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Research Article

EVALUATION OF EARLY MATURE ELITE RICE (*Oryza sativa* L.) HYBRIDS FOR YIELD AND YIELD COMPONENT TRAITS SUITED TO EASTERN PLAIN ZONE OF UTTAR PRADESH

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Abstract: The investigation was accomplished using 19rice hybrids to assess genetic variability, correlation among yield attributing traits and also indirect and direct effects on yield. Analysis of variance revealed that all hybrids showed considerable variation which helps in identification of promising lines for future breeding programme. High level of estimates of PCV and GCV was documented for grain yield/plant, spikelets/ panicle, panicles/m^2. High heritability was recorded for test weight, panicles/m^2 and plant height. Genetic advance as percent mean was highest for plant height, flag lef length, panicles per hill, spikelets per panicle, panciles per square meter, biological yield, test weight and grain yield per plant. High levels of estimates for heritability along with genetic advance as percent of mean were documented in test weight, panicles/m^2 and grain yield/plant. Correlation revealed that grain yield/plant showed positive significant affiliation for majority of the characters excluding spikelets/ panicle, flag leaf width and number of tillers/hill at phenotypic and genotypic levels. Days to maturity, plant height, days to 50% flowering, biological yield had positive direct effect on yield at phenotypic and genotypic level which indicates direct resolution of these traits that would lead for augmentation of grain yield in rice. The investigation concluded that IHRT-E- 3016, IHRT-E- 3006 and IHRT-E-3009 were identified as best hybrids for grain yield.

Keywords: *Genetic variability, Phenotypic coefficient of variation, Genotypic coefficient of variation, Genetic advance, Heritability, Correlation and Path analysis*

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Introduction

Rice (*Oryza sativa* L.), one of the predominant cereal crops in the world and also the main source of carbohydrates for leading group of world population. Over 90% rice production and consumption are done in most of the Asian countries. In India, rice covers about 44.16 million ha, the production level is 115 million tonnes and the productivity is about 2700 kg/ha during 2018-19 [1]. In India, West Bengal stands top in the production of rice with an area of 5.12 million hectares (accounting for 11.68% of entire area) with production of 14.27 million tonnes (accounting for 13.26% of entire production) and productivity of 2926kg/ha. Rice is grown as major crop in Uttar Pradesh which covers about 5.91 m ha (accounting for 13.28% of entire area). The state ranks second in the country in rice production.

The production is 13.27 million tons (accounting for 11.75% of entire area) and productivity is around 2000 kg/ha for the state. Thus, only by developing high yielding rice hybrids the rice productivity in Uttar Pradesh can be enhanced and the needs can be met [2]. Hybrid rice technology plays a vigorous role to crack yield barriers. Majority of the rice hybrids were developed using the CGMS or three-line system in the country and at most of the places in the world. The CGMS system basically implicates three lines, A-line (cytoplasmic male sterile line), B-line (maintainer line), and R-line (restorer line) which possesses dominant fertility restoring genes. The improved qualities of the F1 generation over its parental lines are referred to as hybrid vigour or heterosis. Rice is being cooked and consumed directly as a whole grain. Hence, quality characteristics play an important role in rice breeding programme. For any breeding programme, cognizance of considerable variability along with nature of inter relation among dissimilar characters and their parallel contribution of dissimilar characters to grain yield is essential [3]. For initiating any crop improvement programme critical analysis of genetic variability is required for appurtenant selection.

To find out the guidelines for plant selection, knowledge of inter relation amid the yield and its contributing characters are rudimentary. Path analysis splits total inter relation into direct and indirect effects which helps in making more articulate selection. The current study is focussed on assessment of genetic variability, inter relation among yield and yield attributing traits and their indirect and direct effects on grain yield.

Materials and Methods

The current approach was implemented using 19 rice hybrids at the Field Experimentation Centre, Department of Genetics and Plant Breeding, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, U.P during the period of *Kharif*-2019. The University is located toward the left side of Prayagraj -Rewa National Highway, nearly 5 kms away from Prayagraj City. The experimental material was assigned in Randomized Block Design (RBD).

Seedlings were transplanted when they were 30 days old. Gap of 20cm was maintained among the rows and 15cm amid the plants. Recording of 5 plants data selected from each replication randomly was averaged and mean data was subjected to statistical analysis replication wise for all 14 quantitative characters and 7 quality characters. The per se performance of individual hybrid is implemented for statistical analysis. Test of significance and variance analysis was deliberated by Fisher 1918 method. Components of variance [4] and heritability (h^2) was deliberated by Burton and De Vane (1953) [5] genetic advance as percent of mean and correlation coefficient analysis was deliberated by Johnson *et al*., (1955) [6]. Path coefficient analysis was employed accordingly Dewey and Lu (1959) method [7]. Significance of correlation coefficient values were tested as stipulated by Fisher and Yates (1967) [8].

