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Research Article

EVALUATION OF EXOTIC UPLAND RICE GERMPLASM FOR GRAIN YIELD AND ITS COMPONENT CHARACTERS IN RAINFED ECOSYSTEM (*ORYZA SATIVA*. L)

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ABSTRACT
The present investigation consists of 45 upland rice germplasm provided during 2010 and 2011 at Sam Higginbottom Institute of Agricultural Technology and Sciences, Allahabad, U.P. The experiment was conducted in RBD having three replications. The data were recorded on 12 characters to study the analysis of variance, heritability, genetic advance, coefficient of variation, correlation coefficient and path analysis. Based on the mean performance table IR 82589-B-B-149-4 and IR 82589-B-B-36-2 were identified as best genotype for grain yield. Highly significant variation was obtained for number of spikelets per panicle, plant height, harvest index, biological yield, days to 50% flowering and days to maturity. Seed yield per plant, number of spikelets per panicle, biological yield, flag leaf length and number of tiller per plant showed relatively high GCV and PCV estimates. High heritability was obtained for number of spikelets per panicle (100%), flag leaf width (96%), plant height (93%), biological yield (88%), days to maturity (87%) and days to 50% flowering (84%) which indicates high heritable portion of variation. Characters like number of spikelets per panicle, seed yield per plant, biological yield, flag leaf length and flag leaf width showed high genetic advance as percent of mean, indicating the role of additive gene action and a scope of selection using their phenotypic performance. Number of spikelets per panicle had maximum direct effect and highly significant genotypic correlation coefficient with grain yield. The present study revealed that for increasing rice yield in upland ecology, a genotype should posses more number of spikelets per panicle and more number of tillers per plant.

Keywords: *Rice, Variability, Correlation Coefficient and Path Analysis*

INTRODUCTION
Rice (*Oryza sativa*. L) is a cereal food stuff which forms an important part of the diet of more than three billion people around the world. But water is necessary for the cultivation of rice and now a day's water is increasingly become scarce. Irrigated rice requires lot of water about 3000-5000 liters is used to produce 1 kg of grain (IRRI, 2001). The high requirement of water for rice cultivation is because rice is generally grown under low land conditions (Sharma 1984). Thus it is necessary to develop a better way of growing rice that uses less water, while maintaining high yield (Wang *et al.*, 2002). The upland rice harbours a great genetic potential for rice improvement as subjected to subtle selection over a long period of time. This aids in the adaptation of upland to wide agro-ecological niches and rich variability of complex quantitative traits. The exact genetic potential, differences from commercial varieties and the magnitude of heterogeneity still present in local landraces are not well catalogued (Singh *et al* 2013). So, upland rice is a way of growing rice under rainfed condition with intermittent irrigation. It is system of growing high yielding rice under non puddled and non flooded condition. Grain yield is dependent on many yield contributing traits as well as on the environmental influence. The knowledge about genetic variability of yield contributing traits, interrelationship among them and their relation with yield are necessary for a successful breeding program. Moreover, knowledge of heritability is essential for selection based improvement, as it indicates the extent of transmissibility of a trait into future generations (Sabesan *et al.*, 2009). Keeping in view these perspectives, the present experiment was conducted to study genetic variability for grain yield and character association in short duration upland rice.

MATERIALS AND METHODS

The experimental material comprised of forty five rice genotypes that were evaluated in a randomized block design with 3 replications from kharif 2010 and 2011. The experiment was conducted at the field experimentation centre of Department of Genetics and Plant Breeding, Sam Higginbottom Institute of Agriculture, Technology and Sciences, Allahabad. Each genotype was grown in a plot of 3x2 m spaced at 20x15 cm apart. Standard agronomic practices compatible with this ago-ecological zone were adopted to ensure good crop growth.

Data collection: Observations were recorded on 5 randomly selected plants from each replication for various characters viz., days to 50% flowering, Number of fertile tillers per Plant , flag leaf length, flag leaf width, Panicle length , Plant height, Number of Spikelets per Panicle, Days to Maturity, Biological Yield per Plant, Test Weight, Harvest Index and Grain Yield per Plant.

