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Identification of New Promising F1 Hybrids in Rice with Emphasis on Yield Attributing Traits

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Abstract: *Success and sustenance of hybrid rice technology exclusively depends on the exploitation of heterosis in F1 generation. An experiment was carried out to evaluate the performance of newly developed twenty five (25) F1 hybrids based on IR 58025A by comparing with hybrid and Inbred checks with special emphasis on yield attributing traits. Highest yield (Square meter) was observed by Arize 6444 Gold (0.987 Kg), followed by INDAM 200-017 (0.945 Kg), PRH 8005 (0.938 Kg), JKRH 3333 (0.928 Kg) and PRH 8007 (0.927 Kg) respectively. Among the tested F1 Hybrids PRH 8005 and PRH 8007 were identified as promising by emphasis on yield. PRH 8007 was identified as early maturing Hybrid among the tested materials. Analysis of variance reveals that varietal differences are signified and wide variability present among the genotypes with respect to all the characters. The results clearly indicate that the hybrid rice technology can take part a pivotal role to augment the rice productivity.*

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I. Introduction

Rice (*Oryza sativa* L.) is a universal staple food crop, feeding more than half of the world's population every day. Tropical rice-growing countries need an increased supply of rice because of their increasing populations and decreasing land and water resources. Hybrid rice technology offers an opportunity to increase rice yields and there by ensure a steady supply. (Virmani SS and Kumar Ish , 2004). During last three decades in India, rice yield growth has reached a plateau and no significant increase is being realized in productivity levels. The level of rice production may not be sufficient to feed the ever increasing population in the future. The scope for expansion of area under rice has already been exhausted; the only way to increase the production is by increasing the productivity of rice through frontier technologies (Prakash *et al*., 2017). 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). In China, the development and promotion of hybrid rice over the past several decades has led to widespread adoption, with hybrids accounting for more than half of all area under rice cultivation in the country as of 2010 (David *et al*., 2013). The increase in rice yields attributable to hybrid rice has, in turn, improved food security for an estimated 60 million additional people per year (Li *et al*., 2010). Therefore, the introduction of hybrid technology in India and popularization of their production technology are feasible and readily adoptable to achieve targeted production for stepping up rice production significantly (Verma *et al*., 2016).

II. Materials and methods

The experiment was carried out at Research and Development Division*, Pallishree Ltd, Arambagh, West Bengal during Boro 2017-18. The study was included twenty five (25) F1 Hybrids (which were tested in TCN in Boro 2016-17) developed by crossing between IR 58025A and 25 Restores Lines. Evaluation of hybrids were done along with 8 check varieties, 2 Inbreds and 6 Hybrids.

Table no 1: Details of study materials along with Parentages

Sr. No.	F1 Hybrid	Female Parent (CMS)	Male Parent (Restorer)	Parentages of Restorer
01	PRH 8001	IR 58025A	PRR 301	BR1356 X KMR 3
02	PRH 8002	IR 58025A	PRR 302	BR1356 X KMR 3

03	PRH 8003	IR 58025A	PRR 303	BR1356 X KMR 3
04	PRH 8004	IR 58025A	PRR 304	BR1356 X KMR 3
05	PRH 8005	IR 58025A	PRR 305	BR1356 X Gajapati
06	PRH 8006	IR 58025A	PRR 306	BR1356 X Gajapati
07	PRH 8007	IR 58025A	PRR 307	BR 827-35 X IR 40750R
08	PRH 8008	IR 58025A	PRR 308	BR 827-35 X IR 40750R
09	PRH 8009	IR 58025A	PRR 309	BR 827-35 X IR 40750R
10	PRH 8010	IR 58025A	PRR 310	BR 827-35 X IR 40750R
11	PRH 8011	IR 58025A	PRR 311	BR 827-35 X IR 40750R
12	PRH 8012	IR 58025A	PRR 312	IR 40750R X NDR 97
13	PRH 8013	IR 58025A	PRR 313	IR 40750R X Gajapati
14	PRH 8014	IR 58025A	PRR 314	IR 40750R X KMR 3
15	PRH 8015	IR 58025A	PRR 315	BR 827-35 X KMR 3
16	PRH 8016	IR 58025A	PRR 316	BR 827-35 XIR 10198R
17	PRH 8017	IR 58025A	PRR 317	BR 827-35 XIR 10198R
18	PRH 8018	IR 58025A	PRR 318	BR 827-35 XIR 10198R
19	PRH 8019	IR 58025A	PRR 319	BR 827-35 XIR 10198R
20	PRH 8020	IR 58025A	PRR 320	IR 71604-4-1-4-4-4-2-2-2R X NDR 97
21	PRH 8021	IR 58025A	PRR 321	IR 71604-4-1-4-4-4-2-2-2R X KMR 3
22	PRH 8022	IR 58025A	PRR 322	BR1356 X IR 10198R
23	PRH 8023	IR 58025A	PRR 323	BR1356 X IR 10198R
24	PRH 8024	IR 58025A	PRR 324	BR 827-35 X Gajapati
25	PRH 8025	IR 58025A	PRR 325	BR 827-35 X NDR 97

