Effect of Various Phytochemicals for Evaluating Genetic Variability in Parental Lines for Producing F1 Hybrid Rice Seeds Using Modern CMS Breeding Technology

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Abstract- Hybridization, the most potential breeding system, brought about significant qualitative and quantitative changes in the Indian agricultural scenario. The invention of cytoplasmic male sterile (CMS) lines for production of F_1 hybrid rice seeds using modern CMS rice breeding technology has no doubt created a new approach in agricultural sector.
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 F_1 hybrid seed production by applying various phytochemicals to ascertain the genetic variability as well as phytochemical effects in parental lines particularly CMS line (A-line) and Restorer line (R-line) on the basis of two agro-botanical traits viz. IR58025A (A-line i.e. CMS line) and KMR3 (R-line) in the Boro season 2011-12. For this purpose, Mean value table and Combined ANOVA table were considered for each and every metrical character separately. All the characters were also taken into account for calculating its analyses of variance, components of all variances δ^2g, δ^2p, δ^2e, genotypic and phenotypic coefficient of variations i.e. GCV and PCV including heritability (h^2) to experiment the genetic variability besides the qualitative and quantitative characters of F_1 hybrid seeds were assessed and explored alternative low cost phytochemicals for emerging the inflorescence of A-line (parent cultivar) other than the costly chemical GA_3. The parental behaviour as well as the application of various phytochemicals towards different treatments were thoroughly analysed to find out genetic variability as well as phytochemical effects in parental lines for producing the best potential F_1 rice hybrid seeds.

Index Terms - ANOVA**,** CMS line**,** F_1 hybrid seeds, phytochemicals.

I. INTRODUCTION

Rice is the world's most important food crop and a primary food source for more than one third of global population. In concern over the growing population in India, it needs to increase the productivity of rice (Krishnalatha et al., 2012). As the production of rice in India is not up to the satisfactory level by classical hybridization technique so that the production of hybrid rice seed with positive yield-vigour is an absolute necessity to meet up the consumption of food demand of the people as well as to fall in inflation on benefiting the poor in foreseeable future. Good rice hybrids have potential of yielding 15-20% more than the best inbred variety grown under farmers' field conditions in several countries (Virmani, 1994). A number of rice breeders like (Yuan et al., 1993; Liu et al., 1997; Virmani, 1996; He and Liu, 1998; Virmani et al., 2003) could make the hybrid rice production easier using genetic male sterility. Geetha et al., (1994) stated that various grain characters such as number of panicles, grains per panicle, grain yield, grain weight and shape are useful in identification of rice hybrids.
In India, the Directorate of Rice Research in Rajendranagar, Hyderabad under ICAR is acting as coordinator to look after and monitoring the rice hybrid seed production technology in the country (Paroda and Siddiq 1996). During 2011-12, the special mission mode programme has been undertaken by the Government of India to bring Green Revolution in eastern India, greater emphasis is being given for enhancing rice production and hybrid rice adoption is one of the key components identified, as it is the eastern India, where hybrid rice technology has made an impact. On the plea, application of various phytochemicals for experimenting genetic variability in parental lines has a prominent role for producing best

potential F_1 hybrid seeds. For this purpose, a comparative study of Penicillin and cyclic-AMP induced alpha (α)-amylase formation in rice endosperm was made by Biswas and Mukherjee, 1982. Further, the diversified mechanisms have been evolved for restoring fertility in CMS with the interaction of cytoplasmic factors (now widely identified as mitochondrial genetic factors) and nuclear genes as reported by Chen and Liu (2014).

II. MATERIALS AND METHODS

For the present study, an experimental field like Crop Research Farm under the Department of Botany, the University of Burdwan was taken for experimentation. The seeds were procured from the Rice Research Station, Chinsurah, Hooghly, the Government of West Bengal. The varieties were taken viz. IR58025A (A-line i.e. CMS line) and KMR3 (R-line). The experiment was laid out in a Randomized Block Design having five replications in boro season (2011-2012) with parental A-lines and R-lines as scheduled for the CMS breeding technology. Five treatments viz. **i)** Control set-T_1, **ii)** Penicillin-T_2, **iii)** Sulfonamide-T_3, **iv)** Gentamycin-T_4, **v)** GA_3-T_5 were also undertaken

for experimentation. Eight metrical characters viz. **i)** Tillers plant^{-1} (no), **ii)** Total panicle length plant^{-1} (cm) **iii)** Panicle exsertion length plant^{-1} (cm), **iv)** Unexserted panicle length plant^{-1} (cm), **v)** Total grains panicle^{-1} (no), **vi)** Fertile grain Panicle^{-1} (no), **vii)** Total yield t ha^{-1}, **viii)** 1000 Grain wt. (g) were considered to find out the genetic variability as well as phytochemical effects in parental lines. For this purpose, Two-way table and Combined ANOVA table for each metrical character were applied separately. All the characters were also taken into account for calculating its analyses of variance, components of all variances δ^2g, δ^2p, δ^2e, genotypic and phenotypic coefficient of variations i.e. GCV and PCV including heritability (h^2) to assess genetic variability due to phytochemical effects.