Statistical analysis: The PCV and GCV were calculated by the formula given by Burton (1952), heritability in broad sense (h2) by Burton and de Vane (1953) and genetic advance i.e., the expected genetic gain was calculated using the procedure given by Johnson et al.,(1955). The correlation coefficient and the path coefficient were worked out as for the method recommended by Al-Jibouri et al., (1958) and Deway and Lu (1959) respectively. The estimated values were compared with table values of the correlation coefficient to test the significance of the correlation coefficient prescribed by Fisher and Yates (1967).

RESULTS AND DISCUSSION

Analysis of variance revealed highly significant differences among the genotypes for all the characters except flag leaf width, indicating ample scope for the selection of different quantitative characters for rice improvement (Table 1). Similar findings were also observed in earlier studies (Kole et al., 2008 and Vange 2009). Estimates of genotypic and phenotypic correlation among twelve characters are presented in Table 2. The magnitude of Phenotypic Coefficient of Variance (PCV) was higher than the Genotypic Coefficient of Variance (GCV) for all the quantitative characters. In the present experiment the higher genotypic coefficient of variation accompanied with higher phenotypic coefficient of variability for biological yield per plant, grain yield per plant and number of spikelets per panicle suggest enough variability was present among these 45 rice genotypes. The studies on genotypic and phenotypic coefficient of variation indicated that the presence of high variance and the role of the environment on the expression of these traits. The magnitude of phenotypic coefficient of variation was higher than genotypic coefficient of variation for all the characters, which may be due to the higher degree of interaction of genotypes with the environment. Similar findings were also observed in other studies (Zahid et al., 2006 and Pandey et al., 2010).

Table 1: Analysis of variance for 12 characters among 45 genotypes of upland rice during kharif 2010 and 2011

S.No	Characters	Mean Sum of Squares		
		Replication (d. f=02)	Treatments (d. f=44)	Error (d. f=88)
1	Days to 50% Flowering	0.54	71.29**	4.16
2	Plant height	0.85	182.62**	4.22
3	Flag leaf length	0.59	38.37**	3.52
4	Flag leaf width	0.00	0.03	0.00
5	Tiller/plant	0.02	1.36**	0.61
6	Panicle length	1.07	19.66**	3.39
7	Days to maturity	0.98	68.25**	3.27
8	No of spikelets / panicle	0.05	3322.08**	3.19
9	Biological yield	0.33	77.75**	3.43
10	Harvest index	1.47	97.56**	22.05
11	Test weight	0.53	5.75**	2.94
12	Seed yield / plant	0.32	37.95**	3.02

*** Significant at 5% level*

Heritability measures the possibility of joint transmission of two characters in two correlated characters through selection of one character. It is a measure of the relationship between parent and progeny and has been widely used to assess the degree to which a character may be transmitted from parent to progeny. It also indicates the relative importance of heritability and environment in the expression of character. In the present study traits like number of spikelets per panicle (97.60%), flag leaf width (96.00%), plant height (93.00%), biological yield per plant (88.00%), days to maturity (87.00%), days to 50 percent flowering (84.00%), grain yield per plant (79.00%) and flag leaf length (77.00%) showed high heritibility. Therefore selection from these traits will be valuable for further rice improvement. These results are in accordance with the findings Chaubey and Singh (1994) and Atlin (2003). Estimates of heritability are more advantageous when expressed in terms of genetic advance. Johnson *et al.*, (1955) suggested that without genetic advance estimates of heritability would not be of practical value and emphasized the concurrent use of genetic advance along with heritability. In the present study high estimates of heritability coupled with moderate or high value of genetic advance as a percentage of means was observed and this suggested that there was preponderance of additive gene action for the expression of these characters. Hence, selection of these characters can induce an enhancement of rice production and productivity.