Results and Discussion

The analysis of variance [Table-1] had exhibited the presence of significant variability among the hybrids which helps in making selection and developing varieties with desired forms. Presence of genetic variability in the population of any plant breeding programme makes it more effective for selection. High magnitude of PCV estimates were found compared to GCV estimates indicating the presence of environmental effect on expression of character. GCV and PCV estimates were ranged from (3.06, 3.42) (days to maturity) to (26.21, 33.95) (spikelets/panicle). Dhurai *et al*., (2014) [9] had reported for days to maturity and spikelets per panicle. Minor disparity between GCV and PCV were depicted for flag leaf length, plant height, panicle length, panicles/m^2, biological yield, harvest index, days to maturity, test weight and grain yield/plant. Ghosh *et al*., (2012) [10] reported for flag leaf length, flag leaf width, grain yield/plant and test weight. Heritability (h^2) (broad sense) [Table-2] ranged from 46.43% to 97.97%. The highest heritability (above 60%) was found for test weight, panicles/m^2, plant height, days to 50% flowering, flag leaf length, days to maturity, grain yield/plant, biological yield, panicle length, harvest index, flag leaf width respectively. Dhanwani *et al*., (2013) [11] reported in grain yield/plant, biological yield; Ghosh *et al*., (2012) reported in flag leaf length, test weight; Dhurai *et al*., (2014) for days to 50% flowering and days to maturity. Genetic advance as percent mean was higher for panicles/m^2 (41.79%), spikelets/ panicle (41.71%), grain yield/plant (38.68%), biological yield (28.97%), flag leaf length (28.9%), test weight (28.34%), panicles/hill (23.81%) and plant height (23.41%). Dhurai *et al*., (2014) for grain yield/plant. Moderate estimates were recorded for panicle length (10.17%), harvest index (16.59%), tillers/hill (18.1%) and flag leaf width (18.85%).Ravindra *et al*., (2012) [12] reported moderate estimates in tillers/hill; Ghosh *et al*., (2012) reported in flag leaf length, spikelets /panicle, flag leaf width. High heritability with high genetic advance as percent mean was recorded in test weight (99.97% and 28.34%), panicles per square meter (99.96% and 41.79%), plant height (97.32% and 23.41%), flag leaf length (89.03% and 28.90%), grain yield/plant (84.36% and 38.68%) and biological yield (79.08% and 28.97%). Subbaiah *et al*., (2011) [13] reported for panicle length; Vennila *et al*., (2018) [14] reported for plant height and grain yield/plant; Ghosh *et al*., (2012) in test weight, flag leaf length and plant height.

Table-1 *Analysis of Variance for 14 quantitative characters in 19 rice hybrids*

SN	Characters	Mean sum of squares		
		Replication	Treatment	Error
		(df=2)	(df=18)	(df=36)
1	Days to 50% Flowering	5.12	40.12**	2.23
2	Plant height (cm)	36.67	634.60**	5.77
3	Flag leaf length (cm)	6.93	98.14**	3.87
4	Flag leaf width (cm)	0.00	0.08**	0.01
5	Tillers per hill	14.80	8.90**	2.47
6	Panicles per hill	10.01	9.267**	1.92
7	Spikelets per panicle	2304.49	4447.23**	818.49
8	Panicles per sq. meter	66.64	12874.20**	1.61
9	Panicle length (cm)	0.20	7.90**	0.77
10	Biological yield (g)	44.14	345.85**	28.02
11	Harvest Index (%)	36.69	83.68**	9.03
12	Days to maturity	41.38	43.36**	3.36
13	Test weight (g)	12.34	38.40**	0.00
14	Grain yield per plant (g)	0.94	161.64**	9.40

*** Indicate Significant at 1% level of significance*

The data was further subjected to correlation [Table-3] analysis which showed grain yield was positive significantly associated with days to 50% flowering, flag leaf length, plant height, panicles/hill, panicles/m^2, panicle length, test weight, harvest index, days to maturity and biological yield at both levels. Similarly, positive nonsignificant correlation with spikelets/panicle, flag leaf width, tillers /hill at both the levels. Roy *et al*., (2015) [15] reported for tillers/hill and spikelets/panicle and harvest index; Ramesh *et al*., (2018) [16] reported similar findings in test weight; Roy *et al*., (2015) in. Inter character association revealed, days to 50% flowering showed positive significant correlation with panicles/m^2, plant height, biological yield, flag leaf length, panicle length, days to maturity, harvest index at both the levels. Reddy *et al*., (2008) [17] reported for days to maturity; Chandan *et al*., (2014) [18] for plant height. Plant height was positive significantly associated with days to 50% flowering, test weight, panicle length, flag leaf length, days to maturity at both the levels. Hasan *et al*., (2015) [19] reported for panicle length. Flag leaf length expressed positive significant association with plant height, flag leaf width, panicle length, days to 50% flowering and biological yield at phenotypic level. Ramesh *et al*., (2018) reported for flag leaf width. Flag leaf width with spikelets/panicle, harvest index at phenotypic level. Ramesh *et al*., (2018) reported earlier for flag leaf length. Tillers/hill with panicles/hill and panicles/m^2 at both levels. Nikhil *et al*., (2014) [20] reported earlier for panicles/hill at genotypic level. Panicles/hill with tillers/hill and panicles/m^{2}at both levels.

