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GENETIC VARIABILITY AND CORRELATION STUDIES FOR YIELD AND QUALITY TRAITS OF ELITE MEDIUM DURATION RICE (*Oryza sativa* L.) HYBRIDS

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ABSTRACT

The present investigation was conducted to examine the 27 pre released rice (*Oryza sativa* L.) hybrids along with one national hybrid check (PHB-71) and national varietal check (NDR-359) to study the genetic variability, correlation and path analysis. Analysis of variance among 27 rice hybrids showed significant difference for all characters studied. Maximum V_g and V_p were recorded for spikelets per panicle, biological yield per plant and plant height. High PCV and GCV was observed for grain yield per plant (35.65, 34.78) followed by spikelets per panicle (22.09, 21.54) respectively indicating that characters could be used as selection for crop improvement. High heritability estimates were recorded for biological yield per plant (99.00%), followed by days to 50% flowering (99.00%), High heritability coupled with high genetic advance in the present set of hybrids was recorded for spikelets per panicle (95.00% and 89.87). Further, yield was observed to be positively significant association with biological yield per plant, harvest index, flag leaf width indicates that the characters are positively governed by additive of gene action and are useful for improvement. Path coefficient reveled harvest index, biological yield, days to 50% flowering and flag leaf width had high positive direct influence on grain yield per hill. Selection of plants on these traits would certainly lead to improvement in grain yield. IHRT-M-26 was best because it showed high grain yield and quality characters like low hulling %, medium soft gel consistency, Intermediate alkali spreading value, medium kernel length and width.

KEY WORDS: Hybrid Rice, Genetic variability, Heritability, Correlation and Path analysis.

INRTODUCTION

Rice (*Oryza sativa* L.) is the most important staple food crop in the world. More than 90% of the world's rice is grown and consumed in Asia and it is known as rice bowl of the world, where 60% of the earth's people and two thirds of world's poor live (Khush and Virk 2000). It is also called as the "Grain of Life", because it is not only the staple food for more than 70% of the Indians but also a source of livelihood for about 120-150 million rural households (Directorate of rice research, 2005). Rice is the major crop in Uttar Pradesh and is grown in about 5.92 m ha. The production is 12.51 million tons and productivity of the state is around 2.2 t/ha. Thus, it is understood that there is an extreme need to enhance the rice productivity in Uttar Pradesh, which will be achieved only by developing high yielding hybrid varieties (Agricultural statistics, 2016). Hybrid rice technology has proved to be one of the most feasible and readily adoptable approaches to break the yield barrier, as they yield about 15-20% more than the best of the improved or high yielding varieties. Hybrid technology has been widely acclaimed and accepted (Babu *et al*., 2013). Adoption of hybrid rice is growing at steady rate though at a slower pace due to many factors, particularly inconsistency in yield, grain quality and consequently, lower market price for the produce, thereby affecting overall profitability. However, adoption of hybrids has picked up during the last 4-5 years, because of significant yield gains in eastern Uttar Pradesh, Bihar, Jharkhand, Orissa, Assam and Chhattisgarh. By the year 2016 area under hybrid rice is nearly 5 m. ha contributed significantly through National Food Security Mission (NFSM) launched by the Government of India (GOI) (Anonymous, 2010). The genetic improvement in traits of economic importance, along with maintaining sufficient amount of variability is always the desired in rice breeding programme. Heritability estimates along with genetic advance are normally more helpful in predicting the gain under selection than heritability estimates alone. Expected genetic advance as per cent of mean indicates the mode of gene action in the expression of a trait, which helps in choosing an appropriate breeding method (Kumar *et al*. 2014). Correlation and path analysis thus help in identifying suitable selection criteria for improving the yield. So, the present study was undertaken to know the inter-relation among different yield contributing characters and their association with grain yield. Rice is the only cereal crop cooked and consumed mainly as whole grains, and quality considerations are much more important than for any other food crop. Therefore, the percentage of head grain, grain dimensions, weight, and chalkiness, translucency of the grains, cooking and eating quality should be considered during the development of hybrid varieties. Keeping in view the above perspectives, the present research work was taken up to assessing genetic variability, phenotypic and genotypic associations between various components of grain yield to provide basis for selection and yield improvement in rice.

