Agro-botanical Characterization of some released F1 hybrids in rice (*Oryza sativa* L.)

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Abstract- Success and sustenance of hybrid rice technology solely depends on the exploitation of heterosis in F_1 generation. A study was conducted to find out the performance of released F_1 rice hybrids (developed by both public and private sector) comparing with hybrid check KRH 2 and HYV check Satabdi (IET 4786) on the basis of different agrobotanical traits. The hybrid 'DRH 775' was revealed as an early maturing hybrid variety, while 'HKRH 1' was a late maturing hybrid. The number of panicle per plant ranged from 11.67 to 22. The hybrid 'Indira Sona' was exhibited highest panicle per plant and least was found in 'Sahyadri'. All rice hybrids included in trial were performed better yield than high yielding check Satabdi. Highest yield was produced by 'Indira Sona' (7.37 t/ha) followed by 'Sahyadri 2' (7.23 t/ha), 'CORH 2' (7.20 t/ha), 'HKRH 1'(7.10 t/ha) and 'Sahyadri 3' (7.00 t/ha) respectively with the mean yield of 6.28 t/ha. The high yielding check Satabdi and hybrid check KRH 2 were produced 4.27 t/ha and 6.33 t/ha respectively. High positive correlations were observed between yield and yield attributing traits. The results clearly evinced that hybrid rice technology could offer a pivotal role in augment the rice productivity.

Index Terms- Correlation, Genetic variability, Hybrid rice and Yield.

I. Introduction

Rice is a universal food, feeding more than half of the world's population every day. Rice provides 20 percent of the world's dietary energy supply, while wheat supplies 19 percent and maize 5 percent (FAO, International year of rice, 2004). In Asia, it has a special significance, where about 90% of the rice is produced and consumed as a staple food. In concern over the growing population in India, it needs to increase the productivity of rice (Sidharthan *et al*. 2007). During last two decades, rice yield growth has reached a plateau and no significant increase is being realized in productivity levels. There is no further scope of horizontal expansion of rice production. Hybrid rice offers a wide opportunity to augment rice productivity in India. Hybrid rice has the potential to increase yields by 15% to 20% over those of conventionally bred varieties (Virmani, 1994). Chinese rice scientists developed rice hybrids utilizing cytoplasmic male sterile (CMS) system which boosted up the yield by about 20 percent over semi dwarf rice varieties (Yuan, 1977 and Yuan *et al.*, 1989).

The Government of India has launched a special programme of 'Bringing Green Revolution in Eastern India (BGREI)' - a sub scheme of Rashtriya Krishi Vikas Yojana (RKVY) from the year 2010-11 in the eastern states with an objective to increase the productivity of rice based cropping system. In theses seven states comprises of Assam, Bihar, Chhattisgarh, Jharkhand, Odisha, Uttar Pradesh (East) and West Bengal. Under this programme, increase of area for hybrid rice cultivation is one of the key component. The Govt. of India (GOI) announced in February 2012 that BGREI resulted in a robust increased in foodgrain production. Rice production from the included area under programme was estimated at 562.6 lakh tones with an increase of 19.8 % over the last year. The increase across the country was estimated at 7% (Source: www.gktoday.in/bgrei/).

II. Materials and Methods

The experiment was carried out at Rice Research Station (Govt. of West Bengal), Chinsurah, West Bengal during Kharif 2012. The study was included twenty (20) released F_1 hybrids in rice developed by both public and private sector. Evaluations of hybrids were done along with two check varieties, one high yielding variety Satabdi (IET 4786) and another check was hybrid variety KRH 2.

Table.1 : Details about the twenty released rice hybrids.