Table no 2: Details of Check Entries

Sr. No.	Check Entry	Year of Released / Notification	Developed By
01	KRH 2	1996	. University of Agricultural Science, Mandy, Karnataka, India
02	Arize 6444 Gold	2015	Bayer Crop Science
03	INDAM 200-017	2011	Indo-American seeds
04	Rajlakshmi (CRHR 5)	2005	CRRI
05	CNRH 103	-	Rice Research Station, Chinsurah, West Bengal
06	JKRH 3333	2012	JK Agri Genetics Ltd
07	SATABDI	1977 2000	Central Rice Research Institute, Cuttack (1977) *Identified at* Rice Research Station, Chinsurah, W.B
08	IR 64	1991	IRRI- International Rice Research Institute

Twenty five (25) Entries along with eight (8) Checks (Table – 1 and 2) were analyzed in a randomized Block Design with three replications. Each replication consists of thirty three blocks. Each block was (4 x 5) sqm in size. Twenty five days old seedlings raised in nursery were transplanted at 20 cm x 15 cm spacing. 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.

Square Meter Yield: The yield of total plants belonging to 1m x 1m square block (crop cutting) of each genotype was measured in grams after harvesting of each genotype.

Statistical Analysis was done by using software SPAR 2.0

III. Results and discussion

Assessment of mean performance on agro-botanical traits for F1 Hybrids

Data perusal from mean performance of 25 F1 Hybrids along with 8 Checks (Table -1 and 2) for various quantitative characters was observed that significant variation was in each character. Hybrid PRH 8007 (DTFF 95 Days) was noted to be early maturing hybrid, where PRH 8021 was a late maturing hybrid (DTFF 128.7 Days). Highest plant height was noted in PRH 8019 (135.7 cm) in and lowest in PRH 8003 (106.3 cm) having average plant height 123.7 cm. Among the hybrids investigated, the number of panicle per plant ranged from 8.7 to 16.3. The check entry Satabdi was exhibited highest panicle (16.3) per plant and least (8.7) was found in PRH 8015 while mean for panicle per plant recorded as 12.7. Panicle per plant and filled grains per panicle contributed equally through direct and indirect effects for yield improvement (Gopikannan and Ganesh 2013).

Table no 3: Range and Mean Data for Quantitative Characters

Sr. No.	Character	Mean	Range	Lowest	Highest	SE (1%)
1	Days to 50% Flowering (Days)	117.3	95.0 – 128.7	PRH 8007	PRH 8021	0.697
2	Plant Height (cm)	123.7	106.3- 135.7	PRH 8003	PRH 8019	1.323
3	No. of Panicle/ Panicle	12.7	08.7 – 16.3	PRH 8015	Satabdi	0.962
4	Panicle Length (cm)	28.0	24.7- 32.3	IR 64	PRH 8005	0.116
5	Filled Grain / Panicle	254.3	147.3-294.7	IR 64	Arize 6444 Gold	1.987
6	1000 Seed Weight (gm)	24.7	18.3 - 26.3	Satabdi	PRH 8015	0.097
7	Sqm Yield (kg)	7.7	5.0 – 9.3	PRH 8011	Arize 6444 Gold	1.214

Enlarging the sink capacity through increase in spikelets per panicle has become an important strategy in current high-yielding breeding programs (Xiong *et al.,* 2013 and Meng *et al.,* 2016). The higher yield of super hybrid varieties was attributed to improvement in panicle size (Huang *et al*., 2011). The trait panicle length was varied from 24.7 (IR64) to 32.3 (PRH 8005). Generally, the grains in the upper position of the panicle often exhibit a high grain-filling rate (Yang and Zang, 2010). In our experiment we considered only filled grains during counting. In hybrid Arize 6444 Gold exhibited highest filled grains (294.7) where as IR 64 exhibited lowest (147.3). 1000-grain weight is a stable genetic character in rice (Yoshida, 1981). In this study, 1000 seed weight ranging from 18.3 gm to 26.3 gm and maximum was noted in PRH 8015.

Except two cases, all F1 hybrids demonstrated higher yield over inbred variety. 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 F1 hybrid rice was

17% higher than that of indica inbreds. Perusal from SQM yield table, Highest yield was observed in Arize 6444 Gold (0.987 Kg), followed by INDAM 200-017 (0.945 Kg), PRH 8005 (0.938 Kg), JKRH 3333 (0.928 Kg) and PRH 8007 (0.927 Kg) respectively. On the basis of SQM yield data, best five among the 25 tested F1 Hybrids were PRH 8005 (0.938 Kg), PRH 8007 (0.927 Kg), PRH 8009 (0.923 Kg), PRH 8014 (0.922 Kg) and PRH 8011 (0.908 Kg) respectively. Hybrids are generally characterized by having longer panicles indicating their efficiency in partitioning of assimilates to reproductive parts (Neelam *et al.*, 2009). Similar result was observed for PRH 8005 as it had long panicle length than all entries. Peng *et al*., (2017) reported the effect of different yield component over yield was ranked as follows: number of grains per panicle > setting rate > 1000 grain weight > number of panicles.