MATERIALS & METHODS

Twenty seven pre released medium duration rice hybrids including 2 checks received from Indian Institute of Rice Research (Formerly Directorate of Rice Research (DRR-ICAR)), Hyderabad (A.P) were used in the present investigation. The experiment was conducted at Field Experimentation Centre of Department of Genetics and Plant Breeding, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Allahabad, U.P during *Kharif* 2016.Single seedling was transplanting per hill in plot measuring 5 x 2 m in randomized block design with three replications. The inter and intra-row spacing were 20cm and 15cm respectively. Observations were recorded for grain yield and yield component characters, namely, days to 50% flowering, plant height, flag leaf length, flag leaf width, number of tillers per plant, number of panicles per plant, panicle length, number of spikelets per panicle, biological yield per plant, days to maturity, harvest Index, test weight and grain yield per plant.   All the observations were recorded from five randomly selected plants for each entry in each replication. However, days to 50% flowering and grain yield per plant were recorded on plot basis. The mean data for each character individually was subjected to statistical analysis. Based on spikelets per panicle and grain yield per plant characters selected hybrids qualitative characters are studied they are hulling %, kernel length (mm), kernel width (mm), l/b ratio, kernel length after cooking (mm), kernel width after cooking (mm), elongation ratio, gel consistency (mm) and alkali spreading value. The data were statistically analyzed for ANOVA as per Panse and Sukhatme (1967).The genotypic and phenotypic coefficients of variation were estimated following Burton and De Vane (1953). Heritability in broad sense (h^2bs) and genetic advance as percent of mean were calculated as per Johnson *et al.* (1955).The genotypic and phenotypic correlations among 13 quantitative traits were calculated following Al-jibouri *et al.* (1958) and path coefficient analysis was calculated by Dewey and Lu (1959).

RESULTS & DISCUSSION

The analysis of variance for different characters is presented in (table 1) The treatment *i.e.*, mean sum of squares due to hybrid showed significant differences to all 13 quantitative characters under study at 1% level of significant. This indicates that there was a ample scope for selection of promising lines from the present gene pool for yield and its components. The presence of large amount of variability might be due to diverse source of materials taken as well as environmental influence affecting the phenotypes. These findings are in accordance with the findings of Jayasudha *et al.* (2010), Bagati *et al.* (2016) who also observed significant variability for yield and its components traits in rice.

TABLE 1: Analysis of variance for thirteen quantitative characters in 27 rice hybrids

S. NO	Parameter	Mean sum of squares		
		Replications (df=2)	Treatments (df=26)	Error (df=52)
1.	Days to 50% Flowering	0.45	68.46**	0.79
2.	Plant Height	8.77	249.22**	14.26
3.	Flag Leaf Length	0.05	132.70**	6.24
4.	Flag Leaf Width	0.001	0.09**	0.002
5.	Tillers per hill	0.03	9.14**	0.78
6.	Panicles per hill	0.65	4.84**	0.76
7.	Panicle Length	0.74	7.26**	0.92
8.	Spikelets per Panicle	1.92	6111.90**	104.54
9.	Days to Maturity	0.48	55.59**	0.99
10.	Biological Yield	0.43	390.56**	1.46
11.	Harvest index	1.87	186.41**	1.81
12.	Test Weight	0.08	28.14**	1.46
13.	Grain Yield per hill	1.00	233.21**	3.87