Correlation: The association of grain yield with other characters was estimated by genotypic and phenotypic coefficients (Table 3). Grain yield per plant was correlated positively and significantly with biological yield (0.92), number of spikelet per panicle (0.84), harvest index (0.65), tiller per plant (0.54), test weight (0.35), plant height (0.33), flag leaf length (0.30) and panicle length (0.19) at genotypic and phenotypic level and positively and non significant with flag leaf length (0.13) and flag leaf width (0.03) at both level. Plant height was correlated positively and significantly with all the characters at genotypic level. Grain yield per plant was positively and significantly associated with effective tiller per plant and spikelets per panicle (Manna *et al.*, 2006). Grain yield per plant was significantly associated with plant height Eradasappa *et al.*, (2007). These findings were correlated with Khan *et al.*, (2009) Information on inter association of yield components showed nature and extent of their relationship with each other. This will help in simultaneous improvement of different characters along with yield in breeding programmes.

Path coefficient analysis permits a thorough understanding of the contribution of the various characters by portioning the correlation coefficient into components of direct and indirect effects (Tables 4 & 5). The different yield contributing traits like biological yield (1.0262), harvest index (0.3586), days to maturity (0.0971), test weight (0.0361) and flag leaf width (0.0153)had high positive direct effect on grain yield per plant while number of spikelets per panicle (-0.1764), flag leaf length (-0.0356), panicle length (-0.0335), tiller per plant (-0.0331), days to 50% flowering (-0.0166) and plant height (-0.0028) had negative direct effect on grain yield per plant on genotypic level. Plant height showed negative direct effect on grain yield per plant at genotypic level. Harvest index showed positive and similar direct effect on genotypic level (Chakraborty *et al*., 2010). Similar report on genotypic level for number of spikelets per panicle was given by Vange, (2009). In the present experiment the overall results indicated that the selection of higher biological yield per plant, harvest index and number of fertile tiller per plant were relevant characters.

Conclusion

The present study indicates that there is adequate genetic variability present in the material studied. The genotypes IR 82589-B-B-149-4 and IR 82589-B-B-36-2 were identified as best genotypes for seed yield. Number of spikelet per panicle and seed yield per plant show high GCV and PCV while number of spikelet per panicle exhibited high heritability, number of spikelet per panicle and biological yield coupled with high genetic advance and as percent of mean. Hence these characters also showed positive correlation with seed yield per plant and direct positive effect on it. Spikelet per panicle is the most important traits which should be given due attention in making selection effective for high yielding genotypes in upland ecology. Therefore, from present study it can be forwarded that for increasing rice grain upland ecology, a genotype should posses more number of grains per panicle. Since two year data is not sufficient to conclude concurrent result. So, future experimentation is required to confirm the result.

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Table 1: Mean performance of upland rice genotypes for quantitative characters during kharif 2010 and 2011