Assessment of Genetic Variability

Analysis of variance (ANOVA) of all seven (7) characters exhibited in the table- 3. The calculated values of F ratio for all the replications of seven 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 seven characters are much greater than the tabular value of F at 1% level of significance with degree of freedom 32. Analysis of variance reveals that varietal differences are signified and wide variability present among the genotypes with respect to all the characters.

Table no 4: Mean Square Meter (SQM) Yield in Kg of F1 Hybrids and Checks

Sr. No.	F1 Hybrid	SQM Yield (Kg)	Sr. No.	Check	SQM Yield (Kg)
01	PRH 8001	0.856	01	KRH 2	0.907
02	PRH 8002	0.858	02	Arize 6444 Gold	0.987
03	PRH 8003	0.802	03	INDAM 200-017	0.945
04	PRH 8004	0.786	04	Rajlakshmi	0.837
05	PRH 8005	0.938	05	CNRH 103	0.809
06	PRH 8006	0.845	06	JKRH 3333	0.928
07	PRH 8007	0.927	07	SATABDI	0.742
08	PRH 8008	0.847	08	IR 64	0.765
09	PRH 8009	0.923			
10	PRH 8010	0.844			
11	PRH 8011	0.908			
12	PRH 8012	0.867			
13	PRH 8013	0.854			
14	PRH 8014	0.922			
15	PRH 8015	0.857			
16	PRH 8016	0.813			
17	PRH 8017	0.728			
18	PRH 8018	0.781			
19	PRH 8019	0.786			
20	PRH 8020	0.844			
21	PRH 8021	0.903			
22	PRH 8022	0.860			
23	PRH 8023	0.724			
24	PRH 8024	0.846			
25	PRH 8025	0.787			

Analysis of Genetic Components

The genetic coefficient of variation together with heritability estimate would give the best picture of the amount of advance to be expected from selection (Selvaraj *et al.*, 2011). Both genotypic and phenotypic variation evidenced maximum for the character of Square meter yield and minimum in for the character of Plant Height. 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), Selvaraj *et al*., (2011), Khatun *et al.*, (2015). High heritability percentage was observed in almost all characters. Highest heritability percentage was recorded 98.89 % for the character

Table no - 5 : 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 (σ2g), Phenotypic Variance (σ2p) and Environmental Variance (σ2e) of different agrobotanical traits

Characters	MEAN SUM OF SQUARE			CD		CV	GCV	PCV	H %	GA	σ2g	σ2p	σ2e
	Replic-ation (2)	Variety (32)	Error (64)	at 1%	at 5%								
Days to 50% Flowering	0.527	143.71**	0.05	1.346	0.927	0.927	5.127	5.876	97.33	12.36	48.82	50.17	0.87
Plant Height	37.15	109.04**	1.73	5.221	4.117	3.118	4.223	4.016	78.32	10.74	42.61	46.37	9.98
No. of Panicle/ Plant	2.51	17.14**	2.27	2.392	1.923	7.312	16.553	18.693	68.23	6.67	6.62	8.87	3.03
Panicle Length	3.57	29.73**	3.37	2.221	1.448	4.346	8.228	10.253	78.43	8.77	5.58	7.32	1.98
Filled grain per Panicle	323.38	1603.37**	92.11	21.389	17.927	8.593	14.749	16.988	70.89	47.87	490.89	583.40	86.78
1000 SW	0.02	9.97**	0.01	0.372	0.301	0.723	8.002	9.089	98.89	3.29	3.27	4.03	0.02
SQM Yield	15.87	970.73**	9.82	10273	9.507	8.211	28.335	32.451	88.67	24.37	88.67	98.74	7.79

1000 seed-weight, followed by days to 50% flowering (97.33 %) and Sqm Yield (88.67 %) respectively. High heritability percentage were also reported by Verma *et al*., (2006) and Yadav *et al*., (2008).

IV. Conclusion

The upshots of the present exploration undoubtedly point out that hybrid rice technology is one of the most feasible and promising technology to augment the rice productivity. Highest Square meter yield was produced by Arize 6444 Gold (0.987 Kg), followed by INDAM 200-017 (0.945 Kg), PRH 8005 (0.938 Kg), JKRH 3333 (0.928 Kg) and PRH 8007 (0.927 Kg) respectively. Among the tested F1 Hybrids PRH 8005 and PRH 8007 were identified as promising on the basis of yield. PRH 8007 was also noted as early maturing Hybrid among the tested entries. The increased yield efficiency of hybrid rice can transfigure the global agrarian economic scenario.

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