** Significant at 1% level of significance

In recent decades as living conditions are being steadily improved, human demand for high quality rice is continuously on increase, which entailed in incorporation of preferred grain quality features as the most important objective next to enhancement in yield. Also quality characteristics increase the total economic value of rice. Hence, improving rice grain quality has been a major concern in rice breeding programs to meet the consumer preference and market. Taking into consideration based on spikelets per panicle and grain yield per plant characters selected hybrids qualitative characters are studied (Table 2). The hybrid IHRT-M-26 (65.74 %) recorded minimum mean value for hulling %, whereas maximum mean value for hulling % recorded by IHRT-M-13 (70.10%). Hybrid IHRT-M-5 (7.27 mm) showed maximum mean value for kernel length. IHRT-M-14, IHRT-M-26, IHRT-M-24, IHRT-M-13 showed moderate mean value for kernel length. Kernel width varies from (2.63 mm) IHRT-M-26 to (2.06 mm) IHRT-M-6. Similarly moderate mean values for L/B ratio recorded for these hybrids ranges from (2.88 mm) IHRT-M-14 and IHRT-M-6 to (2.35mm) IHRT-M-13. Kernel length after cooking ranged from (8.26 mm) IHRT-M-5, to (6.73 mm) IHRT-M-6, whereas kernel width after cooking varies from (3.28 mm) IHRT-M-5 to (2.90 mm) IHRT-M-6. Gel consistency recorded highest mean value for (85 mm) IHRT-M-13 and minimum mean value for (42 mm) IHRT-M-14. Intermediate mean value for alkali spreading value recorded for IHRT-M-5, IHRT-M-13, and IHRT-M-14, IHRT-M-26.

Among the medium duration rice hybrids IHRT-M-26 was best because it showed high grain yield and quality characters like low hulling %, medium soft gel

consistency, Intermediate alkali spreading value, medium kernel length and width. The magnitude of phenotypic variance was higher than genotypic variance for all the yield and yield attributing characters indicates that the influence of environmental factors on these traits. Similar findings were reported by Jambhulkar *et al.* (2014), Devi *et al.* (2016) for grain yield per plant, plant height, number of spikelets per panicle and biological yield.

The magnitude of PCV was higher than GCV for all the characters which may due to higher degree of interaction of genotypes with the environment. The observations were in agreement with results of Vange *et al.* (2009).

The PCV was observed for the character ranging from (3.28) for days to maturity to (35.65) for grain yield per hill. Higher magnitude of phenotypic coefficient of variation was recorded for grain yield per hill (35.65), followed by spikelets per panicle (22.09). Lowest magnitude of PCV was recorded for days to maturity (3.28), followed by days to 50% flowering (4.54), panicle length (6.27) and plant height (7.86). Similar findings were reported by Karthikeyan *et al* (2010) and Devi *et al.* (2016) for grain yield per hill and spikelets per panicle.

Genotypic coefficient of variation (GCV) ranged from (3.20) for days to maturity to (34.78) for grain yield per hill. Higher magnitude of phenotypic coefficient of variation was recorded for grain yield per hill (34.78), followed by spikelets per panicle (21.54). Lowest magnitude of PCV was recorded for days to maturity (3.20), followed by days to 50% flowering (4.46), panicle length (5.22) and plant height (7.23). Similar findings were reported by Karthikeyan *et al.* (2010) for grain yield per plant and spikelets per plant, Jambhulkar *et al.* (2014), Rao *et al.* (2014) for grain yield per plant. These PCV, GCV values are not helpful in determining the heritable portion of variation. It can be find out with greater degree of accuracy when heritability is conjunction with genetic advance study.

Heritability and genetic advance were determined to study the scope of improvement in various characters through selection. Heritability and genetic advance are important selection parameters. High heritability estimates along with high genetic advance are more helpful in predicting the gain under selection than heritability estimates alone. However, it is not necessary that a character showing high heritability will also exhibit high genetic advance (Johanson *et al.,* 1955). Heritability is a good index of transmission of characters from parents to its progeny. The estimates of heritability help the plant breeder in selection of elite genotypes from diverse genetic population.

The heritability estimates were showed high for all characters ranges from panicles per hill (64.00%) to biological yield per plant (99.00%).The heritability estimates were high for biological yield per plant (99.00%), followed by days to 50% flowering (99.00%), harvest index (97.00%), spikelets per panicle (95.00%), days to maturity (95.00%), grain yield per hill (95.00%), which suggested that these traits would respond to selection owing is their high genetic variability and transmissibility. Similar results were also reported by

Sabesan *et al.* (2009), for all characters, Bagati *et al.* (2016) recorded high heritability estimates for most of the characters. According to Panse and Sukhatme (1957) such characters governed predominantly by additive gene action and can be improved through individual plant selection.

