IDENTIFICATION OF RESTORERS AND MAINTAINERS FOR DEVELOPING HYBRID RICE

*M. Sabar, M. Akhter, Faiz Ahmad Faiz, Syed Sultan Ali and Mushtaq Ahmad**

ABSTRACT

Some genetic material was evaluated at Rice Research Institute, Kala Shah Kaku, Lahore during 2002-2004 for its use in hybrid rice technology. One hundred and nine rice genotypes were evaluated for their status in hybrid rice parental gene pool. Twenty restorers and 26 maintainers have been identified for use in hybrid rice research programme. Maintainer lines possessing desirable characteristics will be converted into cytoplasmic male sterile (CMS) lines to utilize for the development of rice hybrids.

KEYWORDS: *Oryza sativa;* genotypes; crossbreeding; hybrids; Pakistan.

INTRODUCTION

The potential of hybrid rice in increasing production and productivity was clearly demonstrated by Chinese workers. About 55 percent of rice area in China is already under hybrid rice, producing 66 percent of the total rice production (9). The genetic tools i.e. cytoplasmic male sterile (CMS), maintainer and restorer lines which are essential for production of hybrid rice, were initiated at Rice Research Institute, Kala Shah Kaku in late nineties. The establishment of testcross nursery to identify restorers and maintainers is the first step in three line heterosis breeding.

McWilliam *et. al* (3) found higher frequency of restorers (21%) than maintainers (11%) from the evaluation of 6000 testcrosses in India. On the other hand, less restorer and higher maintainer frequency was observed in the local germplasm of Pakistan (1). Ali and Khan (2) also observed that frequency of the maintainers (63%) was much higher than that of restorers among 76 hybrids tested. Nanda and Virmani (4) observed that IR 58025A is

*Rice Research Institute, Kala Shah Kaku, Lahore, Pakistan.

the only reliable CMS line, being used for the development of commercial rice hybrids in India.
The objective of this study was to identify restorers and maintainers from the local and exotic genetic material for the successful hybrid rice programme in Pakistan.

MATERIALS AND METHODS

Local and exotic genetic material was evaluated to identify the commercially useable restorers and maintainers in Basmati and coarse rice at Rice Research Institute, Kala Shah Kaku. For this purpose, 49 parental lines were grown in the field during kharif season 2002 and crossed with ten CMS lines i.e. IR 58025A, IR 69616A, IR 70372, IR 68280A, IR 75606A, IR 72788A, IR 70369A, IR 73321A and IR 70959A. Again, during kharif season 2003,60 parental lines were crossed with four CMS lines (IR 69628A, IR 58025A, IR 73328A and IR 68897A) under field conditions. During kharif 2003, 130 entries comprising 69 testcrosses alongwith their respective parental lines were transplanted on 07.07.2003 in the rows of 12 plants with 23 cm plant spacing on each side. During kharif 2004, 44 testcrosses and their parental lines were transplanted on 08.07.2004 in the rows of 12 plants with 23 cm spacing on each side. Standard agronomic and plant protection measures were adopted during both the years.

During the year 2003 and 2004, pollen studies were carried out for their fertility / sterility of testcross F_1 plants. For this purpose, 15-20 spikelets from the just emerged panicles of three randomly selected plants were collected in a vial containing 70 percent ethanol. All the anthers from atleast 6 spikelets were taken out with a forceps and placed on a glass slide with a drop of 1 percent iodine potassium iodide (IKI) stain. The anthers were gently crushed by using a needle to release the pollen grains. After removing the debris, a cover slip was placed and the slide was observed under the microscope. For spikelet fertility/sterility, five panicles of each testcross were covered with butter paper bags to avoid foreign pollen contamination and were harvested at maturity. The following criteria for classifying the parental lines as maintainers and restorers were used as proposed by Virmani *et al.* (10).

Pollen fertility (%)	Category	Spikelet fertility (%)
0-1	Maintainers	0

1.1-50	Partial maintainers	0.1-50
50.1-80	Partial restorers	50.1-75
>80	Restorers	>75

RESULTS AND DISCUSSION

From 113 test hybrids evaluated during both the years, 20 restorers, 30 partial restorers, 37 partial maintainers and 26 maintainers were categorized on the basis of pollen and spikelet sterility / fertility. The frequency of restorers, partial maintainers and maintainers were 17, 26, 32 and 23 percent, respectively.

Nine Basmati and 11 coarse lines were identified as restorers from the tested genotypes. All the CMS lines used (Table 1) were carrying wild abortive (WA) cytosterility source except IR 73328. Among these 20 restorers, Basmati 370, Basmati 385, Shaheen Basmati and Super Basmati are the approved and commercial varieties having good cooking quality traits.

Table 1. Rice genotypes identified as restorers.

S.No.	Genotypes	Group	CMS line (s) used.
1.	40265	Basmati	IR 69616 A
2.	4048-3	Basmati	IR 73794 A
3.	48514-99	Coarse	IR 58025 A
4.	485-4	Coarse	IR 69616 A
5.	48414	Basmati	IR 58025 A
6.	96407	Coarse	IR 58025 A
7.	Basmati 370	Basmati	IR 58025 A, IR73321A, IR70372A
8.	Indian Basmati	Basmati	IR 58025A
9.	IR 2053	Coarse	IR 69616A
10.	LG16	Coarse	IR 58025 A
11.	LG 141	Coarse	IR 58025 A
12.	LG-202	Coarse	IR 58025 A
13.	LG-41	Coarse	IR 58025 A
14.	OL-14	Basmati	IR 58025 A
15.	OL-20	Basmati	IR 58025 A
16.	PK1399	Coarse	IR 58025 A
17.	PK3699-43	Coarse	IR 58025 A
18.	Shaheen Basmati	Basmati	IR 58025 A
19.	Super Basmati	Basmati	IR 73228 A

20.	TN 1	Coarse	IR 58025 A

Out of 113 testcrosses, 26 genotypes (10 Basmati and 16 coarse) were identified as maintainers (Table 2). The CMS lines used for these maintainers are given in Table 2. Five varieties i.e. Super Basmati, Basmati 198, Basmati 2000, IR6 and IR9 are commercial varieties being grown in the Punjab. The morphological characters of these varieties except Basmati 2000 are suitable for a CMS line and can be converted into new CMS lines to develop hybrid rice.