Nikhil *et al*., (2014) reported for tillers/ hill at genotypic level. Spikelets/panicle with flag leaf width (both levels). Ramesh *et al*., (2018) for flag leaf width. Panicles/m^2 with grain yield/plant, tillers/hill, days to 50% flowering, panicles/hill, plant height at phenotypic level. Panicle length with days to maturity, biological yield, plant height, flag leaf length, days to 50% flowering (phenotypic level). Ramesh *et al*., (2018) in flag leaf length, plant height. Biological yield with flag leaf length, plant height, test weight, days to maturity, days to 50% flowering, grain yield/plant, panicle length at genotypic level. Lakshmi *et al*.,(2014) [21] reported in days to maturity, plant height; Hasan *et al*., (2015) in grain yield/plant. Harvest index in flag leaf width and grain yield/plant at genotypic level. Dhavaleshvar *et al*., (2019) [22] reported earlier for grain yield/plant. Days to maturity with panicle length, days to 50% flowering, biological yield, plant height, grain yield/plant at genotypic level. Lakshmi *et al*.,(2014)reported earlier for grain yield/plant. Test weight with grain yield /plant (both levels). Ramesh *et al*., (2018) reported earlier for grain yield /plant at both levels.

The results of path coefficient analysis were presented in [Table-4]. Path coefficient analysis revealed positive direct effect on grain yield/plant by days to 50% flowering followed by flag leaf width, plant height, tillers/ hill, panicles/sq.m, panicle length, biological yield, harvest index and days to maturity at phenotypic level. Negative direct effect was showed by spikelets/panicle, flag leaf width, panicles/hill and test weight at phenotypic level. Dhavaleshvar *et al*., (2019) had reported earlier for days to maturity; Ramesh *et al*., (2018) for test weight, panicle length; Fiyaz *et al*., (2011) [23] for harvest index, biological yield, spikelets/panicle. Days to 50% flowering showed negative indirect effect on grain yield/ plant through tillers/hill. Sameera *et al*., (2015) [24] for tillers/hill. Plant height with harvest index, panicle length, days to 50% flowering; Dhavaleshvar *et al*., (2019) for harvest index. Flag leaf length with tillers/hill.

Nikhil *et al*., (2014) reported earlier for tillers/hill. Flag leaf width with flag leaf length, days to 50% flowering, biological yield; Ramesh *et al*., (2018) reported earlier for flag leaf length; Nikhil *et al*., (2014) for biological yield. Tillers/hill with days to maturity and test weight. Ramesh *et al*., (2018) reported earlier for test weight; Dhavaleshvar *et al*., (2019) for days to maturity. Panicles per hill with harvest index. Nikhil *et al*., (2014) reported earlier for harvest index. Spikelets/panicle with tillers/hill, test weight. Ramesh *et al*., (2018) reported earlier for test weight, tillers/hill. Panicle length with days to maturity. Dhavaleshvar *et al*., (2019) reported earlier for days to maturity. Biological yield with test weight, flag leaf width, days to maturity. Yadav *et al*., (2010) [25] for test weight, flag leaf width. Harvest index with plant height. Yadav *et al*., (2010) reported earlier for plant height. Days to maturity with plant height, biological yield. Dhavaleshvar *et al*., (2019) parallelly observed in plant height, biological yield. Test weight with spikelets/panicle. Ramesh *et al*., (2018) reported earlier for spikelets/panicle.

Application of research

Based on correlation and path coefficient analysis studies, characters showed with grain yield/plant also showed positive direct effect which shows their importance in selection and improving yield potential of rice hybrids. Hence, utmost importance should be given for these characters while selection grain yield improvement.