High heritability coupled with high genetic advance (>30) in the present set of hybrids was recorded for spikelets per panicle (95.00% and 89.87), indicating predominance of additive gene effects and the possibilities of effective selection for the improvement of these characters. Similar results were also reported by Chand *et al.* (2004), Bhati *et al.* (2015).

Genetic advance as per cent of mean was highest for grain yield per hill (69.90%) followed by spikelet per panicle (43.25%), harvest index (39.07%), biological yield per plant (38.60%), flag leaf length (30.04%), flag leaf width (25.05%) ,tillers per hill (24.30%), test weight (21.81%). Similar results were also reported by Devi *et al.* (2016) for grain yield per hill, flag leaf length, test weight.

The estimates of correlation coefficients (Table 3) revealed that, in general, the genotypic and the phenotypic correlation coefficients showed similar trend but genotypic correlation coefficients were of higher in magnitude than the corresponding phenotypic correlation coefficients. This indicates that the characters are positively governed by additive of gene action and are useful for improvement. Grain yield per hill showed the positive significant genotypic association with biological yield per plant (0.93**), harvest index (0.88**), flag leaf width (0.64**), plant height (0.58**), spikelets per panicle (0.50**) and flag leaf length (0.25**). The correlation shows positive non significant association with days to maturity (0.09). Correlation shows negative significant association with panicles per hill (-0.29**). The correlation shows negative non significant association with tillers per hill (-0.4), days to 50% flowering (-0.05) and test weight (-0.04). Similar results also reported by Parvin *et al.* (2007), for positive significant correlation of biological yield and harvest index with grain yield per plant. Paul *et al.* (2011), observed positive correlation of harvest index and spikelets per panicle with grain yield per plant at genotypic level.

Grain yield per hill showed positive significant phenotypic association with biological yield per plant (0.92**), harvest index (0.88**), flag leaf width (0.59**), plant height (0.53**), spikelet's per panicle (0.47**), flag leaf length (0.23**), while negative significant association with tillers per hill (-0.45**), panicles per hill (-0.27*). The correlation showed negative non-significant association with days to 50% flowering (-0.04), test weight (-0.03). Days to maturity (0.09) shows positive non-significant association. Similar results also reported by Parvin *et al.* (2007), Rai *et al.* (2014) for positive significant correlation of biological yield and harvest index with grain yield per plant. Yadav *et al* (2010), were observed positive correlation of flag leaf length with grain yield per plant at phenotypic level.

TABLE 2 : Mean performances of best 06 rice Hybrids for 9 quality parameters during Kharif 2016

S. No.	Genotypes	Hulling %	Kernel Length (mm)	Kernel Width (mm)	L/B ratio	Kernel length after cooking (mm)	Kernel width after cooking (mm)	Elongation ratio	Gel consistency (mm)	Alkali spreading value
1	IHRT-M-5	66.67	7.27	2.61	2.79	8.26	3.28	1.10	45	Intermediate
2	IHRT-M-6	68.50	5.95	2.06	2.88	6.73	2.90	1.07	73	Low
3	IHRT-M-13	70.10	6.26	2.60	2.35	7.28	3.41	1.11	85	Intermediate
4	IHRT-M-14	67.25	6.91	2.40	2.88	7.57	3.27	1.01	42	Intermediate
5	IHRT-M-24	66.00	6.63	2.50	2.66	7.36	3.08	1.10	58	High
6	IHRT-M-26	65.74	6.74	2.63	2.56	7.72	3.26	1.12	67	Intermediate
Mean		67.37	6.62	2.47	2.68	7.48	3.20	1.08	61.66	
Range lowest		65.74	5.95	2.06	2.35	6.73	2.90	1.01	42	
Range highest		70.10	7.27	2.63	2.88	8.26	3.41	1.12	85	

