USE OF TGMS LINES FOR TWO LINE RICE HYBRIDS IN PAKISTAN

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ABSRACT

Six Thermosensitive Genetic Male Sterile (TGMS) lines were evaluated for their sterility / fertility behavior. Three stable TGMS lines were used for floral, morphological, agronomic and quality traits to find out commercially useable TGMS lines for two line hybrid seed production. IR73834-21-26-15-25-4 had shortest plant height (63 cm) with minimum number of tillers per plant (8.0). Phenotypic acceptability was highest for IR73834-21-26-15-25-4, therefore, has the potential for commercial utilization in hybrid seed production. During sterility phase, highest temperature ranged between 39.45^{0}C in May to 31.62^{0}C in October whereas minimum temperature was observed to be 27.64^{0}C in May to 21.64^{0}C in October. However, critical fertility phase may be observed in last decade of October with maximum and minimum temperatures of 28.5^{0}C and 19.57^{0}C, respectively. Critical fertility phase may be extended upto first decade of November. Four TGMS lines i.e. IR73827-23-26-15-7, IR73834-21-26-15-25-4, IR75589-31-27-8-33 and IR76761-4-3-17-34-1 showed TGMS behaviour at Kala Shah Kaku. IR68301-11-6-4-4-3-6-6 and IR76753-41-6-34-13 did not produce any seed and remained un productive throughout the growth period. TGMS lines, IR73827-23-26-15-7, IR75589-31-27-8-33 and IR73834-21-26-15-25-4 showed no difference for leaf blade pubescence, leaf blade colour, legule colour, collar colour, apiculous colour and stigma colour. Anther colour was yellow in IR73827-23-26-15-7. This TGMS line also showed green basal leaf sheath colour as compared to light green in other TGMS line. IR75589-31-27-8-33 had erect flag leaf while horizontal in others. Maximum anther length (2.14 mm) and stigma length (2.0 mm) was observed in IR73834-21-26-15-25-4. Turnucate legule was present in IR73827-23-26-15-7 as compared to 2-cleft legule in others. Straw colour short awns were found only in IR73834-21-26-15-25-4 with intermediate panicle type. However, other TGMS lines showed compact panicle type.

Key word: Two line rice hybrid, TGMS, characteristics

INTRODUCTION

The Chinese experience and the dire need of increasing rice productivity and production encouraged rice scientists to develop and disseminate hybrid rice technology in the tropics. About 2 million ha are presently planted with hybrid rice in India, Vietnam, Philippines, Bangladesh, Myanmar and Indonesia where about 2.0-2.5 million ton of extra paddy is being produced (Ali and Khan, 1994, Sabir and Akhter 2003, Hoan and Nghia 2003, Shihua *et al*.2006, Akhter *et al*., 2007). During the past few decades, another type of male sterility that is sensitive to the environment and is induced by the interaction of environmental factors with nuclear genes has also been used to develop rice hybrids (Virmani and Ilyas-Ahmed 2001). The discovery and application of thermo sensitive genic male sterility has great potential for revolutionizing hybrid seed production technology in rice. TGMS lines have great potential in tropical countries like India. Acknowledge of male sterility mechanism in TGMS lines is essential for hybrid rice development through two line breeding approach. In the tropics TGMS is more practical to use since day length differences are small (Virmani and Ilyas-Ahmed 2001). At IRRI six TGMS–bred lines –IR68301-11-6-4-4-3-6-6, IR73827-2326-15-7, IR73834-21-26-15-25-4, IR75589-31-27-8-33, IR76753-41-6-34-13 and IR76761-4-3-17-34-1 have been found to have a low critical sterility point and are being used to develop two line hybrid for tropical conditions. Additional TGMS lines possessing good phenotypic acceptability and good grain quality are being developed . Efforts are also under way to develop TGMS lines in other tropical countries. India (DRITG-1 to 4 and TS29l;UPRI 95-140 and UPRI 167) Veitnam (UTGMS 6S, VTGMS 7S, VTGMS 8S and VTGMS 11S)and the Phillippines. Vietnam has recently commercialized a two line hybrid (TH 3-3) that is reported to have high yield and good grain quality (Hoan 2004-Pers.Commun)

