OPENING MINDS:
RESEARCH FOR SUSTAINABLE
DEVELOPMENT

Comparative Study of Growth Performance of F_1 and F_2 Rice Hybrids Cultivars in Sri Lanka

W.S. Priyantha*, D.D. Witharana, R.P.D.H. Hemachandra and D.M.O.K.B. Dissanayake

Rice Research and Development Institute, Batalagoda, Ibbagamuwa, Sri Lanka

**Corresponding author: Email: rrdihybridrice@gmail.com*

1 INTRODUCTION

The enhancement of rice production is an important requirement to meet increasing demand for rice in the future. The development of high yielding varieties with multiple resistance to biotic and abiotic stresses is important to cater to the present and future changing environment. The introduction of hybrid rice has had a dramatic influence in increased crop production (Duvick, 1999) and minimization of unrealistic crop yield. Hybrid rice technology assures the rice farmers with increased yield over improved conventional varieties, thereby enhancing field incomes. Hybrid rice area is now rapidly increasing outside China ever since the release of the first set of hybrids in 1976 (Yaun, 1998). Presently, many countries other than China like Vietnam, India, Indonesia, Iran, Philippines, United States of America, Bangladesh, Sri Lanka, Myanmar and Egypt are currently engaged in developing hybrid rice technology to suit their local conditions (Dorosti, 2014). In Sri Lanka, the research and development (R and D) program on hybrid rice began in 1983 (Pathinayaka, 1985) at the Central Rice Breeding Centre, Batalagoda. Under this program several hybrids have been identified with 1.0 -1.5 t ha-1 yield advantage over the best inbred grown under similar environments (Iqbal, 2009) and the first hybrid rice variety, Bg 407H was released in 2005. F1 seed production of hybrid rice is very important to enhance the seed paddy availability among farmers. Therefore seed production technology of hybrid rice was introduced to farmers. The low yield of F1 hybrid was the main obstacle to limit the cultivation of hybrid rice in the country. Some farmers adopted the cultivation of the seeds of F2 generation and obtained satisfactory grain yield. In general F2 generation of hybrids was not recommended to cultivate because decreasing of heterosis. Hence this study was conducted to identify the performance of (F2) rice hybrids of Bg 407H and HR-10.

2 METHODODLOGY

This experiment was conducted at the Rice Research and Development Institute (RRDI), Batalagoda, Low Country Intermediate Zone (IL1a) in Sri Lanka. Two promising hybrids of Bg 407H (120 days) and HR-10 (105 days) were included in the experiment and F2 generation of respective hybrids. Inbred rice varieties; Bg 357 (105 days) and Bg 403 (120 days) were included as standard checks for respective age groups. Sixteen days old seedlings of all treatments were transplanted in a well prepared field one plant per hill basis. Spacing within two plants were 15x 15 cm and spacing between two rows were 20 x 20 cm. All

the other agronomic and plant protection practices were adopted according to the department of agriculture (DOA) recommendations. Randomize Complete Block Design (RCBD) was adopted with four replicates in this experiment. Plant growth parameters and yield parameters were recorded. Mean separation was done by Duncan Multiple Range Test (DMT) by using SAS statistical software package 9.1. Standard heterosis (SH) of F1 and F2 hybrids and inbreeding depression of F2 hybrids were calculated for yield separately.

$$\mathbf{SH} = \frac{(\mathbf{F1} - \mathbf{SC})}{\mathbf{sc}} \times \mathbf{100}$$

SH = Stranded Heterosis, F1 = Value of tested traits of hybrid, SC = Value of stranded check

$$\text{Inbreeding depression (\%)} = \frac{(\mathbf{F2}-\mathbf{F1})}{\mathbf{F1}} \times \mathbf{100}$$

F2 – value of respective trait of F2 generation, F1 - value of respective trait of F1 generation

3 RESULTS AND DISCUSSION

Results showed that regardless of the varieties and age groups F2 generation significantly reduced yield over both F1 generations and inbred varieties except in Yala season. Inbred varieties showed higher yield over the F2 hybrids but not significantly different. The number of productive tiller/hill (NPT/H) of all F1 and F2 hybrids did not show a significant difference. However Bg 403 showed a significantly higher NPT/H over F1 and F2 hybrids of Bg 407H, Although no such significant effect was recorded in F1 and F2 hybrids of HR-10 compared with Bg 357 in Yala. F1 hybrid of HR-10 showed significantly higher NPT/H over its F2 hybrid in Maha season. The number of unproductive tillers per hill (NUPT/H) of F1 and F2 hybrids did not show a significant difference among them in both seasons. Meanwhile NUPT/H recorded no significant effect regardless to the varieties and age groups in Yala season but such effect did not appear in Maha season. Thousand grain weight (TGW) of F1 and F2 hybrids of Bg 407H was not significantly different over seasons but TGW of F1 and F2 hybrids of HR-10 showed significant difference over seasons. Results showed that no Cytoplasmic genetic Male Sterile (CMS) plant count was recorded in 105 and 120 days old inbred rice varieties. In both seasons highest significant CMS plant count was recorded in F2 hybrids of Bg 407H and HR-10. Crop uniformity was observed in both F1 hybrids and two inbred varieties but such uniformity was not observed in the plots of F2 hybrids due to segregation of the respective alleles. The results revealed significant yield reduction in F2 generations due to loss of hybrid vigor. Segregation of respective alleles reduces heterozygosity of F2 generation by 50% and it generates different phenotypes which have poor and various vigor levels in F2 population. Considerable amount of CMS plants could be identified in the generation of F2 hybrids with unfilled grains caused yield reduction irrespective of varieties and age of F2 hybrids.