TABLE 3: Mean performance of 27 rice Hybrids for 13 characters during *Kharif*-2016

S. No	Character	Days for 50% Flowering	Plant Height (cm)	Flag Leaf Length (cm)	Flag Leaf Width (cm)	Panicle Length (cm)	Tillers / Hill	Panicles/ Hill	Spikelets / Panicle	Days to Maturity	Biological Yield/ Plant (g)	Harvest Index (%)	Test Weight (g)	Grain Yield (g)
1	IHRT-M-01	108.67	118.03	38.10	1.46	27.03	15.33	11.97	137.33	139.67	49.52	39.42	27.67	19.53
2	IHRT-M-02	109.33	111.60	33.73	1.10	27.13	12.50	8.53	151.47	133.33	45.71	31.49	26.91	14.40
3	IHRT-M-03	102.33	110.10	34.27	1.52	28.07	14.33	11.87	178.20	128.33	56.69	38.03	26.84	21.57
4	IHRT-M-04	107.33	128.20	44.10	1.27	28.33	13.80	11.47	213.60	130.00	38.03	46.11	26.69	16.90
5	IHRT-M-05	107.33	120.50	47.07	1.71	30.37	9.43	9.23	222.83	135.33	81.75	50.85	31.61	41.57
6	IHRT-M-06	110.00	130.00	37.40	1.52	30.03	12.70	10.47	309.17	135.33	70.15	44.62	19.10	31.30
7	IHRT-M-07	110.33	133.50	42.80	1.41	29.97	12.50	9.83	209.83	138.00	68.59	42.38	22.64	29.07
8	IHRT-M-08	102.00	106.87	32.93	1.27	27.73	13.50	11.07	192.73	127.67	53.48	33.89	26.77	18.13
9	IHRT-M-09	109.67	123.10	52.87	1.26	26.73	14.23	11.67	144.03	137.67	48.53	40.41	28.92	19.63
10	IHRT-M-11	104.67	122.90	41.47	1.42	26.93	12.50	10.97	170.90	130.00	49.15	30.85	31.71	15.17
11	IHRT-M-12	100.33	115.87	30.13	1.50	26.53	12.40	12.27	184.20	130.33	73.38	49.97	27.74	36.67
12	IHRT-M-13	104.00	137.60	45.43	1.80	27.43	10.03	9.33	263.53	132.67	75.76	50.46	25.42	38.23
13	IHRT-M-14	108.33	130.33	46.77	1.56	28.97	13.00	10.97	244.80	136.00	69.69	50.65	27.48	35.97
14	IHRT-M-15	106.00	125.70	48.47	1.36	29.87	14.93	12.90	170.17	132.00	65.60	42.57	30.74	27.93
15	IHRT-M-16	102.67	111.87	38.20	1.40	27.53	13.30	11.77	193.03	130.00	56.57	32.45	27.98	18.37
16	IHRT-M-17	113.00	123.60	43.40	1.33	27.83	14.00	11.37	194.50	139.00	54.61	26.79	25.76	14.63
17	IHRT-M-18	107.33	129.13	39.03	1.47	26.83	10.67	9.57	211.57	133.67	58.62	32.21	29.00	18.90
18	IHRT-M-19	112.00	117.40	47.17	1.51	27.33	11.07	10.17	262.80	138.67	57.04	31.87	27.33	18.20
19	IHRT-M-20	113.33	117.30	44.40	1.10	25.40	13.40	10.33	144.07	137.67	60.98	46.29	22.12	28.23
20	IHRT-M-21	109.00	121.17	49.70	1.15	26.30	11.67	9.93	220.00	134.00	60.92	47.65	24.20	29.03
21	IHRT-M-22	110.33	121.27	49.60	1.18	27.93	15.43	13.93	230.67	136.67	48.57	33.75	20.91	16.40
22	IHRT-M-23	105.67	101.33	35.67	1.14	25.70	10.37	9.43	210.43	134.00	50.22	27.59	23.43	13.87
23	IHRT-M-24	107.00	132.03	39.53	1.48	27.93	11.07	10.37	266.77	133.67	77.67	45.48	24.00	35.33
24	IHRT-M-26	108.67	138.97	52.87	1.66	31.70	8.93	8.73	297.77	136.67	80.22	51.07	26.53	40.97
25	IHRT-ME-27	101.00	128.60	41.00	1.32	29.13	13.30	10.37	220.30	131.67	66.73	50.43	23.88	30.33
26	PHB-71 (Hybrid Check)	105.67	124.41	36.86	1.41	25.67	11.13	11.23	190.43	132.00	60.10	43.51	25.61	26.13
27	NDR-359 (Local check)	90.33	122.67	28.72	1.39	26.87	12.03	11.17	174.50	120.00	53.48	39.78	23.81	22.23
	Mean	106.53	122.37	41.54	1.40	27.83	12.50	10.77	207.76	133.48	60.44	40.76	26.10	25.14
	Range Lowest	90.33	101.33	28.72	1.10	25.40	8.93	8.53	137.33	120.00	38.03	26.79	19.10	13.87
	Range Highest	113.33	138.97	52.87	1.80	31.70	15.43	13.93	309.17	139.67	81.75	51.07	31.71	41.57
	C.D. 5%	1.46	6.19	4.09	0.09	1.58	1.45	1.44	16.75	1.63	1.98	2.21	1.98	3.23
	C.V.	0.83	3.09	6.02	3.77	3.46	7.08	8.14	4.92	0.75	2.00	3.30	4.63	7.83