Sr. No.	Hybrid Variety	Developed by	Year of released
1	DRRH2	Directorate of Rice Research (DRR), Hyderabad, India	2005
2	DRRH3	Directorate of Rice Research (DRR), Hyderabad, India	2009
3	Sahyadri	Regional Agricultural Research Station, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Karjat, Maharashtra	1998
4	Sahyadri 2	Regional Agricultural Research Station, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Karjat, Maharashtra	2005
5	Sahyadri 3	Regional Agricultural Research Station, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Karjat, Maharashtra	2005
6	Sahyadri 4	Regional Agricultural Research Station, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Karjat, Maharashtra	2008
7	PA 6129	Bayer Bio-Science, Hyderabad, India	2007
8	PA 6444	Bayer Bio-Science, Hyderabad, India	2001
9	PSD 1	Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, Uttarakhand	1997
10	PSD 3	Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, Uttarakhand	2004
11	US 312	Seed Works International Pvt Ltd, Hyderabad	2010
12	CORH 2	Tamil Nadu Agricultural University, Coimbatore	1999
13	Pusa RH10	Indian Agricultural Research Institute (IARI), New Delhi	2001
14	Indira Sona (IRH 5)	Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh	2007
15	GK5003	Ganga Kaveri Seeds Private Limited, Hyderabad, Andhra Pradesh	2008
16	Suruchi	Mahyco Ltd. , Maharashtra	2004
Sr. No.	**Hybrid Variety**	**Developed by**	**Year of released**
17	HKRH 1	Regional Research Station , Chaudhary Charan Singh Haryana Agricultural University,Karnal, Haryana	2006
18	DRH775	Metahelix Life Sciences *Limited*, Bangalore	2009
19	NSD 2	Narendra Deva University of Agricultre and Technology (*NDUAT*), Faizabad ,Uttar Pradesh	1998
20	CRHR 5	Central Rice Research Institute (CRRI), Cuttack, India	2005
Check 1	Shatabdi	Central Rice Research Institute, Cuttack (1977) *Identified at* Rice Research Station, Chinsurah, W.B	2000 (SVRC,W.B)
Check 2	KRH 2	Vishweshwaraiah Canal (V.C) Farm. University of Agricultural Science, Mandy, Karnataka, India	1996

Twenty released rice hybrids along with two check varieties (Table - 1) were analyzed in a randomized Block Design with three replications. Each replication consisted of twenty two blocks. Each block was 15sqm in size. Twenty five days old seedlings raised in nursery were transplanted at 20 cm x 15 cm. Normal recommended cultural practices and protections measured were followed. Five representative plants for each hybrid in each replication were randomly selected to record observations on the quantitative characters under study.

Observations were recorded for quantitative characters on –

Days to 50% flowering : Days to heading of each genotype was determined when 50% plants of an entry have shown ear emergence starting from the date of sowing and days to maturity of each genotypes was determined at the maturity stage when 50% plants of an entry have matured starting from the date of sowing.

Plant height : Plant height was measured in cm from the plant base to the tip of panicle.

Number of panicle per plant : Productive tillers of each plant were counted to determine the total number of panicles in each plant.

Panicle length : The panicle length of the central tiller of the each plant was measured in cm.

Grains per panicle : Seeds per panicle of main tiller of each plant was counted separately after harvesting.

1000 seed weight : The 1000 seed weight of each genotype was measured by weighting 1000 filled grains after harvesting.

Yield per plant : The whole plant yield of each genotype was measured in grams after harvesting of each genotype.

Plot yield per : Plot yield of each hybrid was taken by the total yield of a plot after threshing.

III. Results and Discussion

Assessment of mean performance of hybrid varieties for various agrobotanical traits.

The data pertaining to the mean performance of F_1 rice hybrids for various quantitative characters is presented in table – 2. Days to 50% flowering ranged from 80.67 days to 111.33 days with the mean of 100.37 days. The hybrid 'DRH 775' was noted to be early maturing hybrid variety, while 'HKRH 1' was a late maturing hybrid. Early maturing hybrids are desirable as they produce more yield per day and fit well in multiple cropping systems (Neelam *et al*,.2009). Highest plant height was observed in 'PA 6444' (127 cm) and lowest in 'US 312' (102 cm). Among the hybrids investigated, the number of panicle per plant ranged from 11.67 to 22. The hybrid 'Indira Sona' was exhibited highest panicle per plant and least was found in 'Sahyadri' while check KRH 2 and Satabdi exhibited 14 and 13 respectively. Hybrids are generally characterized by having longer panicles indicating their efficiency in partitioning of assimilates to reproductive parts (Neelam *et al*,.2009).The trait panicle length was varied from 23.33 (in US 312) to 32.20 (in Sahyari 3). Filled grain per panicle was exhibited highest in 'CORH 2'(203.67) and lowest in 'PSD 3' (118.00). Hybrid 'HKRH 1' was exhibited highest 1000 seed weight (25.97 gm), while 'DRRH 3' and 'PSD 1' both were exhibited lowest (19.33 gm) along with mean 22.62 gm.

