Sterility, Fertility status of TGMS lines in Kerala

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Abstract

A study was conducted to analysis the Sterility/fertility status of TGMS lines in Kerlala. Based on the sterility/fertility behavior of TGMS lines, the entire study period could be classified into two distinct periods *viz*, pollen sterile and pollen fertile months. Pollen sterile months were April and May when 100 per cent sterility was observed . July and August could be considered as pollen fertile months. Those months exhibited unstable expression of sterility/fertility and hence could not be grouped under pollen sterile or pollen fertile months. All seven TGMS lines exhibited 100 per cent fertility from July 2nd week to September Ist week. TGMS lines were fully fertile throughout the year at CRS Pampadumpara. CRS Pampadumpara and College of Horticulture Vellanikkara can be considered as clearly defined fertility, sterility alteration regimes for the TGMS lines. These are the two major desirable locations for the maintenance of TGMS lines and for two line hybrid rice seed production respectively.

Key words

Rice, TGMS , Two line breeding ,Sterility, Fertility

Introduction

Farming always depend upon human induced modifications of the natural world and heterosis , meaning ‘ to alter’ in Greek, is a prime example of technology in the service of agriculture. The green revolution undoubtedly established the technical feasibility of maintaining rice production will ahead of population growth in many developing countries. Recent observations, however , have shown a fall in gains and a sign of stress in intensively cultivated irrigated lands. In order to meet the ever growing demand, about 10 million tonnes of more rice per year has to be produced. New technology frontiers need to be explored to increase rice production in support of food security. Environment friendly and socio economically acceptable technologies need to be developed to optimize the efficient use of water, fertilizer and other inputs and to enhance productivity. Hybrid rice technology offers scope for increasing the yield potential of rice beyond the level of high yielding varieties.

Till date, CMS system has been the most effective for developing rice hybrids in China and elsewhere. However , the inherent limitations associated with CMS system limit the wide spread adoption of this technology (Salgotra *et al*., 2012) .Discovery of EGMS in rice has resulted in two line hybrid breeding system which is simple and more efficient than the three line breeding system. It has the advantage of exploiting freely available fertility restorers in the production of hybrids and it does not need maintainer lines. It’s simple seed producers, low cost and increased vigour are worth mentioning After the

discovery of the first PGMS line Nongken in 1973 several elite PGMS and TGMS lines have been developed in China and two line hybrids have been released for cultivation.

In tropical countries like India , where day length differences are marginal , TGMS system is considered more useful than PGMS system as there is adequate variation in temperature over seasons . After the first reported TGMS lines Annong 1S, Norin PL12 and IR 32364 from China , Japan and IRRI respectively several TGMS lines have been developed from spontaneous mutants induced mutants and by hybridization.

The preliminary step in exploitation of two line system hybrid rice on a large scale is the identification of TGMS lines with stable fertility transformation behavior. The lines with complete pollen sterility under high temperature condition are considered as promising TGMS lines for commercial exploitation .Two line breeding is a viable proposition in a state like Kerala where rice is cultivated from below mean sea level to altitudes of 1500 MSL. Exploiting the difference in temperatureregimes between the higher altitudes and plains , the male sterile lines can be multiplied and hybrids can be produced on a commercial scale.Hence the present study envisaged to identify stable TGMS lines for the development of two line rice hybrids.

MATERIALS AND METHODS

Materials

The materials used in the study comprised seven TGMS lines collected from Paddy Breeding Station, Tamil Nadu Agricultural University, Coimbatore. The details of the genotypes are given in Table 1. Evaluation was carried out at two locations namely College Of Horticulture Vellanikkara, Cardamom Research Station, Pampadumpara.

Methodology

Sequential sowing of TGMS lines was done from second week of March 2011 to second week of March 2012. Twenty five days old seedlings were transplanted in single seedlings per pots. Five plant per entry were maintained. Manures and plant protection chemicals were applied as recommended in the Package of Practices Recommendations: Crops, Kerala Agricultural University (2010). Observations on morphological characters were recorded on each of five plants per entry. Pollen sterility/fertility behavior was studied in relation to weather parameters collected from the Department of Meteorology, College of Horticulture Vellanikkara.