TABLE 4: Genetic parameters for 13 quantitative characters in 27 rice hybrids

S. NO.	Characters	V_g	V_p	Coefficient of variation		h^2 % (B.S.)	GA	GA as % of mean
				GCV	PCV			
1.	Days to 50% Flowering	22.56	23.35	4.46	4.54	97.00	9.62	9.03
2.	Plant Height	78.32	92.58	7.23	7.86	85.00	16.77	13.70
3.	Flag Leaf Length	42.15	48.40	15.63	16.75	87.00	12.48	30.04
4.	Flag Leaf Width	0.03	0.03	12.68	13.23	92.00	0.35	25.05
5.	Tillers per hill	2.79	3.57	13.35	15.11	78.00	3.04	24.30
6.	Panicles per hill	1.36	2.13	10.81	13.53	64.00	1.92	17.80
7.	Panicle Length	2.11	3.04	5.22	6.27	70.00.	2.50	8.97
8.	Spikelets per Panicle	2002.45	2107.00	21.54	22.09	95.0	89.87	43.25
9.	Days to Maturity	18.20	19.20	3.20	3.28	95.00	8.56	6.41
10.	Biological Yield	129.70	131.17	18.84	18.95	99.00	23.33	38.60
11.	Harvest index	61.54	63.35	19.24	19.53	97.00	15.93	39.07
12.	Test Weight	8.89	10.36	11.42	12.33	86.00	5.69	21.81
13.	Grain Yield per hill	76.45	80.32	34.78	35.65	95.00	17.57	69.90

TABLE 5: Correlation coefficient between yield and its related traits in 27 rice hybrids at genotypic level

Characters	Plant Height	Flag Leaf Length	Flag Leaf Width	Panicle Length	Tillers /hill	Panicles /hill	Spikelets /Panicle	Days to Maturity	Biological Yield/ plant	Harvest index	Test Weight / hill	Grain Yield / hill
Days to 50% Flowering	0.15	0.63**	-0.17	0.10	0.07	-0.16	0.15	0.92**	-0.01	-0.09	-0.12	-0.05
Plant Height		0.46**	0.51**	0.07	-0.27*	-0.22*	0.52**	0.23*	0.52**	0.59**	-0.11	0.58**
Flag Leaf Length			0.07	0.36**	-0.05	-0.04	0.28**	0.64**	0.19	0.28**	0.12	0.25*
Flag Leaf Width				0.49**	-0.49**	-0.19	0.51**	0.00	0.68**	0.43**	0.30**	0.64**
Panicle length					-0.14	-0.17	0.55**	0.18	0.55**	0.41**	0.03	0.52**
Tillers/ hill						0.83**	-0.56**	0.03	-0.56**	-0.24*	-0.07	-0.4
Panicles /hill							-0.38**	-0.15	-0.56**	-0.13	0.02	-0.29**
Spikelets /Panicle								0.18	0.57**	0.33**	-0.37**	0.50**
Days to Maturity									0.15	0.00	-0.10	0.09
Biological Yield / plant										0.67**	-0.03	0.93**
Harvest index											-0.08	0.88**
Test Weight												-0.04

