Assessment of Seasonal Stress for the Production of F1 Hybrid Rice Seed through CMS Breeding Technology

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Abstract

IR58025A as A-line, and KMR-3 as R-line were procured from the State Rice Research Station, Chinsurah, Hooghly which are grown in the research plot in the Crop Research Farm under the Department of Botany of the University of Burdwan following the norms of CMS breeding layout design. Hybrid rice is the commercial rice crop from F_1 seeds of cross between two genetically dissimilar parents. Good rice hybrids have potential of yielding 15-20% more than the best inbred variety grown under similar conditions. At present there are three types of hybrid seed production system based on the number of parental lines involved viz. A-line (CMS-line), B-line (Maintainer line) and R-line (Restorer line).

1. Introduction

After independence we had to face severe famine in the country in 1940s'. The quantity of food production which we had achieved from green revolution of the sixties could have met up the present food scarcity of increasing by growing population of our country. Cereal crop yield could reach 3-6 times more yield by introducing new high yielding photo insensitive cultivars (especially in case of rice). Gradually the green revolution has converted as 'green' to 'greed' by sacrificing some traditional valuable *indica* rice cultivars. Seed to seed duration of *indica* rice cultivars has reduced in 115-120 days from its long duration i.e. 160-170 days. 'Taichung' Native-1 rice variety was introduced in India first in 1965 but it could not survive in this country in any agro-climatic zone out of 6 zones in our country. Simultaneously the scientists of International Rice Research Institute discovered the most high yielding rice cultivar IR-8 for maximum yield in tropical country like India. The seed to seed duration of IR-8 was 130-135 days. It was a matter of water stress for the cultivation of IR-8 in winter- summer- boro season in artificial irrigation. Indeed, we had no sufficient arrangement of artificial irrigation for boro cultivation of rice cultivars at that time. In course of time a few rice cultivars were evolved which were 110-115 days of seed duration and replace the IR-8 rice cultivars. The cultivation of high yielding rice varieties became saturated in 1984-1985 in our country. Thereafter, the enhanced production of rice became deteriorated due to genetic erosion, technological shortfalls and agronomical practices. Within this seed production system, the out-crossing potential of the seed parent is assessed and the easy of production of particular hybrid combinations determined. The quality of output of the various seed production steps are determined through grow outs conducted after each season (Toldeo et al., 1996). Different doses of chemical viz. GA_3, penicillin, Sulfonamide, and gentamicin were applied as foliar spay during flowering times in three phases. This practice for producing F_1 seeds from the A-line and R-line were done in both the seasons i.e. (i) winter-summer-boro and (ii) kharif seasons. The produced F_1 seeds as well as R-line seeds were measured in various agronomic parameters for assessing the seasonal variations over the same location. All these data were analysed following the model of Singh and Chaudhary, 1985. The calculations of component of variance, genotypic co-efficient of variation (GCV), phenotypic co-efficient of variation (PCV), heritability (h^2) of each treatment have been exhibited in this context.

The aims and objects of this experiment were to assess the heterosis in different seasons in a year and to explore the inflorescence emerging by applying low cost alternative chemicals other than GA_3.

High yielding rice cultivars were evolved during 1960's in our country to fulfil green revolution moto. Initially, the photosensitive *indica* rice cultivars were replaced by Taichung Native 1 and thereafter IR8.But indeed; it was a great problem of water stress for the cultivation of IR8 (160 days) in winter-summer boro season where we had low sufficient artificial irrigation facilities in our country. In course of time, within a couple of years a few promising rice cultivars (110-115 days) were evolved to replace IR8 rice cultivar. Thereafter the enhanced productions of rice become deteriorated due to genetic erosion, technological shortfalls and agronomical practices. The basic work on hybrid rice was initiated in early seventies (Swaminathan et al., 1972). More organised and systematic research on both basic and applied aspect was started by Indian Council of Agricultural Research (ICAR) in December, 1989 under a mission mode project. The cytoplasmic male sterile (CMS) lines of Chinese origin were received through International Rice Research Institute, Philippines.

2. Materials and Methods

CMS abortive lines IR58025A and restorer line KMR-3 were collected from the State Rice Research Station, Chinsurah, Hoogly, West Bengal, India. These seeds were sown in the seed bed during December 18-25, 2011 following the norms of CMS technology. After a month the seedlings were transplanted in the field following the CMS technology. Six A-lines were transplanted having two R-lines aside both sides of each replication of A-line. Metrical characters of rice were studied and all these data were recorded properly for further computations. CD and CV values were calculated the following Sing and Chaudhary (1985). Organic manures were directly applied in the soil at the following doses.