S.N.	Characters / Genotypes	Days to 50% flowering	Plant height (cm)	Flag leaf length (cm)	Flag leaf Width (cm)	Tillers/ plant	Panicle length (cm)	Days to maturity	No of spikelet's/panicle	Biological Yield (g)	Harvest Index	Test Weight (g)	Seed Yield/Plant(g)
1	IR 82635-B-B-82-2	80.00	96.32	21.28	1.04	5.00	19.94	105.00	113.00	18.38	52.15	21.33	9.65
2	IR83384-B-B-102-3	78.00	96.17	27.37	1.09	5.50	21.62	108.00	86.00	16.62	52.57	21.45	8.74
3	IR82589-B-B-114-3	89.33	88.36	25.59	0.92	4.67	21.06	114.00	121.67	18.39	51.40	18.75	9.50
4	IR 82590-B-B-98-2	82.67	99.83	26.28	1.01	4.33	22.56	108.33	88.33	16.29	49.88	19.54	8.23
5	IR82635-B-B-143-1	85.00	77.30	23.38	1.03	4.67	20.50	109.00	99.00	17.42	60.92	19.09	10.61
6	IR 82635-B-B-47-2	87.00	93.84	26.39	1.04	4.67	23.29	112.00	100.33	18.72	56.29	18.65	10.56
7	IR82635-B-B-58-1	85.33	96.34	25.60	1.10	5.00	24.52	109.00	100.00	16.70	51.27	20.22	8.62
8	IR 82635-B-B-88-2	86.33	93.49	25.39	0.99	4.67	19.69	110.00	118.00	18.70	46.14	20.63	8.69
9	IR 82635-B-B-25-4	84.00	82.52	23.68	0.99	5.00	19.86	109.33	85.00	15.87	49.04	19.02	7.81
10	IR 82589-B-B-44-4	82.33	82.38	27.04	1.03	5.33	19.81	108.00	134.00	19.03	61.36	19.95	11.74
11	IR 82589-B-B-84-3	81.00	93.42	24.48	1.02	4.50	24.32	105.67	164.00	30.96	58.73	20.44	18.52
12	IR 82635-B-B-72-2	86.33	93.22	29.46	1.09	5.00	25.82	111.00	127.67	20.40	58.16	18.72	11.92
13	IR 82635-B-B- 75-2	87.33	93.65	29.30	1.12	5.00	26.54	111.00	102.00	18.67	49.46	20.32	9.28
14	IR 83747-B-B-81-1	83.00	97.24	30.38	1.29	4.67	24.57	108.00	123.00	18.58	63.43	18.47	11.84
15	IR 82639-B-B-3-3	83.00	110.34	32.48	1.06	5.50	25.40	109.00	121.67	22.45	57.20	17.71	12.89
16	IR 82635-B-B-93-2	82.00	84.17	29.39	1.03	6.00	25.13	107.33	116.00	23.57	61.24	20.72	14.46
17	IR 82590-B-B-102-4	88.00	95.35	31.75	1.06	5.33	27.92	116.33	71.33	15.43	55.08	19.64	8.57
18	IR 83750-B-B-30-3	88.33	97.89	31.79	1.02	4.00	25.66	113.00	122.67	20.53	59.41	17.50	12.22
19	IR 78914-B-22-B-B-B	92.00	96.52	25.33	1.10	5.00	26.41	117.00	138.00	22.10	63.33	18.61	14.04
20	IR 72860-107-3-12	91.33	90.44	27.31	0.86	4.50	26.79	116.33	138.00	18.75	57.23	20.48	10.80
21	IR 82635-B-B-3-3 59-2	89.00	98.62	29.28	1.01	4.00	23.84	114.33	161.00	23.56	53.06	18.19	12.40
22	IR 82639-B-B-200-4	89.00	100.51	32.31	1.11	5.50	26.70	114.33	132.00	22.12	61.01	20.74	13.57
23	IR 82589-B-B-67-2	85.00	91.05	26.39	1.11	4.50	27.81	112.00	76.00	15.35	51.77	18.64	8.03
24	IR 83749-B-B-46-1	86.00	106.26	26.34	1.25	5.50	27.70	111.33	103.00	19.77	54.07	17.34	10.76
25	IR 82589-B-B-51-4	86.67	92.42	27.52	1.06	5.17	25.86	111.33	113.00	21.10	55.66	19.24	11.80
26	IR 82589-B-B-124-2	84.00	93.39	23.43	1.04	4.50	23.73	108.00	93.33	17.83	47.79	20.09	8.56
27	IR 82589-B-B-13-3	85.33	85.21	24.41	0.80	4.50	23.76	110.00	78.00	16.62	51.24	19.06	8.50
28	IR 82589-B-B-2-2	86.33	86.23	27.19	1.03	4.50	23.68	112.33	81.00	16.64	54.29	19.14	9.10
29	IR 84135-11-6-B-B	88.00	90.63	23.00	1.02	5.00	21.68	113.00	92.33	16.26	47.84	19.25	7.79
30	IR 82635-B-B-47-1	92.67	98.45	23.60	1.09	5.00	23.65	119.00	111.33	18.52	50.74	20.26	9.43
31	IR 82590-B-B- 32-2	91.00	94.29	24.68	1.02	4.33	23.09	116.33	117.33	20.49	50.46	17.44	10.39
32	IR 84984-27-1	88.00	99.62	26.32	1.13	5.00	25.23	113.33	152.00	21.38	52.11	19.04	11.21