**1% and * 5% level of significance respectively

TABLE 6: Correlation coefficient between yield and its related traits in 27 rice hybrids at phenotypic level

Characters	Plant Height	Flag Leaf Length	Flag Leaf Width	Panicle Length	Tillers /hill	Panicles /hill	Spikelets /Panicle	Days to Maturity	Biological Yield/ plant	Harvest index	Test Weight	Grain Yield / hill
Days to 50% Flowering	0.15	0.57**	-0.15	0.10	0.06	-0.13	0.15	0.88**	-0.01	-0.08	-0.09	-0.04
Plant Height		0.48**	0.50**	0.52**	-0.21	-0.10	0.52**	0.16	0.47**	0.52**	-0.07	0.53**
Flag Leaf Length			0.10	0.36**	-0.01	-0.00	0.28**	0.54**	0.17	0.25*	0.12	0.23*
Flag Leaf Width				0.47**	-0.40**	-0.16	0.48**	-0.00	0.65**	0.40**	0.30**	0.59**
Panicle length					-0.03	-0.06	0.50**	0.10	0.45**	-0.33**	0.07	0.43**
Tillers/ hill						0.71**	-0.27*	-0.00	-0.51**	-0.24*	-0.05	-0.45**
Panicles /hill							-0.46**	-0.14	-0.30**	-0.14	0.03	-0.27*
Spikelets /Panicle								0.15	0.55**	0.31**	-0.31**	0.47**
Days to Maturity									0.14	0.01	-0.08	0.09
Biological Yield / plant										0.67**	-0.03	0.92**
Harvest index											-0.07	0.88**
Test Weight												-0.03

**1% and * 5% level of significance respectively

TABLE 7: Direct and indirect effects at genotypic level for different quantitative characters on grain yield

Characters	Days to 50% Flowering	Plant Height	Flag Leaf Length	Flag Leaf Width	Panicle length	Tillers /hill	Panicles / hill	Spikelets /Panicle	Days to Maturity	Biological Yield	Harvest index	Test Weight	Grain Yield / hill
Days to 50% Flowering	**0.0698**	0.0107	0.0442	-0.0123	0.0074	0.0053	-0.0116	0.0109	0.0643	-0.0010	-0.0067	-0.0088	-0.0574
Plant Height	-0.0036	**-0.0238**	-0.0111	-0.0122	-0.0124	0.0065	0.0054	-0.0125	-0.0055	-0.0125	-0.0141	0.0028	0.5884
Flag Leaf Length	-0.0212	-0.0157	**-0.0336**	-0.0024	-0.0121	0.0019	0.0017	-0.0095	-0.0217	-0.0065	-0.0095	-0.0041	0.2536
Flag Leaf Width	-0.0055	0.0159	0.0022	**0.0310**	0.0153	-0.0152	-0.0061	0.0159	0.0001	0.0213	0.0134	0.0095	0.6424
Panicle length	0.0098	0.0477	0.0331	0.0454	**0.0917**	-0.0135	-0.0157	0.0513	0.0168	0.0512	0.0382	0.0035	0.5289
Tillers/ hill	-0.0214	0.0776	0.0164	0.1385	0.0415	**-0.2821**	-0.2367	0.1599	-0.0105	0.1598	0.0683	0.0200	-0.4816
Panicles /hill	-0.0299	-0.0406	-0.0089	-0.0355	-0.0308	0.1505	**0.1794**	-0.0693	-0.0271	-0.0651	-0.0247	0.0050	-0.2935
Spikelets /Panicle	-0.0206	-0.0697	-0.0373	-0.0678	-0.0740	0.0749	0.0511	**-0.1322**	-0.0246	-0.0760	-0.0442	0.0497	0.5061
Days to Maturity	0.0156	0.0039	0.0110	0.0001	0.0031	0.0006	-0.0026	0.0032	**0.0170**	0.0026	0.0001	-0.0018	0.0942
Biological Yield / plant	-0.0076	0.2690	0.0982	0.3512	0.2853	-0.2893	-0.1852	0.2936	0.0767	**0.5107**	0.3442	-0.0182	0.9357
Harvest index	-0.0499	0.3066	0.1466	0.2239	0.2159	-0.1253	-0.0714	0.1733	0.0025	0.3490	**0.5179**	-0.0445	0.8877
Test Weight	0.0072	0.0067	-0.0070	-0.0175	-0.0022	0.0041	-0.0016	0.0215	0.0062	0.0020	0.0049	**-0.0572**	-0.0442