Table 1. List of TGMS lines taken for evaluation

Sl.No	TGMS lines	Source
1	TGMS 74S	TNAU, Coimbatore
2	TGMS 81S	TNAU, Coimbatore
3	TGMS 82S	TNAU, Coimbatore
4	TGMS 91S	TNAU, Coimbatore
5	TGMS 92S	TNAU, Coimbatore
6	TGMS 93S	TNAU, Coimbatore
7	TGMS 94S	TNAU, Coimbatore

The lines were evaluated for various morphological characters, spikelet characters and sterility/fertility behaviour during the year 2011 March to 2012 March. The data were subjected to statistical analysis and the results are presented below.

Sterility/fertility behavior

Weekly sterility/fertility pattern of TGMS lines are presented in **Table 2.**

Table 2. Sterility/ fertility behaviour of TGMS lines at COH Vellanikkara 2011-2012

Month (week)	**TGMS 74S**	**TGMS 81S**	**TGMS 82S**	**TGMS 91S**	**TGMS 92S**	**TGMS 93S**	**TGMS 94S**	**Remarks (7TGMS LINES)**
March								
1	79.17	83.33	88.88	83.72	62.79	61.54	82.61	**PF-PS**
2	83.33	89.47	92.68	86.05	67.44	64.10	86.96	**PF –S**
3	94.44	98.20	95.12	90.69	69.56	69.23	91.30	**PF-S**
4	99.50	100	100	93.02	73.91	84.21	95.65	**PS-CS**
Average	**89.11**	**92.75**	**94.17**	**88.37**	**68.43**	**69.77**	**89.13**	
Remarks	**PS**	**S**	**S**	**PS**	**PF**	**PF**	**PS**	
April								
1	100	100	100	93.48	86.96	91.30	100	**PS to CS**
2	100	100	100	100	100	100	100	**CS**
3	100	100	100	100	100	100	100	**CS**
4	100	100	100	100	100	100	100	**CS**
Average	**100**	**100**	**100**	**98.37**	**96.74**	**97.83**	**100**	
Remarks	**CS**	**CS**	**CS**	**S**	**S**	**S**	**CS**	
May								

1	100	100	100	100	100	100	100	**CS**
2	100	100	100	100	100	100	100	**CS**
3	100	100	100	100	100	100	100	**CS**
4	100	100	100	100	100	100	100	**CS**
Average	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**CS**
Remarks	**CS**	**CS**	**CS**	**CS**	**CS**	**CS**	**CS**	
June								
1	100	100	100	100	100	100	100	**CS**
2	100	100	100	100	100	100	100	**CS**
3	83.72	65.12	78.72	65.21	25.53	28.26	29.27	**F to PS**
4	48.78	37.04	68.75	30.00	15.63	13.95	11.11	**F to PF**
Average	**83.13**	**75.54**	**86.88**	**73.80**	**60.29**	**60.55**	**60.09**	
Remarks	**PS**	**PS**	**PS**	**PS**	**PF**	**PF**	**PF**	
July								
1	10.71	14.29	38.46	14.29	09.76	10.64	09.30	**FF-PF**
2	0	0	0	0	0	0	0	**FF**

3	0	0	0	0	0	0	0	**FF**
4	0	0	0	0	0	0	0	**FF**
Average	**2.68**	**3.57**	**9.62**	**3.57**	**2.44**	**2.66**	**2.33**	
Remarks	**FF**	**FF**	**FF**	**FF**	**FF**	**FF**	**FF**	
August								
1	0	0	0	0	0	0	0	**FF**
2	0	0	0	0	0	0	0	**FF**
3	0	0	0	0	0	0	0	**FF**
4	0	0	18.42	26.32	0	0	0	**F**
Average	**0**	**0**	**4.61**	**6.58**	**0**	**0**	**0**	
Remarks	**FF**	**FF**	**FF**	**FF**	**FF**	**FF**	**FF**	
September								
1	39.95	34.75	31.71	41.30	42.85	47.62	30.00	**F –PF**
2	42.31	37.04	34.04	43.38	48.72	58.97	28.70	**F-PF**
3	46.88	39.29	36.17	47.83	53.85	61.54	30.10	**F-PF**
4	57.69	46.34	41.30	63.04	65.79	61.54	63.16	**PF**
Average	**46.71**	**39.36**	**35.79**	**48.89**	**52.80**	**57.42**	**37.99**	
Remarks	**PF**	**PF**	**PF**	**PF**	**PF**	**PF**	**PF**	