Evaluation of TGMS lines for floral, morphological and agronomic traits is a pre requisite to find out commercially useable TGMS lines (Virmani *et al* 1997 and Kalaiarasi and Vaidyanathan 2002). TGMS lines with maximum anther length and stigma length may be useful to achieve higher out crossing rate as they correlate positively (Ali *et al.* 1993 and Virmani 1973). Thermosensitivity is a recessive and monogenecally controlled trait and also easily transferable into elite line (Ali and Khan 1997). The objective of the study was to identify commercially useable TGMS lines for two line hybrid seed production.

MATERIALS AND METHODS

Six Thermosensitive Genetic Male Sterile (TGMS) lines were sown on three different dates i.e. 31.5.06, 14.6.06 and 17.6.06 to study the fertility / sterility inducing temperature regimes. Date of transplanting of these trials were10.7.06, 14.7.06 and 22.7.06. Nursery was transplanted in the field in single plots of 2.0 meter length. Pollen studies were carried out in the Hybrid Rice Lab. Rice Research Institute, Kala Shah Kaku under the microscope to observe fertility / sterility status of TGMS lines. For this 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. For spikelet fertility / sterility, 5 panicles of each testcross were covered with butter paper bags to avoid foreign pollen contamination (Virmani *et al*. 1997). Out of six TGMS lines, three promising TGMS lines were evaluated for

a) Floral traits i.e. anther length (mm), anther colour, stigma length (mm), and stigma colour.
b) Morphological traits i.e. leaf blade pubescence (LBP), leaf blade colour (LBC), legule colour, collar colour, apiculous colour, basal leaf sheath colour (BLSC), awn colour and flag leaf angle.
c) Agronomic traits i.e. plant height (cm), number of tillers per plant, 50 % days to flower and phenotypic acceptability.
d) Quality Traits i.e. Paddy length (mm), Paddy width(mm) and Paddy thickness (mm)

RESULTS AND DISCUSSION

It is evident from table 1 that TGMS lines IR 68301-11-6-4-4-3-6-6 and IR 76753-41-6-34-13 showed complete sterility . Temperature was higher than 35 C. These lines could not produce any seed even during critical fertility phase when maximum and minimum temperature ranged between 28 C -19 C. Maximum seed set was observed in IR 76761-4-3-17-34-1 across the dates. However, highest fertility % age was observed in 3rd date i.e. 17-6-06. TGMS lines IR73827-23-26-15-7, IR73834 -21-26-15-25-4 and IR75589-31-27-8-33 showed complete sterility during critical sterility phase with temperature greater than 30°C and showed spikelet fertility during critical fertility phase when temperature ranged between 28 °C-19°C. These results are in line with the research findings of Virmani and Ilyas, (2001).

Table 1: Fertility status of TGMS lines across the dates

TGMS lines	D.O.S 31.5.06	D.O.S 14.6.06	D.O.S 17.6.06
IR68301-11-6-4-4-3-6-6	Remained sterile all the different stages		
IR73827-23-26-15-7	1.98	4.83	5.36
IR73834-21-26-15-25-4	3.35	5.34	7.97
IR75589-31-27-8-33	5.30	5.80	8.72
IR76753-41-6-34-13	Did not flowered		
IR76761-4-3-17-34-1	28.80	38.50	37.11

Table 2: Floral, morphological and agronomic and quality traits of promising TGMS lines