Research Category: Genetics and Plant Breeding

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Table-2 *Estimates of variability and genetic parameters for 14 quantitative characters in 19 Rice hybrids*

Traits	V_g	V_p	GCV	PCV	h^2 %(BS)	GA	GAM
Days to 50% flowering	12.63	14.86	4.03	4.37	84.97	6.74	7.65
Plant height (cm)	209.60	215.38	11.51	11.67	97.32	29.42	23.41
Flag leaf length (cm)	31.42	35.29	14.87	15.76	89.03	10.89	28.90
Flag leaf width (cm)	0.02	0.03	11.04	13.33	70.59	0.26	18.85
Tillers per hill	2.144	4.61	12.90	18.93	46.43	2.05	18.10
Panicles per hill	2.447	4.37	15.45	20.65	55.97	2.41	23.81
Spikelets per panicle	1209.58	2028.07	26.21	33.95	59.64	55.33	41.71
Panicles per sq. meter	4290.86	4292.47	20.29	20.30	99.96	134.91	41.79
Panicle length (cm)	2.37	3.14	5.68	6.53	75.48	2.76	10.17
Biological yield (g)	105.94	133.97	15.81	17.78	79.08	18.85	28.97
Harvest Index (%)	24.88	33.92	9.40	10.98	73.36	8.80	16.59
Days to maturity	13.33	16.7	3.06	3.42	79.83	6.72	5.63
Test weight (g)	12.8	12.81	13.76	13.77	99.97	7.36	28.34
Grain yield per plant(g)	50.74	60.15	20.44	22.26	84.36	13.47	38.68

Vg = genotypic variance, Vp = Phenotypic variance, GCV = Genotypic coefficient of variation, PCV = phenotypic coefficient of variation, h^2 = Heritability (broad sense), GA = Genetic advance, GAM = genetic advance as percent mean at 5 % level.

Table-3 *Estimation of Phenotypic and Genotypic correlation coefficients for yield related traits on yield in 19 rice hybrids*

Traits	Days to 50% flowering	Plant height	Flag leaf length	Flag leaf width	Tillers/ hill	Panicles/ hill	Spikelets/ panicle	Panicles/m^2	Panicle length	Biological yield	Harvest index	Days to maturity	Test weight	Grain yield/plant
Days to 50% flowering	1	0.483***	0.358**	0.089	-0.001	0.143	0.155	0.272*	0.381**	0.333*	0.278*	0.774***	0.224	0.601**
Plant height	0.522**	1	0.771***	0.053	-0.111	-0.007	0.071	0.299*	0.753***	0.444***	0.055	0.307*	0.372**	0.475**
FL Flag leaf length	0.400**	0.802**	1	0.355**	-0.194	-0.092	0.192	0.188	0.722***	0.377**	0.204	0.150	0.181	0.320*
Flag leaf width	0.105	0.043	0.395**	1	-0.445 ***	-0.313*	0.404**	-0.253	0.150	0.115	0.342**	0.085	-0.154	0.082
Tillers/ hill	0.047	-0.164	-0.354**	-0.717**	1	0.846***	-0.299*	0.586***	-0.276*	0.157	-0.224	0.074	0.071	0.193
Panicles/ hill	0.229	-0.003	-0.224	-0.508**	0.971**	1	-0.267*	0.708***	-0.182	0.218	-0.088	0.226	0.069	0.264*
Spikelets/ panicle	0.18	0.113	0.338*	0.733**	-0.627**	-0.509**	1	-0.260	0.182	0.195	0.087	0.131	-0.171	0.11
Panicles/m^2	0.296*	0.303*	0.198	-0.303*	0.856**	0.944**	-0.335*	1	0.029	0.207	0.019	0.108	0.202	0.314*
Panicle length	0.506**	0.847**	0.833**	0.176	-0.318*	-0.249	0.256	0.033	1	0.258	-0.119	0.272*	0.066	0.304*
Biological yield	0.439**	0.484**	0.407**	0.102	0.176	0.213	0.223	0.233	0.263*	1	0.039	0.383**	0.467***	0.798**
Harvest index	0.399**	0.038	0.234	0.470**	-0.331*	-0.135	0.17	0.022	-0.154	0.117	1	0.233	0.099	0.325*
Days to maturity	0.911**	0.354**	0.157	0.097	0.124	0.239	0.125	0.121	0.358**	0.454**	0.245	1	0.137	0.670**
Test weight	0.241	0.378**	0.192	-0.182	0.1	0.091	-0.223	0.203	0.078	0.526**	0.117	0.156	1	0.374**
Grain yield/plant	0.769**	0.496**	0.332*	0.052	0.239	0.296*	0.179	0.341**	0.336*	0.821**	0.295*	0.773**	0.407**	1

*Upper diagonal values at phenotypic and lower diagonal values at genotypic level. ***, ** And * indicates significance at 0.1%, 1% and 5% level of significance respectively.*

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Cultivar / Variety / Breed name: Rice (*Oryza sativa* L.)

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