33	IR 82589-B-B-7-2	88.00	98.49	25.21	1.04	4.67	26.57	113.00	159.67	24.42	54.67	18.78	13.37
34	ZHONGHOA-10	74.00	72.26	17.80	0.80	5.00	17.17	99.00	87.00	16.38	46.76	20.55	7.73
35	IR 83750-B-B-131-1	83.00	88.29	19.57	0.86	4.00	25.81	110.00	67.00	15.59	47.84	20.43	7.51
36	IR 82589-B-B-138-2	82.00	89.26	19.01	1.16	6.00	24.35	110.00	72.33	13.83	62.22	20.96	8.61
37	IR 82638-B-B-147	80.00	88.20	22.50	1.15	6.33	25.74	109.67	102.00	18.73	54.34	19.46	10.24
38	IR 82635-B-B-145-1	79.67	81.31	19.44	1.18	5.00	21.81	107.33	83.33	16.03	47.70	19.86	7.71
39	IR 82590-B-B-87-4	86.00	92.47	25.32	1.18	4.50	24.61	114.33	158.00	21.32	65.68	17.33	13.98
40	IR 82589-B-B-2-3	78.00	100.38	25.70	1.05	6.00	23.93	103.00	137.00	24.43	60.56	21.57	14.81
41	IR 82589-B-B-121-3	80.00	94.37	26.27	0.94	6.67	23.72	105.00	175.33	34.40	56.84	19.91	19.58
42	IR 82589-B-B-149-4	78.00	95.30	27.41	0.93	6.50	20.83	103.00	194.00	34.47	60.41	22.67	20.82
43	IR 82589-B-B-36-2	76.00	102.62	26.34	1.07	6.50	21.69	100.67	178.67	32.62	62.26	20.01	20.26
44	IR 82589-B-B-95-2	76.67	93.52	18.90	1.13	5.50	21.09	101.67	194.33	29.81	62.98	21.65	18.79
45	VANDANA (check)	71.00	113.13	29.59	0.93	5.67	20.43	98.00	109.00	25.34	41.79	23.48	10.58
	Grand mean	84.12	93.44	25.80	1.04	5.07	23.68	109.71	117.72	20.54	54.83	19.67	11.42
Range	Max	92.66	113.13	32.48	1.28	6.66	27.92	119.00	194.33	34.70	65.68	23.48	20.81
	Min	71.00	72.26	17.80	0.80	4.00	17.17	98.00	67.00	13.83	41.78	17.32	7.51
	C.D. at 5%	3.31	3.33	3.04	0.03	1.27	2.98	2.93	2.90	3.00	7.62	2.78	2.82

Table 2: Estimates of components of variance and genetic parameters for different characters in upland rice during kharif 2010 and 2011

S.No.	Characters	Mean	VG	VP	GCV%	PCV%	h^2 (bs)%	GA	GA as % of mean
1	Days to 50% Flowering	84.12	22.37	26.54	5.62	6.12	84	8.95	1.63
2	Plant height	93.44	59.47	63.69	8.25	8.54	93	15.35	16.43
3	Flag leaf length	25.80	11.62	15.15	13.21	15.08	77	6.15	23.83
4	Flag leaf width	1.04	0.01	0.01	9.66	9.87	96	0.20	19.48
5	No of tiller/plant	5.07	0.25	0.87	9.88	18.37	29	0.55	10.94
6	Panicle length	20.43	5.43	8.82	9.83	12.54	62	3.76	15.98
7	Days to maturity	98.00	21.66	24.93	4.24	4.55	87	8.94	8.14
8	No of spikelets / panicle	109.00	1106.63	1109.82	28.26	28.30	100	68.43	58.13
9	Biological yield	25.34	24.77	28.21	24.23	25.85	88	9.61	46.77
1	Harvest index	41.79	25.17	47.22	9.15	12.53	53	7.54	13.75
11	Test weight	23.48	0.93	3.88	4.91	10.01	24	0.98	4.97
12	Seed yield / plant	10.58	11.64	14.67	29.86	33.51	79	6.26	54.80

VG= Genotypic Variance, VP=Phenotypic Variance, GCV=Genotypic Coefficient of Variation, PCV=Phenotypic Coefficient of Variation, , h^2(bs) = Heritability(broad sense), GA= Genetic Advance

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Table 3: Estimates of phenotypic correlation coefficient between seed yield and its attribute traits in 45 upland rice genotypes during kharif 2010 and 2011