Treatment	Chemical
T_1	Control
T_2	Penicillin
T_3	Sulphonamide
T_4	Gentamicin
T_5	GA_3

Doses	Fertilisers [for the area of 532 m^2]
	1.MOP-7 kg.
A. First dose	2.Super phosphate-8 kg
	3. Urea-4 kg
	4. Vermicompost-12 kg.
B. Second dose	1.MOP-2 kg.
	2. Super Phosphate-5 kg.
	3. Urea-2 kg.
	4. Vermicompost-2 kg.

3. Results and Discussion

The two way tables of 15 metrical characters were analysed for calculating the value of CD, and CV which have been cited in Table 1. The components of variances were calculated accordingly for further information of the genotypes which have been exhibited in tabulated form in the Table 2. The genotypic coefficients of variations, phenotypic coefficients of variations and heritability of genotypes were also determined following Singh and Chaudhary (1984) which have been exhibited in the Table 3.

In this case plant height was measured twice. The final plant height has been exhibited in the Table 1 as its significant F value at PO.01 level where the CD and CV were measured as 3.23 and 7.17 respectively. Simultaneously the value of variance ratio (F value) as calculated in case of number of grains panicle^{-1} was indicated 12.26 i.e., significant at p=0.01% as a result the grains panicle^{-1} should be significant in any case. It is calculated that the F value was significant at p=0.05% in case of grain yield plant^{-1}. Normally the 1000 grains weight indicated the significant result which is directly variable with the grain yield plant^{-1}. But in our case the result of CD indicated insignificant. Because the grain filling of F_1 seeds is no doubt not up to the mark like normal other cultivars. The interesting feature was that no pathogenic occurrence was happened in field population. This might be due to application of organic manure and vermicompost. The application of vermicompost helps to the F_2 rice population to protect any insect and pathogenic attack (Tah and Chakraborty, 2002).

The components of variances in case of nine characters (Table 2) viz. plant height (cm) in 20 days, final plant height (cm.), no. of tiller plant^{-1}, no. of leaves plant^{-1}, no. of rachilla panicle^{-1}, no. of fertile grains panicle^{-1}, 1000 grain weight (g) treatment^{-1}, length of awn (mm) treatment^{-1} and straw weight (kg) treatment^{-1} were exhibited negative values which indicate the further exercise for betterment or standardization.

Similarly the values of h_2 were also calculated as negative form for the same reasons. However, the total yield plant^{-1} showed the positive and significant in the sense of F_1 seed production. The stress condition of pollination was nothing but the wind factor i.e. seasonal factor (i.e. wind speed and direction, temperature, humidity etc). Though, artificial pollination was occurred, the seed formation (F_1 seed) could not hamper any more.

Table 1: Combined ANOVA for the studied material (extracted from 2 way ANOVA)

Sr. N.	Character	S. V.	Df	SS	MS	F value	CD	CV	Remarks
1	Plant height (cm) in 20 days	Treatment	4	0.572	0.143	0.55	-		NS
		Replication	4	0.652	0.163			3.20	
		Error	16	4.136	0.2585	0.630	-		
2	Final Plant height (cm)	Treatment	4	1.46	0.365	0.11	-		NS
		Replication	4	140.46	35.115			7.17	
		Error	16	49.14	3.07	11.43**	3.23		S *(p=0.01)*
3	Tiller Plant^{-1}	Treatment	4	3.3	0.825	0.84	-		NS
		Replication	4	10.1	2.525			17.41	
		Error	16	15.6	0.975	2.589	-		NS
4	Leaves plant^{-1}	Treatment	4	18.76	4.69	0.55	-		NS
		Replication	4	62.26	15.56			45.33	
		Error	16	135.37	8.46	1.83	-		NS
5	Panicle length treatment^{-1} (cm)	Treatment	4	12.7	3.17	1.62	-		NS
		Replication	4	11.6	2.92			7.67	
		Error	16	31.2	1.95	1.49	-		NS
6	No. of rachilla Panicle^{-1}	Treatment	4	4.16	1.04	0.93	-		NS
		Replication	4	0.16	0.04			8.92	
		Error	16	17.84	1.11	0.03	-		NS
7	No. of grain panicle^{-1}	Treatment	4	172.4	43.1	2.87	-		NS
		Replication	4	735.6	183.9			9.36	
		Error	16	240	15	12.26**	7.12		S (*p*=0.01)
8	No. of fertile grain panicle^{-1}	Treatment	4	39.76	9.94	0.71	-		NS
		Replication	4	34.56	8.64			11.34	
		Error	16	223.04	13.94	0.61	-		NS
9	Grain yield (g) plant^{-1}	Treatment	4	17.17	4.29	4.612*	1.29		S (*p*=0.05)
		Replication	4	0.62	0.15			7.04	NS
		Error	16	14.88	0.93	0.16	-		
10	Total yield hectare^{-1} (kg)	Treatment	4	2.157	0.539	1.55	-		NS
		Replication	4	1.918	0.479			7.97	
		Error	16	5.555	0.347	1.38	-		NS
11	1000 grain weight treatment^{-1}(g)	Treatment	4	2.87	0.71	0.68	-		NS
		Replication	4	0.25	0.06			8.14	
		Error	16	16.68	1.04	0.05	-		NS
12	Length of grain Treatment^{-1} (mm)	Treatment	4	10.46	2.615	1.08	-		NS
		Replication	4	3.46	0.865			22.91	
		Error	16	38.74	2.42	0.35	-		NS
13	Breadth of grain-treatment^{-1} (mm)	Treatment	4	0.86	0.215	2.55	-		NS
		Replication	4	0.36	0.09			15.44	
		Error	16	1.34	0.084	1.07	-		NS
14	Length of awn treatment^{-1} (mm)	Treatment	4	0.3	0.075	0.11	-		NS
		Replication	4	0.348	0.087			15.44	
		Error	16	10.212	0.638	0.13	-		NS
15	Straw weight treatment^{-1} (kg)	Treatment	4	0.19	0.04	0.11	-		NS
		Replication	4	1.37	0.34			4.09	
		Error	16	5.87	0.36	0.94	-		NS