All rice hybrids included in trial were performed better yield than high yielding check Satabdi. Higher yield of hybrids resulted from their increased spikelet number and to some extent increased grain weight, which enhanced the sink capacity (Ponnuthurai *et al.*, 1984). Peng *et al*. (2003) reported that the average yield of F_1 hybrid rice was 17% higher than that of indica inbreds. Yield per plant was recorded highest in 'CORH 2' (49.47 gm) and lowest in 'DRH 775' (25.6 gm). Plot yield was transformed into yield ton per hectare. Highest yield was produced by 'Indira Sona' (7.37 t/ha) followed by 'Sahyadri 2' (7.23 t/ha), 'CORH 2' (7.20 t/ha), 'HKRH 1'(7.10 t/ha) and 'Sahyadri 3' (7.00 t/ha) respectively with the mean yield of 6.28 t/ha. The high yielding check Satabdi and hybrid check KRH 2 were produced 4.27 t/ha and 6.33 t/ha respectively.

Assessment of Genetic Variability

Analysis of variance (ANOVA) of all eight (8) characters exhibited in the table- 3. The calculated values of F ratio for all the replications of eight characters are lesser than the tabular value at 1% level of significance with degree of freedom 2. Hence, the differences within replications are not significant. The calculated values of F ratio for treatments (varieties) with respect to eight characters are much greater than the tabular value of F at 1% level of significance with degree of freedom 19. Analysis of variance reveals that varietal differences are signified and wide variability present among the genotypes with respect to all the characters.

Analysis of Genetic Components

The estimation of genetic parameters like genotypic coefficient of variation, heritability and genetic advance are presented in table –3. Both genotypic and phenotypic variation recorded maximum for the character of yield per plant. Low PCV & GCV estimates for days to 50% flowering and panicle length have been reported by Shinha *et al.* (2004) and Patil *et al.* (2003). The phenotypic coefficient of variation (PCV) was greater than genotypic coefficient of variation (GCV) in all included characters. It was also indicated close resemble between the corresponding estimation of PCV and GCV in almost all characters, concluded that the characters were least affected by the environment factors in their expression. Similar findings were earlier reported by Singh and Chakraborty (1996), Devi *et al.* (2006).

High heritability percentage was observed in almost all characters. Highest heritability percentage was recorded 99.04 % for the character 1000 seed-weight, followed by days to 50% flowering (98.04 %), yield per plant (92.51 %) and grain per panicle (84.33 %) respectively. High heritability percentage were also reported by Shivani and Reddy (2000), Devi *et al.* (2006) and Yadav *et al*. (2008).

Correlation Analysis among pairs of the quantitative characters

The phenotypic and genotypic correlations among the traits are presented in table- 4. The phenotypic and genotypic correlations were closely agreed for the most of characters, where as in some cases the difference was higher that signified the role of environmental effects in estimating these characters. Highest strong positive significant correlation was observed in between yield/plant and yield (t/ha) at both genotypic and phenotypic level [r = 0.935 (at genotypic level), 0.915 (at phenotypic level)] respectively followed by in between no. of panicle/plant and yield/plant [r = 0.839 (at genotypic level), 0.774 (at phenotypic level)] respectively, no. of panicle/plant and yield (t/ha) [r = 0.727(at genotypic level), 0.698 (at phenotypic level)] respectively. Grain yield has been reported to be influenced by the number of grains per panicle and 1000 grain weight (Yang, 1986), number of grains per panicle (Ram, 1992), plant height and tiller number (Kumar, 1992).