III. EXPERIMENTAL RESULTS

Experimental results were obtained from the present study towards the effects of treatments and their interactions on different characters through the mean values of different metrical traits were recorded in (Table I) and combined ANOVA (Table.2) from the 25A (CMS line) population at the time of harvest as furnished below:

Table.I: Mean values of various metrical characters of Boro season (2011-12)

Treatment	**No.of tiller plant^{-1}**	**Total panicle length (cm) plant^{-1}**	**Panicle exsertion length (cm) plant^{-1}**	**Unexerted panicle length (cm) plant^{-1}**	**Total no. of grain panicle^{-1}**	**No. of fertile grain panicle^{-1}**	**Total yield t ha^{-1}**	**1000 grain weight (g)**
T_1	9.26	20.26	16.93	3.32	189.36	71.09	2.07	18.23
T_2	10.33	24.39	21.27	3.12	206.87	77.48	2.48	20.54
T_3	9.36	23.38	19.93	3.45	201.54	72.23	2.24	18.54
T_4	9.90	23.45	20.20	3.25	202.24	73.89	2.29	20.64
T_5	10.14	24.26	21.03	3.23	203.29	75.03	2.40	19.13

At the time of ***harvesting*** the data were collected for the season of Boro (2011-12) and furnished below the same in tabulated form (Table II).

Table II : Combined ANOVA for all metrical characters during the time of harvest

CHARACTER	COMBINED ANOVA							COMPONENTS OF VARIANCES			GENOTYPIC COEFFICIENT OF VARIATIONS, PHENOTYPIC COEFFICIENT OF VARIATIONS AND HERITABILITY		
	Source of variation	**df**	**SS**	**MS**	**F**	**CD Value**	**CV Value**	**$\delta^2 g$**	**$\delta^2 p$**	**$\delta^2 e$**	**GCV**	**PCV**	**h^2**
No. of tiller plant^{-1}	**Treatment**	4	4.44590	1.11147	10.77**	0.26	3.27	0.20	0.30	0.10	4.56	5.58	0.66
	Replication	4	0.33798	0.08449	0.82 NS								
	Error	16	1.65158	0.10322									
Total panicle length (cm) plant^{-1}	**Treatment**	4	56.4000	14.1000	4753.08**	0.007	0.23	2.81	2.813	0.003	7.23	7.24	0.99
	Replication	4	0.0411	0.0103	3.46*	0.005							
	Error	16	0.0475	0.0030									
Panicle exsertion length (cm) plant^{-1}	**Treatment**	4	60.3265	15.0816	4544.71**	0.008	0.28	3.01	3.013	0.003	8.72	8.73	0.99
	Replication	4	0.0555	0.0139	4.18*	0.006							
	Error	16	0.0531	0.0033									
Unexserted panicle length (cm) plant^{-1}	**Treatment**	4	0.311144	0.077786	429.76**	0.0004	0.41	0.01	0.0101	0.0001	3.05	3.06	0.99
	Replication	4	0.003304	0.000826	4.56*	0.0003							
	Error	16	0.002896	0.000181									

Table II (Contd.): Combined ANOVA for all metrical characters during the time of harvest

CHARACTER	COMBINED ANOVA							COMPONENTS OF VARIANCES			GENOTYPIC COEFFICIENT OF VARIATIONS, PHENOTYPIC COEFFICIENT OF VARIATIONS AND HERITABILITY		
	Source of variation	**df**	**SS**	**MS**	**F**	**CD Value**	**CV Value**	**δ^2g**	**δ^2p**	**δ^2e**	**GCV**	**PCV**	**h^2**
Total no. of grain panicle^{-1}	**Treatment**	4	881.72	220.430	32.68**	17.09	1.27	42.77	49.31	6.54	3.25	3.49	0.86
	Replication	4	62.01	15.501	2.37NS								
	Error	16	104.73	6.545									
No. of fertile grain panicle^{-1}	**Treatment**	4	123.860	30.9649	60.68**	1.33	0.96	6.09	6.60	0.51	3.33	3.47	0.92
	Replication	4	3.204	0.8009	1.57NS								
	Error	16	8.165	0.5103									
Total yield ha^{-1} (ton)	**Treatment**	4	0.476064	0.119016	69.56**	0.004	1.79	0.02	0.021	0.001	6.14	6.29	0.95
	Replication	4	0.009624	0.002406	1.41NS								
	Error	16	0.027376	0.001711									
1000 grain weight (g)	**Treatment**	4	25.1111	6.27777	30.26**	2.88	2.34	1.21	1.41	0.20	5.66	6.11	0.85
	Replication	4	0.6399	0.15997	0.77NS								
	Error	16	3.3196	0.20747									