S=Significant; NS=Non-significant

Table 2: Components of variances

Character	δ^2g	δ^2p	δ^2e
1. Plant height (cm) in 20 days	-0.11	0.14	0.25
2. Final plant height (cm)	-2.71	0.36	3.07
3. No. of tiller plant^{-1}	-0.15	0.82	0.97
4. No. of leaves plant^{-1}	-3.77	4.69	8.46
5. Panicle length (cm) treatment^{-1}	1.22	3.17	1.95
6. No. of rachilla panicle^{-1}	-0.07	1.04	1.11
7. No. of grain panicle^{-1}	28.1	43.1	15
8. No. of fertile grain panicle^{-1}	-0.8	13.14	13.94
9. Grain yield (g) plant^{-1}	3.36	4.29	0.93
10. Total yield (kg) ha^{-1}	0.19	0.53	0.34
11. 1000 grain weight (g) treatment^{-1}	-0.33	0.71	1.04
12. Length of grain (mm) treatment^{-1}	0.19	2.61	2.42
13. Breadth of grain (mm) treatment^{-1}	0.13	0.21	0.08
14. Length of awn (mm) treatment^{-1}	-0.56	0.07	0.63
15. Straw weight treatment^{-1} (kg.)	-0.32	0.04	0.36

Table 3: Genotypic coefficients of variations, phenotypic coefficients of variations and heritability

Character	GCV	PCV	h^2
1. Plant height (cm) in 20 days	4.09	4.59	-0.78
2. Final plant height (cm)	3.83	1.40	-7.52
3. No. of tiller plant^{-1}	6.78	16.07	-0.18
4. No.of leaves plant^{-1}	10.39	11.57	-0.80
5. Panicle length (cm) treatment^{-1}	4.33	7.00	0.38
6. No. of rachilla panicle^{-1}	2.09	8.11	-0.06
7. No. of grain panicle^{-1}	3.30	4.09	0.65
8. No. of fertile grain panicle^{-1}	0.72	2.94	0.06
9. Grain yield (g) plant^{-1}	13.85	15.66	0.78
10. Total yield (kg ha^{-1})	9.88	16.55	0.35
11. 1000 grain weight (g) treatment^{-1}	4.46	6.57	-0.46
12. Length of grain (mm) treatment^{-1}	4.07	15.24	0.07
13. Breadth of grain (mm) treatment^{-1}	16.07	20.08	0.61
14. Length of awn (mm) treatment^{-1}	17.91	6.29	-8
15. Straw weight (kg) treatment^{-1}	6.36	2.27	-8

4. Conclusion

The genetic potentiality of A-line was tested by the scientists of IRRI against any adverse condition of seasonal factor in tropical country like India. So, the capability for adaptation of A-line had no more question of stress like that. However, the application of vermicompost along with other organic manures in the soil was recommended for producing disease free healthy rice population prevailing such environmental factors.

5. References

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