S. No	Characters	Days to 50% flowering	Plant height	Flag leaf length	Flag leaf width	Tiller /plant	Panicle length	Days to maturity	No of spikelets /panicle	Biological Yield	Harvest Index	Test Weight	Seed yield / plant
1	Days to 50% flowering	**1.00**	0.06	0.35**	0.13	-0.18*	0.57**	0.93**	-0.07	-0.23**	0.15	-0.19*	-0.12
2	Plani height		**1.00**	0.53**	0.30**	0.24**	0.38**	0.05	0.32**	0.40	0.08	0.15	0.33**
3	Flag leaf length			**1.00**	0.16*	0.24**	0.53**	0.31**	0.17*	0.25**	0.31**	0.12	0.30**
4	Flag leaf width				**1.00**	0.19*	0.37**	0.21*	0.06	-0.03	0.36**	-0.07	0.10
5	Tiller/lant					**1.00**	0.24**	-0.18*	0.23**	0.49**	0.38**	0.65**	0.54**
6	Panicle length						**1.00**	0.59**	-0.02	0.07	0.36**	0.09	0.19*
7	Days to maturity							**1.00**	-0.16*	-0.32**	0.14	-0.23**	-0.21*
8	No of spikelets/panicle								**1.00**	0.85**	0.45**	0.09	0.84**
9	Biological Yield									**1.00**	0.38**	0.34**	0.92**
10	Harvest Index										**1.00**	0.16*	0.65**
11	Test Weight											**1.00**	0.35**

*** Significant at 1% level.*

Table 4: Estimates of genotypic correlation coefficient between seed yield and its attributes traits in 45 upland rice genotypes kharif 2010 and 2011

S. No	Characters	Days to 50% flowering	Plant height	Flag leaf length	Flag leaf width	Tiller/ plant	Panicle length	Days to maturity	No of spikelet /panicle	Biological Yield	Harvest Index	Test Weight	Seed yield / plant
1	Days to 50% flowering	**1.00**	-0.02	0.22**	0.08	-0.92**	0.47**	0.96**	-0.10	-0.39**	-0.02	-1.13**	-0.35**
2	Plant height		**1.00**	0.51**	0.28**	0.11	0.32**	-0.01	0.32**	0.36**	-0.00	-0.06	0.27**
3	Flag leaf length			**1.00**	0.10	-0.19*	0.37**	0.20*	0.17*	0.14	0.16*	-0.59**	0.13
4	Flag leaf width				**1.00**	0.14	0.36**	0.17*	0.05	-0.08	0.38**	-0.40**	0.03
5	Tiller/plant					**1.00**	-0.50**	-0.81**	0.38**	0.53**	0.18*	0.14	0.48**
6	Panicle length						**1.00**	0.54**	-0.06	-0.14	0.16*	-1.03**	-0.09
7	Days to maturity							**1.00**	-0.20*	-0.47**	-0.03	-1.06**	-0.41**
8	No of spikelets/panicle								**1.00**	0.89**	0.58**	0.12	0.92**
9	Biological Yield									**1.00**	0.42**	0.21*	0.96**
10	Harvest Index										**1.00**	-0.56**	0.66**
11	Test Weight											**1.00**	-0.00

*** Significant at 1% level.*

Table 5: Estimates of direct and indirect effects between seed yield and its attributes traits in 45 upland rice genotypes at phenotypic level