October								
1	65.12	43.48	42.86	66.66	68.00	65.21	65.79	**PF**
2	71.40	45.65	46.15	68.29	69.56	67.39	67.39	**PF**
3	80.00	46.43	47.22	74.42	73.91	73.91	68.00	**PF -PS**
4	85.00	47.05	48.15	76.74	76.08	78.95	72.34	**PF - PS**
Average	**75.38**	**45.65**	**46.09**	**71.53**	**71.89**	**71.37**	**68.38**	
Remarks	**PS**	**PF**	**PF**	**PS**	**PS**	**PS**	**PF**	
November								
1	86.05	45.83	51.22	82.98	76.08	82.05	76.47	**PF – PS**
2	88.00	46.15	53.66	84.78	78.95	83.72	77.77	**PF – PS**
3	90.69	46.43	56.09	86.96	86.84	85.19	81.25	**PF – S**
4	91.18	46.51	57.45	89.13	89.74	87.50	83.33	**PF – S**
Average	**88.98**	**46.23**	**54.61**	**85.96**	**82.90**	**84.62**	**79.71**	
Remarks	**PS**	**PF**	**PF**	**PS**	**PS**	**PS**	**PS**	

December								
1	92.31	46.81	58.97	90.00	93.02	88.00	84.21	**PF – S**
2	93.02	48.94	60.87	90.90	95.35	91.49	86.84	**PF – S**
3	95.35	61.70	55.32	84.37	97.67	93.62	87.18	**PF –S**
4	97.67	63.83	48.84	90.24	97.83	95.74	89.74	**PF - S**
Average	**94.59**	**55.32**	**56.00**	**88.88**	**88.47**	**92.22**	**86.99**	
Remarks	**CS**	**PF**	**PF**	**PS**	**PS**	**S**	**PS**	
January 12								
1	94.87	48.15	83.72	84.78	95.55	95.83	82.93	**PF-S**
2	97.43	54.17	65.00	86.96	95.74	96.15	85.37	**PF – S**
3	88.00	66.66	60.00	87.23	96.15	97.37	87.80	**PF – S**
4	88.88	90.00	65.12	89.36	95.83	97.56	48.84	**PF - S**
Average	**92.30**	**64.75**	**68.46**	**87.08**	**95.82**	**96.73**	**76.24**	
Remarks	**S**	**PF**	**PF**	**PS**	**S**	**S**	**PS**	
February								
1	41.46	38.46	42.55	11.63	12.50	35.71	16.66	**FF-PF**
2	43.90	36.84	55.32	12.50	17.86	42.31	36.11	**FF-PF**

3	48.84	53.85	59.57	43.75	21.43	53.13	61.11	**F-PF**
4	55.81	76.08	81.39	62.50	53.85	59.26	72.22	**PF-PS**
Average	**47.50**	**51.28**	**59.71**	**32.59**	**26.41**	**47.60**	**46.53**	
Remarks	**PF**	**PF**	**PF**	**PF**	**F**	**PF**	**PF**	

CS:Complete sterile, S:Sterile, PS:Partially sterile, PF:Partially fertile, F:Fertile

Influence of weather parameters on sterility/fertility

The sterility/fertility behaviour of TGMS lines were studied in relation to weather parameters namely, maximum temperature, minimum temperature, sunshine hours, relative humidity and rainfall. Abstract of monthly weather data is given in **Table 3.**

Table 3. Monthly weather data of COH Vellanikkra (2011-2012)

Month	**Maximum Temperature (^{0}C)**	**Minimum temperature (^{0}C)**	**Relative humidity (%)**	**Sunshine hours**	**Rainfall (mm)**
March -11	34.8	23.9	43	8.7	010.0
April	34.3	24.5	58	6.6	207.1
May	33.0	24.9	63	6.8	198.5
June	29.3	23.6	82	2.5	799.6
July	29.1	22.5	81	1.6	500.2
August	29.4	22.9	78	2.2	713.0

September	30.0	23.1	75	5.4	435.2
October	31.1	23.5	65	6.1	193.0
November	31.4	22.9	57	6.3	240.0
December	31.9	21.9	49	7.3	002.4
January -12	32.8	21.3	58	9.5	000.0
February	35.1	22.1	54	9.2	000.0
March-12	35.2	24.2	67	7.6	003.5

Among the seven TGMS lines, TGMS 74S, TGMS 81S, TGMS 82S and TGMS 94S showed completely male sterile (100 per cent) during April first week to June second week. TGMS 91S, TGMS 92S and TGMS 93S showed completely male sterile (100 per cent) from April second week to June second week. On visual inspections, white coloured non dehiscent anthers were noted and no seed was set in the bagged panicles.

