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Evaluation of Rice Germplasm for the Development of Hybrid Rice

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Abstract: Hybrid rice varieties have shown 15-20% higher yield potential than inbred varieties. Future food security of Pakistan lies in the development of hybrid rice varieties. Procedures for developing rice hybrids are quite distinct from those employed for breeding conventional varieties. Three hundred uniform lines including sixteen (16) cytoplasmic male sterile (CMS) lines from International Rice Research Institute (IRRI), Philippines were collected to evaluate the local material for identification of restorer and maintainer lines. Furthermore, agronomic traits i.e., plant height, maturity days, number of grains per panicles, productive tillers per plant and paddy yield of these lines were also categorized. 26 restorers and 34 maintainers had been identified.

Key words: Hybrid rice, restorers, maintainers

INTRODUCTION

Rice is the second staple food after wheat in the Punjab. But the yield level of Basmati and non-Basmati varieties has plateaued or stagnant. More and more rice has to be produced from lesser land and with lesser inputs. In recent years, utilization of hybrid vigor in rice has become an important economic tool for increasing rice production. Several other countries such as Bangladesh, Brazil, Colombia, Egypt, Democratic People's Republic of Korea, Japan, Malaysia, Myanmar, Philippines, Republic of Korea, Sri Lanka, Thailand and USA are currently exploring the prospects of hybrid rice. (Virmani *et al.*, 1997). Future food security of Pakistan lies in the development of hybrid rice varieties.

To meet the continuous expanding needs of varietal improvement through hybrid rice breeding, the assemblage, evaluation and preservation of the parental lines are essential to more rewarding efforts (Sabar and Akhter, 2002). The cytoplasmic genetic male sterility system is a three-line system involving a CMS source, a maintainer and a restorer and is extensively being used in the production of commercial rice hybrids (Virmani *et al.*, 1997).

McWilliam *et al.* (1995) found that the percentage of restorers was more (21%), whereas the percentage of maintainers (11%) was less from the evaluation of the 6000 testcrosses in India. On the other hand, less restorer and higher maintainer frequency were observed in the local germplasm of Pakistan (Ali, 1998; Ali and Khan, 1996) also observed that frequency of the maintainers (63%) was much higher than that of restorers among 76 hybrids tested.

The objective of this study was to evaluate the local and exotic genetic material for the agronomic traits and identification of restorers and maintainers.

MATERIALS AND METHODS

Evaluation of germplasm: Local and exotic genetic material was evaluated for agronomic traits at Rice Research Institute, Kala Shah Kaku. For this purpose, a source nursery comprising of 144 uniform rice genotypes was transplanted on three different dates i.e., June 20th, July 5th and July 20th in 2001.

During 2002, 300 entries of the source nursery were transplanted on three different dates i.e., June 28th, July 6th and July 25th. Standard agronomic and plant protection measures were adopted during both the years. Data regarding plant height, number of grains per panicle, productive tillers per plant, maturity days and paddy yield were recorded.

Identification of restorers and maintainers: Selected lines from the germplasm were crossed with eight Cytoplasmic Male Sterile (CMS) lines i.e., SSMS-1A, SSMS-2A, IR68280A, IR 69628A, IR 58025A, IR67684A, IR 70369A and IR68885A in 2000. During 2001, parental lines were crossed with 10 CMS lines i.e., SSMS-2A, IR68280A, IR 69628A, IR 58025A, IR 70369A, IR 69616A, IR69617A, IR 68275 A, IR70372A and IR70362A. During kharif 2001, forty-eight (48) testcrosses along with respective male parents were transplanted on 30.06.2001 in the rows of 12 plants with 23 cm spacing on each side. During kharif 2002, one hundred and seventy six (176) testcrosses along with respective male parents were transplanted on 13.07.2002 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 from the germplasm and the test hybrids.

Pollen studies were carried out for their fertility/sterility of testcross F₁ plants. For the purpose, 15-20 spikelets from the just emerged panicles of 3

randomly selected plants were collected in a vial containing 70% ethanol. All the anthers from at least 6 spikelets were taken out with the help of a forceps and placed on a glass slide with a drop of 1% 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. The criteria for classifying the parental lines as maintainers and restorers was followed as proposed by Virmani *et al.* (1997). Data on the agronomic characters of the potential restorers and maintainers were collected from 5 selected plants.

RESULTS AND DISCUSSION

Three hundred uniform lines were evaluated for identification of restorer and maintainer lines. Furthermore, agronomic traits i.e., plant height, maturity days, number of grains per panicles, productive tillers per plant and paddy yield of these lines were also categorized. The variability of economic traits of identified restorers

and maintainers and CMS lines is given in Table 1. The selected material was further classified according to their group (Basmati/coarse). One hundred three (103) restorers and 68 maintainer have been identified from the local and exotic genetic material by the Institute. There is a sufficient variability for the recorded traits for the effective use of the selected genetic stock for the production of coarse hybrids.

Out of 224 testcrosser, Thirteen (13) Basmati and thirteen (13) coarse lines were identified as restorers from the gene pool. The CMS line(s) used for these restorers are given against each in Table 2. Among these 26 restorers, Basmati 385 is one of the major commercial varieties. This variety is very popular among the farmers for its yield, earliness and good cooking quality traits. On the basis of the agronomic data, five restorers i.e., 33608, Super fine, KSK 133, 49931 and PK1 78-2 have also been identified as potential restorers for the production of new hybrids.