S. No	Character	Days to 50% flowering	Plant height	Flag leaf length	Flag leaf width	Tillers /plant	Panicle length	Days to maturity	No of spikelets /panicle	Biological Yield	Harvest Index	Test Weight	Seed Yield /Plant
1	Days to 50% flowering	**0.1218**	0.0083	0.0434	0.0170	-0.0220	0.0696	0.1144	-0.0094	-0.0281	0.0183	-0.0233	-0.1232
2	Plani height	-0.0033	**-0.0488**	-0.0263	-0.0147	-0.0120	-0.0186	-0.0028	-0.0159	0.0199	-0.0041	-0.0074	0.3331
3	Flag leaf length	0.0030	0.0046	**0.0085**	0.0014	0.0021	0.0045	0.0027	0.0015	0.0021	0.0027	0.0011	0.3089
4	Flag leaf width	0.0008	0.0017	0.0009	**0.0056**	0.0011	0.0021	0.0012	0.0003	-0.0002	0.0021	-0.0004	0.1022
5	Tiller/plant	-0.0058	0.0078	0.0079	0.0063	**0.0319**	0.0078	-0.0058	0.0076	0.0158	0.0123	0.0208	0.5498
6	Panicle length	0.0376	0.0250	0.0351	0.0247	0.0162	**0.0659**	0.0391	-0.0015	0.0046	0.0242	0.0064	0.1972
7	Days to maturity	-0.1522	-0.0091	-0.0516	-0.0341	0.0297	-0.0962	**-0.1620**	0.0274	0.0529	-0.0242	0.0373	-0.2146
8	No of spikelets/panicle	-0.0080	0.0336	0.0179	0.0062	0.0246	-0.0024	-0.0175	**0.1033**	0.0879	0.0469	0.0102	0.8409
9	Biological Yield	-0.1586	0.2802	0.1728	-0.0210	0.3413	0.0481	-0.2242	0.5843	**0.6866**	0.2614	0.2359	0.9287
10	Harvest Index	0.0465	0.0258	0.0971	0.1127	0.1200	0.1137	0.0463	0.1406	0.1179	**0.3098**	0.0523	0.6537
11	Test Weight	-0.0050	0.0040	0.0034	-0.0019	0.0170	0.0025	-0.0060	0.0026	0.0090	0.0044	**0.0261**	0.3589

R SQUARE = 0.9735 RESIDUAL EFFECT = SQRT (0.1627)

Table 6: Estimates of direct and indirect effects between seed yield and its attributes traits in 45 rice genotypes at genotypic level

S. No	Character	Days to 50% flowering	Plant height	Flag leaf length	Flag leaf width	Tillers/ plant	Panicle length	Days to maturity	No of spikelets /panicle	Biological Yield	Harvest Index	Test Weight	Seed Yield /Plant
1	Days to 50% flowering	**-0.0166**	0.0003	-0.0037	-0.0015	0.0154	-0.0079	-0.0160	0.0017	0.0066	0.0005	0.0189	-0.3550
2	Plani height	0.0001	**-0.0028**	-0.0014	-0.0008	-0.0003	-0.0009	0.0000	0.0009	-0.0010	0.0000	0.0002	0.2781
3	Flag leaf length	-0.0080	-0.0184	**-0.0356**	-0.0038	0.0069	-0.0132	-0.0075	-0.0062	-0.0053	-0.0059	0.0212	0.1352
4	Flag leaf width	0.0014	0.0043	0.0016	**0.0153**	0.0022	0.0056	0.0027	0.0008	-0.0013	0.0059	-0.0062	0.0391
5	Tiller/plant	0.0307	-0.0038	0.0064	-0.0048	**-0.0331**	0.0166	0.0269	-0.0127	-0.0178	-0.0061	-0.0049	0.4825
6	Panicle length	-0.0158	-0.0108	-0.0124	-0.0122	0.0168	**-0.0335**	-0.0184	0.0021	0.0048	-0.0056	0.0346	-0.0933
7	Days to maturity	0.0934	-0.0012	0.0203	0.0170	-0.0788	0.0533	**0.0971**	-0.0195	-0.0461	-0.0030	-0.1036	-0.4160
8	No of spikelets/panicle	0.0180	-0.0577	-0.0307	-0.0095	-0.0677	0.0111	0.0354	**-0.1764**	-0.1584	-0.1034	-0.0226	0.9248
9	Biological Yield	-0.4068	0.3707	0.1525	-0.0844	0.5500	-0.1467	-0.4868	0.9212	**1.0262**	0.4394	0.2189	0.9691
10	Harvest Index	-0.0104	0.0000	0.0598	0.1385	0.0657	0.0595	-0.0110	0.2101	0.1535	**0.3586**	-0.201	0.2019
11	Test Weight	-0.0410	-0.0025	-0.0215	-0.0147	0.0054	-0.0373	-0.0385	0.0046	0.0077	-0.0203	**0.0361**	-0.0093

R SQUARE = 1.0154 RESIDUAL EFFECT = 1.015

Research Article

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