analysis of plant height, yield and yield components in rice (*Oryza sativa* L.). *Annuals of Biology*. **28(1):** 45-52.

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

Fisher, R. A. and Yates, F. 1967. Statistical tables for Biological,

Agricultural and Medical Research, *Longmen Group Limited*, London.

Ishwar Datt, Mehla, B. S., Goyat, B. and Kaliramana, R. S. 2012. Variability and correlation coefficient analysis of plant height, yield and yield components in rice *(Oryza sativa L.) Annals of Biology*. **28(1):** 45-52.

Johnson, H. W., Robinson, A. E. and Comstock, R. E. 1955. Estimates of genetic and environmental variability in soyabeans. *Agronomic Journal*. **47:** 314-318.

Kole, P. C., Chakraborty, N. R and Bhat, J. S 2008. Analysis of variability, correlation and path coefficients in induced mutants of aromatic non-basmati rice. *Tropical Agricultural Research & Extension*.11.

Mulugeta, Seyoum., Sentayehu, Alamerew and Kassahun, Bantte 2012. Genetic variability, heritability, correlation coefficient and path analysis for yield and yield related traits in upland rice (*Oryza sativa* L.). *J. Plant Science*. pp. 1-10.

Nandan, R., Sweta, and Singh, S. K. 2010. Character association and path analysis in rice (*Oryza sativa* L.) genotypes. *World J. Agricultural Science*. **6(2):** 201-206.

Nayak, A. R., Chaudhary, D. and Reddy, J. N. 2002. Estimated Genetic Variability, Heritability and Genetic Advance in Scented Rice (*Oryza Sativa* L.). *Indian Agriculturist*. **46(12):** 45-47.

Neha, Lal, G. M. 2012. Studies on genetic variability and character association among yield and yield attributes in rice (*Oryza sativa L.*). *Trends in Biosciences*. **5(4):** 335-337.

Pandey, V. R., Singh, P. K., Verma, O. P and Pandey, P. 2012. Inter-relationship and path coefficient estimation in rice under salt stress environment. *International J. Agricultural Research*. **7(4):** 169-184.

Panse, V. G and Shukhatme, P. V. 1967. Statistical methods for agricultural workers 2nd *Edition ICAR,* New Delhi. pp. 152-157.

Panwar, A., Dhaka, R. P. S. and Kumar, V. 2007. Path analysis of grain yied in rice. *Advances in Plant Sciences*. **20(1):** 27-28.

Paul, A., Babu, G. S., Lavanya, G. R. and Singh, C. M. 2011. Variation of Association among yield and yield component characters in upland rice (*Oryza sativa* L.). *Environment and Ecology*. **29(2):** 690-695.

Rakesh kumar Dhanwani, A., Sarawgi, K., Akash Solanki and Jitendra kumar Tiwari 2013. Genetic variability analysis for various yield attributing and quality traits in rice (O.SATIVA L.). *The Bioscan*. **8(4):** 1403-1407.

Robinson, H. F., Comstock, R. E. and Haevey, P. H. 1951. Genotypic and phenotypic correlations in corn and their implication in selection, *Agron. J.* **43:** 262-267.

Sharma, R., Singh, D., Kaushik, R. P. and Pandey, D. P. 2012. Correlation and path analysis for grain yield and its component traits in rice. *Oryza*. **49(3):** 215-218.

Singh, S. K., Singh, C. M. and Lal, G. M. 2011. Assessment of geneti variability for yield and its component characters in rice (*Oryza sativa L.*). *Research in Plant Biology*. **1(4):** 73-76.

Singh, V., Jain, R. K. and Kumar, M. 2013. Genetic analysis of japonica × *indica* recombinant inbred lines and characterization of major fragrance gene by microsatellite markers. *African J. Biotechnology*. **12(32):** 5022-5028.

Warakad, D. P., Babu, G. S. and Lavanya, G. R. 2013. Genetic variability in exotic rice germplasm (*Oryza sativa* L.). *J. Agriculture Research and Technology*. **38(3):** 488-490.

Yadav, R. K. 2000. Studies on genetic variability for some quantitative characters in rice Advance *in Agriculture Research*. **13:** 205-207.

Zahid, M. A., Akhatar, M., Sabar, N., Zaheen, M. and Tahir, A. 2006. Correlation and path analysis studies of yield and economics traits in Basmati rice (*Oryza sativa* L.) *Asian J. Plant Science*. **5(4):** 643-645.