Table: 2. Rice genotypes identified as maintainers.

S. No.	Genotypes	Group	CMS line(s) used
1.	00518-1	Basmati	IR58025A
2.	00518-2	Basmati	IR58025A
3.	1053-2-2	Basmati	IR 69616A
4.	4365	Basmati	IR73794A
5.	49931	Basmati	IR69616A
6.	98801	Coarse	IR58025A
7.	99509	Basmati	IR69616A
8.	99722	Coarse	IR69616A
9.	99723	Coarse	IR58025A
10	Basmati 198	Basmati	IR69616A
11.	Basmati 2000	Basmati	IR69616A, IR70372A
12.	CB 268-02	Basmati	IR58025A
13.	DR60	Coarse	IR70959A
14.	IR36	Coarse	IR69616A
15.	IR55186-46-4-3-2	Coarse	IR58025A
16.	IR6	Coarse	IR70959A
17.	IR9	Coarse	IR58025A
18.	LG-25	Coarse	IR58025A
19.	PARC97	Coarse	IR58025A
20	PARC154	Coarse	IR58025A
21.	PK3849-18	Coarse	IR58025A, IR70372A
22.	PK3717-12	Coarse	IR70372A
23.	PK939-4-1-6	Coarse	IR58025A
24.	Shadab	Coarse	IR58025A
25.	Shua92	Coarse	IR58025A, IR69616A
26.	Super Basmati	Basmati	IR75606A

In addition, nine best heterotic combinations were also identified from the testcrosses on the basis of filled grains per panicle and spikelet fertility (Table 3). It was revealed that seven identified heterotic hybrid combinations had more than 80 percent spikelet fertility and acceptable maturity days and plant height. All the test hybrids had more number of filled grains per panicle than both the check varieties. Yield performance on larger area and cooking quality characteristics need to be determined before their release for commercial cultivation.

Table 3. Morphological attributes of heterotic rice hybrids identified from the testcrosses.

S.No.	Parentage	Maturity days	Plant height (cm)	Tillers/ plant	Filled grains/ panicle	Spikelet fertility (%)
1.	IR69617A/Basmati.385	98	129	10	167	91
2.	IR 58025A/OL-14	114	112	14	165	82
3.	IR 58025A/48514-99	105	108	15	122	84
4.	IR 58025A/T(N)1	115	118	28	152	77
5.	IR 58025A/48414	110	124	15	150	72
6.	IR 58025A/Shaheen Basmati	100	121	15	204	85
7.	IR 58025A/LG-141	94	83	25	144	84
8.	IR 58025A/Basmati 385	110	145	11	208	82
9.	IR 73328A/Super Basmati	119	138	14	211	87
10.	Basmati 385 (check variety)	110	130	14	125	81
11.	Super Basmati (check variety)	116	125	16	85	85
	Means	108	121	16	158	83

The study concludes that the frequency of maintainers was quite higher than restorers amongst the tested genotypes. Similar results were obtained by earlier workers (1, 2, 5, 6, 8) . Goal oriented breeding for the development of new maintainer and restorer lines with desirable plant traits is very important for successful hybrid rice breeding programme.

REFERENCES

1. Ali, S. S. 1998. Hybrid rice research in Pakistan. IRR N.L. 23(2):17.
2. Ali, S. S. and M. G. Khan. 1996. Maintainers and restorers identified in some rice cultivars of Pakistan. IRR N.L. 21(2-3)-31.
3. McWilliam, J. R., H. lkehashi and S. K. Sinha. 1995. Progress in hybrid rice in India. Int. Rice Comm. N.L. 44:80-86.

4. Nanda, J. S. and S. S. Virmani. 2000. 'Hybrid rice' *In:* Rice Breeding and Genetics: Research Priorities and Challenges. J. S. Nanda (ed.). New Delhi, India. p. 23-52.
5. Sabar, M. and M. Akhter. 2002. Rice germplasm collection, conservation and utilization for hybrid rice. Proc. Seminar "Sustainable Utilization of Plant Genetic Resources for Agricultural Productions". p. 55-61.
6. Sabar, M. and M. Akhter. 2003. Evaluation of rice germplasm for the development of hybrid rice. Asian J. Plant. Sci. 2:1195-1197.
7. Sarial, A. K. and V. P. Singh. 2000. Identification of restorers and maintainers for developing basmati and non-basmati hybrids in rice, *Oryza sativa*. Plant Breeding. 119:243-247.
8. Virmani, S. S. and I. Kumar. 2004. Development and use of hybrid rice technology to increase rice productivity in the tropics. IRR N.L. 29:10-19.
9. Virmani., S. S., P. J. Jachuck, S. D. Chatterjee and M. I. Ahmad. 1998. Opportunities and challenges of developing hybrid rice technology for rainfed lowland and boro ecosystems. *In:* Rainfed Rice for Sustainable Food Security. S. K. Mohanty (ed.). Cuttack, India. p. 53-62.
10. Virmani, S. S., B.C. Viraktamath, C. L. Casal, R. S. Toledo, M. T. Lopez and J. O. Manalo. 1997. Hybrid Rice Breeding Manual. International Rice Research Institute, Philippines.