So far, 20 Basmati and 14 coarse lines were identified as maintainers from the gene pool. The CMS line(s) used

Table 1: Variability in morphological traits of the available genetic stock

Category	Origin	Entries	Morphological Traits variability (range)					
			Plant Height (cm)	Maturity days	Grains panicle ⁻¹	Tillers plant ⁻¹	Paddy yield (t ha ⁻¹)	Group
Restorers	Exotic	77	69-115	79-121	69-115	14-27	1.7-11.9	Coarse
	Local	26	84-141	85-109	84-141	12-23	1.6-8.1	Coarse=13 Basmati=13
CMS lines	Exotic	16	59-101	93-120	75-170*	14-33	1.2-3.5	Coarse
	Local	2	96-98	83-86	75-95*	13-15	1.5-2.0	Fine
Maintainers	Exotic	40	74-110	79-125	46-157	13-29	1.5-4.2	Coarse
	Local	29	94-153	80-125	52-146	10-26	1.4-6.1	Coarse=5 Basmati=17

*Spikelets/panicle

Table 2: Elite genotypes identified as restorers during 2001 and 2002

Genotype	Group	CMS line (s) used.
Basmati 385	Basmati	SSMS-1A, SSMS-2A, IR68280A, IR58025A, IR68275A, IR69628A, IR70372A, IR 69617A
60001	Basmati	IR69628A
33608	Basmati	IR68280A, IR 69616A, SSMS-2A
98PP3	Basmati	IR69628A
Shaheen Basmati	Basmati	IR68280A
Basmati Pak	Basmati	IR68280A, IR 69617A
LG-25	Basmati	IR68280A
Basmati134	Basmati	SSMS2A
99722	Coarse	IR67683A
IR74	Coarse	IR58025A
1R72	Coarse	IR58025A
Super fine	Coarse	SSMS2A
PK 178-2	Coarse	IR69617A
LG-97	Coarse	IR58025 A, IR 68280A
LG-275	Coarse	IR68280A
KSK 133	Coarse	IR68280A
IRRI-GP 275	Coarse	IR58025A
IRRI-GP 2	Coarse	IR58025 A
IR 2053	Coarse	IR70369A
IR 184	Coarse	IR69628A
485-4	Coarse	IR70362A
33897	Basmati	IR68280A, IR70369A
97502	Basmati	IR58025A
49931	Basmati	IR70369A
45287	Basmati	IR58025A
4266	Basmati	SSMS2A

Table 3: Elite genotypes identified as maintainer during 2001 and 2002

Genotype	Group	CMS line (s) used.
Super Basmati	Basmati	IR69628A, IR68280A, SSMS2A, IR70369 A
Basmati. 2000	Basmati	IR69628A, IR68280A
Shaheen Basmati	Basmati	IR58025A, IR68280A
Kernal local	Basmati	IR58025A, IR69628A
52773-2	Basmati	IR68280A
52799	Basmati	IR68280A
OP56/99	Basmati	SSMS2A
98PP50	Basmati	SSMS2A, IR69628
97409	Basmati	IR68280A
99509	Basmati	IR58025A, IR67684A
IR64	Coarse	IR58025A, SSMS2A
PK578-20-1-2-1-1	Coarse	IR58025A
IR60	Coarse	IR68885A,
DR60	Coarse	IR58025A, IR69628A
IR6	Coarse	IR58025A, SSMS1A, SSMS2A
LG116	Coarse	IR68280A
IR9	Coarse	SSMS2A, IR70369A, IR69628A, IR70362A
IR36	Coarse	SSMS2A, IR70369A, IR69628A
DR83	Coarse	SSMS2A
98PP47	Basmati	IR68280A
96408	Basmati	SSMS2A, IR69628A
47456	Basmati	IR58025A
4365	Basmati	SSMS2A, IR70369A
4291	Basmati	SSMS2A, IR68280A, IR69617A
4029-3	Basmati	IR68280A
33797-1	Coarse	IR58025A, IR70362A
LG176	Coarse	IRS8025A
LG60	Coarse	IR68280A
LG78	Basmati	IR68280A, IR70372A
LG184	Coarse	IR68280A
KS282	Coarse	SSMS2A
98PP17	Basmati	IR70372A
98313	Basmati	IR68280A
97502	Basmati	SSMS2A

for these maintainers are given against each in Table 3. Among these 34 maintainers, Super Basmati, Basmati 2000, Shaheen Basmati, IR6 and IR9 are commercial varieties being grown in the Punjab. Except Basmati 2000, all of these varieties can be converted in new CMS lines for the development of hybrid rice. Basmati 2000 is not suitable for the conversion of a new CMS line due to its tallness.

From the perusal of Table 2 and 3, it is depicted that the frequency of maintainers is quite higher than the restorers in the local germplasm. The same results were also found by Ali and Khan (1996 and 1998).

In conclusion, there was a sufficient variability for the recorded economic traits in the evaluated germplasm. We found that local genetic stock has the higher frequency of maintainers than the restorers. For the development of local commercial Basmati rice hybrids, we have to develop the commercially usable CMS lines from the identified maintainers.

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