The inbreeding depression (Fehr, 1987) was calculated for F2 hybrids and results showed a negative effect for all selected traits of F2 hybrid. Maximum inbreeding depression (IBD) was showed by F2 hybrid of Bg 407H (-37.16%) in Yala season (Table 2.). However, less IBD was obtained by all F2 hybrids in Maha compared to Yala season. Stranded hetorosis (SH) was estimated for selected traits for both F1 and F2 hybrids and results revealed that negative hetorosis for F2 hybrids. In Yala season maximum negative hetorosis recorded by F2 of HR-10 (-27.15%) while in Maha season maximum negative hetorosis recorded by F2 hybrid of Bg 407H (-27.25%). Meanwhile positive SH was showed by F1 hybrids of Bg 407H 34.14% and HR-10 9.69% in Yala season. Those two hybrids showed (-4.11%) and 16.07% SH

ISSN 2012-9916 © The Open University of Sri Lanka

respectively for Maha season. It indicated that F2 hybrids of both varieties cannot be recommended for cultivation. But only F1 hybrids of Bg 407H better to be cultivated in Yala and HR-10 for only Maha season.

Table 1: Mean of morphological and reproductive traits

Treatments	TGW(g)		CMSPC		GY(t ha^{-1})	
	Yala	***Maha***	***Yala***	***Maha***	***Yala***	***Maha***
Bg 407H (F_2)	28.8a	29.10a	35.40b	60.33b	2.79b	4.78c
Bg 407H	29.53a	29.03a	3.61c	2.33c	4.44a	6.30a
Bg 403	25.13bc	25.43c	0.00d	0.00d	3.31ab	6.57a
HR 10(F_2)	24.03c	26.53b	50.69a	87.67a	2.63b	4.63c
HR 10	25.36b	25.43c	1.16c	2.67c	3.96a	6.21a
Bg 357	21.56d	23.70d	0.00d	0.00d	3.61ab	5.35b
CV	1.32	1.85	0.85	16.73	1.13	5.12
LSD	2.28	0.89	17.52	1.01	18.09	0.52

Treatments	NPT/H		NUPT/H		PH(cm)	
	Yala	***Maha***	***Yala***	***Maha***	***Yala***	***Maha***
Bg 407H (F_2)	8.24c	8.24b	12.19a	1.04a	117.27b	24.33ab
Bg 407H	8.01c	8.64b	1.51a	0.92a	123.2a	25.73a
Bg 403	12.04a	12.46a	1.90a	0.09b	107.93c	25.13ab
HR 10(F_2)	11.83ab	12.04a	2.16a	0.86a	106.00c	23.73b
HR 10	11.28ab	9.30b	2.06a	0.30ab	107.00c	23.73b
Bg 357	10.24b	8.64b	0.96a	0.04b	92.93d	20.23c
CV	0.26	6.51	0.83	44.47	5.24	4.07
LSD	4.49	0.37	34.44	0.54	2.64	1.77

NPT/H - No. of Productive Tiller/hill, **NUPT/H** - No. Unproductive Tiller/hill, **PH**-Plant Height, **TGW**-Thousand Grain Weight, **CMSPC- CMS** Plant Count, **GY**- Grain Yield

Table 2: Inbreeding depression and standard heterosis of F_1 and F_2 hybrids for grain yield

Treatments	IBD (%)		SH (%)	
	Yala	Maha	Yala	Maha
Bg 407H (F_2)	-37.16	-24.12	-15.71	-27.25
HR 10 (F_2)	-33.59	-12.01	-27.15	-13.46
Bg 407H(F_1)	-	-	34.14	-4.11
HR 10(F_1)	-	-	9.69	16.07

***IBD**- Inbreeding Depression, **SH**- Stranded Hetorosis*

Grain yield of two F_1 hybrid showed high yield compared to respective standard check varieties except Bg 407H(F_1) and it showed -4.11% SH compared to its check variety Bg 403 in *Yala* season. Meanwhile all F_2 hybrids showed poor SH compared to respective check varieties.

4 CONCLUSIONS AND RECOMMENDATIONS

The study concluded that the use of F2 hybrid varieties was not suitable to cultivate because of their high inbreeding depression and poor grain yield compared to F1 hybrid as well as inbred varieties. However F1 hybrids have better standard heterosis for grain yield so that can obtain high yield.

REFERENCES

Dorosti H., Monajjem S., 2014, Gene action and combining ability for grain yield and yield related traits in rice (Oryza sativa L.), The Journal of Agricultural Sciences, 2014, vol.9, no3. pp 100-108.

Duvick D.N, 1999, Heterosis: Feeding People and Protecting Natural Resources, Coors J.G. and Pandey S. (Eds.), The Genetics and Exploitation of Heterosis in Crops. ASA, CSSA, SSSA, Madison, WI. pp 19-29.

Fehr W.R., 1987. Principle of Cultivars Development, Macmillan publishing company. A Division of Macmillan Inc. New York. pp 1: 1-465.

Iqbal Y.B., 2009. Analysis of combining ability to identify suitable parents for heteritic rice breeding. M.Phil Thesis University of Peradeniya Sri Lanka, pp 253

Pathinayaka B.D, Dhanapala M.P, 1985, Present status of hybrid rice research in Sri Lanka, Tropical Agriculturist, Vol 141. pp 77-80.

Yuan L.P., 1998. Hybrid rice breeding in China. Virmani S.S. Siddiq E.A., Muralidharan K. (Eds.) Advances in hybrid Rice Technology. International Rice Research Institute, Manila, Philippines. pp 27-33.

ISSN 2012-9916 © The Open University of Sri Lanka