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Correlation coefficient values do not reveal the real association pattern of the independent variables with dependent one. Path coefficient analysis on the other hand is an efficient statistical technique specially designed to qualitative interrelationship of different components and their direct and indirect effect on seed yield. In the present study the results of path coefficient analysis indicated that, the traits having direct effects on grain yield are understood to be strongly associated with it. Therefore any variations in these traits were highly influence grain yield per plant.

Path coefficient at genotypic level revealed that harvest index (0.5179) had highest positive direct effect on grain yield followed by biological yield (0.5107), panicles per hill (0.1794), panicle length (0.0917), days to 50% flowering (0.0698), flag leaf width (0.0310) and days to maturity (0.0170). The path coefficient shows negative direct effect was observed in tillers per hill (-0.2821), followed by spikelets per panicle (-0.1322), test weight (-0.0572), flag leaf length (-0.0336) and plant height (-0.0238). Similar results were also reported by Ekka *et al.* (2011) for flag leaf length.

Path coefficient at phenotypic level revealed that biological yield per plant (0.5691) had highest positive direct effect on grain yield followed by harvest index (0.4887), days to 50% flowering (0.0525), flag leaf width (0.0420). The path coefficient shows negative direct effect was observed in tillers per hill (-0.0706), followed by spikelets per panicle (-0.0473), days to maturity (-0.0469), plant height (-0.0254). Similar reports were also reported by Jayasudha and Sharma (2010), panicles per hill, spikelets per panicle and panicle length showed maximum positive direct effects and indirect contribution through other character on grain yield.

In the present study path coefficient reveled harvest index, biological yield, days to 50% flowering and flag leaf width had high influence on grain yield per hill. Selection of plants on these traits would certainly lead to improvement in grain yield. Similar results were obtained by Jayasudha and Sharma (2010).

CONCLUSION

The present investigation concluded that presence of adequate amounts of variability for yield and its associated traits. Among the 27 rice hybrids on the basis of mean performances IHRT-M-05 (6.8 t/ha) was found to be superior in grain yield followed by IHRT-M-26 (6.6 t/ha) and IHRT-M-13 (6.4 t/ha). Among the medium duration rice hybrids IHRT-M-26 was best because it showed high grain yield and quality characters like low hulling %, medium soft gel consistency, Intermediate alkali spreading value, medium kernel length and width. High heritability coupled with high genetic advance in the present set of hybrids was recorded for spikelets per panicle. Genetic advance as per cent of mean was highest for grain yield per hill followed by spikelet per panicle, harvest index, biological yield per plant. Characters like biological yield per plant and harvest index exhibited maximum positive direct effect on grain yield seems to be primary yield contributing characters and could be relied upon for selection of hybrids to improve genetic yield potential of rice. Hence, utmost importance should be given to these characters during selection for single plant yield improvement. Since one year data is not sufficient to conclude results. So, further experimentation is required to corroborate the results.

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