Trait	TGMS LINES		
	IR73827-23-26-15-7	IR75589-31-27-8-33	IR73834-21-26-15-25-4
Floral traits			
Anther length (mm)	2.0	2.0	2.14
Anther colour	Yellow	White	White
Stigma length (mm)	1.77	1.16	2.00
Stigma colour	White	White	White
Pollen sterility (%)	100	100	100
Morphological traits			
Basal leaf sheath colour	Green	Light Green	Light Green
Leaf blade colour	Light Green	Light Green	Light Green
Flag leaf angle	Horizontal	Erect	Horizontal
Auricle colour	Light Green	Light Green	Light Green
Legule length (mm)	9.33	10.5	9.66
Legule colour	White	White	White
Legule shape	Truncate	2-cleft	2-cleft
Collar colour	Light Green	Light Green	Light Green
Panicle type	Compact	Compact	Intermediate
Awn colour	Straw	Straw	Straw
Apiculous colour	White	White	White
Agronomic traits			
Plant height (cm)	77	88	63
No. of tillers / plant	29	16	8
Days to 50% flowering	74	75	49
Phenotypic acceptability	7	5	3
Quality traits			
Paddy length (mm)	9.2	8.4	10.3
Paddy width (mm)	2.2	2.1	1.9
Paddy thickness (mm)	1.9	1.8	1.7

Table 2 indicated that all the three TGMS lines showed no difference for leaf blade pubescence, stigma

colour, leaf blade colour, legule colour, collar colour and apiculous colour. Anther length (2.14 mm) and stigma length (2.0 mm) was highest in IR73834-21-26-15-25-4. Yellow anthers were present in IR73827-23-26-15-7 whereas white in others. Ternucate legule shape was present in IR73827-23-26-15-7 when compared with 2-cleft legule shape in others. Intermediate panicle type was observed in IR73834-21-26-15-25-4. Compact panicle type was evident in others. Straw colour awns were present only in IR73834-21-26-15-25-4. Minimum days to 50% flowering were taken by IR73834-21-26-15-25-4 which had shortest plant height (63 cm) with minimum tillers per plant. Phenotypic acceptability was also highest for IR73834-21-26-15-25-4. Keeping in view floral, morphological and agronomic traits, TGMS line IR73834-21-26-15-25-4 showed the potential for commercial utilization in two line rice hybrids seed production.

REFERENCES

Akhter, M. M. Sabar, M. A. Zahid and M. Ahamd (2007). Hybrid Rice Research and Development In Pakistan. Asian j. of Pl. Sci. (accepted for publication).

Ali, S. S., S. J. H. Jafri and M. A. Butt (1993). Genetic study of allogamic traits in oryza sativa L. MARDI Res.J. 21(1):71-75. .

Ali, S.S., and M.G. Khan (1994). Performance of IRRI rice hybrids at Rice Research Institute, Kala Shah Kaku, Lahore, Pakistan. Inti. Rice Res. Newsletter, 7 (6): 3

ALi, S.S and M.G. Khan (1997). Inheritance studies for thermosensitive male sterility in rice. IRRN 3(1): 17.

Hoan N. T and N. H. Nghia (2003). Development and use of hybrid rice in Vietnam.In:Virmani SS, Mao CX, Hardy B, editors. Hybrid rice for food security, poverty alleviation and environmental protection.

Kalaiyarasi, R and P. Vaidyanathan (2002). Cytological differentiation of TGMS genes expression in rice indica/Japonica derivatives. (2002). Centre for plant breeding and Genetics Tamil Nadu Agricultural university, Coimbatore, India.Proceedings of the 4th international symposium on Hybrid Rice, 14-17 May2002, Hanoi, Vietnam. Los Banos (Phillippines): International Rice Research Institute. P357-371.

Sabar, M. and M. Akhter (2003). Evaluation of rice germplasm for the development of hybrid rice. Asian J. Plant. Sci., 2:1195-1197.

Shihua, C., L. Cao and H. Zhal (2006). Super hybrid rice breeding in China. Presented in the 2nd International Rice Congress, New Delhi. Oct 9-13,2006.

Virmani, S. S. and D. S. Athwal (1973). Genetic variability in floral characteristics influencing outcrossing in oryza sativa L. Crop Sci. 13:66-70.

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.

Virmani SS, M. A. Ilyas (2001). Environment- sensitive genic male Sterility (EGMS) in crops Adv-Agron-72:139-195.

Virmani, S.S. and I. Kumar (2004). Development and use of hybrid rice technology to increase rice productivity in the tropics. IRRN. 29:10-19.