Panicle length and filled grain per panicle were correlated positively and significantly at both genotypic and phenotypic level [r = 0.623(at genotypic level), 0.686 (at phenotypic level) respectively]. Positive significant correlation also present in between filled grain per panicle and yield per plant [r = 0.668 (at genotypic level), 0.664 (at phenotypic level)] respectively. Bhadru *et al*., (2011) with study on 93 rice genotypes involving hybrids and their parental lines reported that plant height, filled grains per panicle, days to 50 percent flowering and panicle weight had a significant positive association with yield. Gulzar *et al.,* (2012) demonstrated that grain per panicle had maximum positive effect and highly significant genotypic correlation coefficient with grain yield. Ravindra Babu *et al*., 2012 evinced that productive tillers per plant possessed positive association with yield.

Negative correlation also present in between no. of panicle/ plant and panicle length [r = - 0.459(at genotypic level), -0.422(at phenotypic level)] respectively. Non significant and negligible associations were also present in some characters like days to 50% flowering, plant height etc.

IV. Conclusion

These results clearly indicate that hybrid rice technology is one of the most feasible and promising technology to augment the rice productivity. Highest yield was produced by 'Indira Sona' (7.37 t/ha) followed by 'Sahyadri 2' (7.23 t/ha), 'CORH 2' (7.20 t/ha), 'HKRH 1'(7.10 t/ha) and 'Sahyadri 3' (7.00 t/ha) respectively. 'DRH 775' was noted to be early maturing (108 days) hybrid variety. The increased yield efficiency of hybrid rice can revolutionize in global agrarian economic scenario.

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Table - 2 : Mean values of hybrid varieties for various agrobotanical traits.

Sr. No.	Hybrid Variety	Days to 50% Flowering	Plant Height (cm)	No. of Panicle/ Plant	Panicle Length	Filled grain per Panicle	1000 SW	Yield / Plant	Yield (t/ha)
1	DRRH2	107.67	108.00	14.00	25.73	181.33	23.17	30.27	5.70
2	DRRH3	109.33	113.67	12.33	23.47	159.33	19.33	27.30	6.19
3	Sahyadri	100.33	115.00	11.67	28.73	143.33	24.57	29.07	5.87
4	Sahyadri2	94.00	106.00	20.33	30.17	176.00	22.37	42.13	7.23
5	Sahyadri3	103.67	121.33	15.33	32.20	180.00	23.37	38.07	7.00
6	Sahyadri4	92.00	107.67	12.33	23.20	124.67	21.47	26.50	6.13
7	PA 6129	91.33	114.33	14.33	26.70	146.33	21.53	32.20	6.27
8	PA 6444	103.00	127.00	12.00	26.57	151.33	23.33	27.20	6.00
9	PSD 1	97.00	106.33	12.33	25.50	123.33	19.33	26.30	5.63
10	PSD 3	103.33	113.67	15.33	28.70	118.00	23.93	26.73	5.80
11	US 312	100.67	102.00	15.33	23.33	141.33	22.13	26.47	5.33
12	CORH2	101.33	111.33	20.33	29.47	203.67	20.30	49.47	7.20
13	Pusa RH10	104.00	113.00	16.00	31.40	149.33	23.40	31.07	6.30
14	Ind. Sona	99.33	112.00	22.00	30.03	165.67	25.53	45.17	7.37
15	GK5003	101.33	116.00	16.67	27.47	168.67	20.20	40.27	6.97
16	Suruchi	108.33	104.67	14.00	25.50	142.33	19.97	26.47	5.43
17	HKRH 1	111.33	122.67	17.33	25.37	131.67	25.97	40.57	7.10
18	DRH775	80.67	104.67	15.67	24.80	153.67	25.17	25.60	5.57
19	NSD 2	97.67	114.00	16.33	26.10	144.33	24.47	25.83	5.77
20	CRHR 5	101.00	124.33	17.33	27.80	151.67	22.77	37.23	6.83
	MEAN	**100.37**	**112.88**	**15.55**	**27.11**	**152.80**	**22.62**	**32.70**	**6.28**
Check	Shatabdi	90.33	83.67	13.00	22.57	149.00	17.77	24.13	4.27
Check	KRH 2	99.00	108.00	14.00	26.33	157.33	22.70	34.57	6.33
	SE(1%)	**0.578**	**1.857**	**1.016**	**0.840**	**5.232**	**0.116**	**1.214**	**0.166**