IV. DISCUSSION

While considering the value of variance ratio in each character it appeared that in all cases the ‘F’ value against treatment source of variation was found to be significant at 5% and 1% level of probability. The ‘F’ value was found to be significant at 5% level against replication source of variation though it should not be marked in any case of significance against the replication source of variation. That is why it was quite reasonable to assume that this might be due to the soil heterogeneity factors.

The metrical characters of raw data were converted into two-way-mean table for calculating its analyses of variance, components of all variances δ^2g, δ^2p, δ^2e, genotypic and phenotypic coefficient of variations i.e. GCV and PCV including heritability (h^2). These yield components data were exhibited in a Combined ANOVA as presented in Table II. It was critically observed various peculiarities during cropping time till harvesting. The length of panicle exsertion was found to be highest (21.27cm) in treatment- 2 (Penicillin) and lowest length (19.93 cm) of exserted panicle in case of treatment-3 (Sulfonamide). Accordingly the exserted panicle length was observed 20.20 cm and 21.03 cm in case of Gentamycin and GA_3 respectively. A comparative study of Penicillin and cyclic-AMP induced alpha (α)- amylase formation in rice endosperm was made by Biswas and Mukherjee, 1982.

In other major yield characters viz. total no. of grains panicle^{-1}, total yield plant^{-1} and 1000 grain weight were also studied. In all the cases the highest data recorded in treatment- 2 and lowest was in treatment- 3. Evidently treatment-4 and 5 i.e. Gentamycin and GA_3 were in same sequence as good as panicle exsertion length.

The value of heritability in yield components was found to be within the limit of 1.00. That is why a heritability measure close to 1.00 indicates that almost all variation in the population results from variation in genotypes and nearly nothing from environment. High heritability coupled with high genetic advance and Genotypic and Phenotypic Coefficient of Variation are also observed by Sureshbabu et al., (2013).

Different treatments like GA_3, Penicillin and Gentamycin undertaken in this experimentation were considered highest magnitude. All these three might be considered the highest effect for panicle exsertion in CMS (‘A’line). Treatment-2 (Penicillin) having low cost reflected more significant and excellent results than other treatments although different treatments used as alternative costly phytochemicals of GA_3 were considered in Boro season (2011-12). Gentamycin was also used as alternative low cost chemical of GA_3. By its nature Gentamycin inhibits protein synthesis by binding to the bacterial ribosome. Gentamycin is an aminoglycoside antibiotic used in Mexico and USA for several agricultural purposes. The rice was most sensitive to sulfonamide. In this experiment, it also strongly affected the growth of rice plant and shown lower yield performance. The effective concentrations of sulfonamide increased soil respiration activity which was reported by Frund et al., 2000, Halling-Sorensen 2003 and Schmitt et al, 2004. Therefore, it is an established fact that the effects of various phytochemicals in different treatments have had more or less genetic variability in parental lines to achieve good yield performance.

V. CONCLUSION

During Boro season 2011-12, it was found that the ranges of value of heritability (h^2) in almost all the cases were lying in between 0.85 to 0.99 i.e. within the value of 1.00. That is why a heritability measure close to 1.00 indicates that almost all variation in the population results from variation in genotypes and nearly nothing from environment. Therefore, it is very clear that every treatment had its specific phytochemical effect causing to generate genetic variability in parental lines. In the present study, Treatment-2 (Penicillin) having low cost reflected more significant and provided excellent results showing highest yield performance than other treatments except GA_3 for its specific chemical properties although different treatments used as alternative phytochemicals of GA_3 were considered in this cropping season. Other treatments were established according to their mode of action having some variation in genotypes due to effect of phytochemicals. Therefore, it may be concluded that the effect of phytochemicals enlarged the considerable genetic variability in most of the plant characters besides high heritability percentage was observed in almost all characters. High heritability percentages were also reported by Shivani and Reddy (2000), Devi *et al.* (2006) and Yadav *et al*. (2008). Nevertheless, by inter-varietal crossing, a lot of improvement might be achieved in the field of F_1 hybrid seed production.

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