Table - 3 : Analysis of Variance (ANOVA) and comparative study of Critical Difference (CD),Coefficient of Variance (CV), Genetic Coefficient of Variance (GCV), Phenotypic Coefficient of Variance (PCV), Heritability % (H%) and Genetic Advance (GA), Genotypic Variance (σ^2g), Phenotypic Variance (σ^2p) and Environmental Variance (σ^2e) of different agrobotanical traits

Characters	MEAN SUM OF SQUARE			CD		CV	GCV	PCV	H %	GA	σ^2g	σ^2p	σ^2e
	Replication (2)	Variety (19)	Error (38)	at 1%	at 5%								
Days to 50% Flowering	0.617	151.51**	1.01	2.248	1.669	0.998	7.057	7.127	98.04	14.30	50.17	51.17	1.00
Plant Height	44.01	144.36**	10.35	7.224	5.364	2.850	5.921	6.571	81.19	12.41	44.67	55.02	10.35
No. of Panicle/ Plant	3.15	25.41**	3.09	3.952	2.934	11.318	17.539	20.874	70.60	4.73	7.44	10.54	3.10
Panicle Length	4.03	21.04**	2.12	3.266	2.425	5.365	9.265	10.706	74.89	4.47	6.31	8.43	2.12
Filled grain per Panicle	299.55	1408.01**	82.11	20.346	15.108	5.930	13.759	14.982	84.33	39.77	441.97	524.08	82.11
1000 SW	0.05	12.59**	0.04	0.452	0.336	0.891	9.047	9.091	99.04	4.20	4.19	4.23	0.04
Yield / Plant	2.02	168.27**	4.42	4.723	3.507	6.433	22.604	23.501	92.51	14.64	54.62	59.04	4.42
Yield (t/ha)	0.068	1.351**	0.082	0.646	0.479	4.575	10.345	11.311	83.64	1.20	0.42	0.51	0.08

*significant at 5% probability level, **significant at 1% probability level

Table - 4: Correlation Analysis among pairs of the agrobotanical traits

	Days to 50% Flowering	Plant Height	No. of Panicle/ Plant	Panicle Length	Filled grain per Panicle	1000 SW	Yield / Plant	Yield (t/ha)
Days to 50% Flowering	1.000							
Plant Height	G 0.377 P 0.348	1.000						
No. of Panicle/ Plant	G -0.070 P -0.073	G -0.019 P -0.229	1.000					
Panicle Length	G 0.097 P 0.066	G 0.351 P 0.221	G -0.459* P -0.422	1.000				
Filled grain per Panicle	G 0.081 P 0.065	G 0.067 P 0.111	G 0.129 P 0.153	G 0.623** P 0.686**	1.000			
1000 SW	G -0.106 P -0.108	G 0.307 P 0.279	G 0.287 P 0.257	G 0.271 P 0.261	G -0.119 P -0.094	1.000		
Yield / Plant	G 0.141 P 0.128	G 0.269 P 0.244	G 0.839** P 0.774**	G 0.598** P 0.558*	G 0.668** P 0.644**	G 0.469* P 0.483*	1.000	

Yield (t/ha)	G 0.126 P 0.109	G 0.416 P 0.374	G 0.727^{**} P 0.698^{**}	G 0.610^{**} P 0.598^{**}	G 0.539^{*} P 0.511^{*}	G 0.114 P 0.128	G 0.935^{**} P 0.915^{**}	1.000

*significant at 5% probability level, **significant at 1% probability level, P=Phenotypic correlation coefficient, G= Genotypic correlation coefficient.