June third week onwards slowly changed to fertile condition to partial fertile and all TGMS lines showed 100 % fertile from July second week to August third week. During this period the anthers were yellow and dehiscent. Seeds were produced in the bagged panicles. Fertile pollen grains which were spherical and stained were noted mixed with lightly stained and spherical unstained pollen grains.

Sterility/fertility pattern of TGMS lines was studied for the twelve months during March 2011 to March 2012 and the results are shown in **Table 4**

Table 4. Monthwise sterility/fertility status

TGMS LINES	TGMS 74S	TGMS 81S	TGMS 82S	TGMS 91S	TGMS 92S	TGMS 93S	TGMS 94S
March	PS	S	S	PS	PF	PF	PS
April	CS	CS	CS	S	S	S	CS
May	CS	CS	CS	CS	CS	CS	CS
June	PS	PS	PS	PS	PF	PF	PF
July	FF	FF	FF	FF	FF	FF	FF
August	FF	FF	FF	FF	FF	FF	FF
September	PF	PF	PF	PF	PF	PF	PF
October	PS	PF	PF	PS	PS	PS	PF
November	PS	PF	PF	PS	PS	PS	PS
December	CS	PF	PF	PS	PS	S	PS
January	S	PF	PF	PS	S	S	PS
February	PF	PF	PF	PF	F	PF	PF
March	PS	S	S	PS	PF	PF	PS

Sterility/fertility behaviour.

The two-line system simplifies the production of hybrid, since only pair of pure fertile and sterile lines are required. It can also eliminate the potential negative effects associated with the CMS. Furthermore, the nuclear genes responsible for sterility are relatively easy to be transferred to diverse genetic background. However, owing to the limitation of the temperature and/or photoperiod requirement, an EGMS line can only be used in a relatively narrow zone, and suitable sterile lines must be developed for a target production environment (He *et al.*, 2006). Therefore characterization of TGMS lines with respect to their fertility / sterility alteration behaviour will provide clear cut idea of utilization of that particular line for predicting appropriate timings for hybridization programme (at sterile phase) as well as seed multiplication (at fertile phase).

Based on sterility /fertility behaviour the entire study period of 2010 March to 2011 March can be grouped as two distinct periods *viz* pollen sterile and pollen fertile . In the present study the pollen sterile months indicated April, May when 100 per cent sterility was observed . July and August can be considered as pollen fertile months. other months exhibited un stable expression of sterility /fertility and hence could not be grouped under pollen sterile or pollen fertile months. In the present study the sterile period was longest in TGMS 82S (87 days) followed by TGMS 81S (83 days). Since all these lines were completely sterile for more than 30 consecutive days during sterile phase hybrid seed production utilizing these lines can be taken up at COH Vellanikkara by raising the lines in such a way that following coincides with the sterile phase.

All the lines reverted in to fertile from July 2nd week to September I st week . In the present study all lines exhibited 100 per cent pollen fertility during the periods .Since all these were completely fertile for more than 30 consecutive days

during fertile phase multiplication of TGMS lines with purity standard will be easier for these lines. Lu *et al*. (1998) suggested that for successful utilization of TGMS lines the sterile and fertile phase should be atleast for 30 consecutive days. Similar findings was reported by Latha *et al*. (2004) in TS6 completely sterile for 78 consecutive days and reverted to fertile for continuously 69 days in the same Coimbatore location.

References

He, H., Peng, X., Gong, H., Zhu, C. and Ye, G. 2006. Fertility behaviour of rice (*Oryza sativa)* lines with dominant male sterile gene and inheritance of sterility and fertility restoration. Field crops Res. 98(1): 30-38.

Latha, R., Thiyagarajan, K. and Senthilvel, S. 2005. Critical temperature and stages of fertility alteration in TGMS lines of rice. 4th *International Crop Science Congress*.pp 1-6

Lu, X.G., Virmani, S.S. and Rencui, Y. 1998. Advances in Two line hybrid rice breeding.pp. 89-98. In: S. S.Virmani, E. A. Siddiq and K.Muralidharan (eds.). Advances in Hybrid Rice Technology. International Rice Research Institute, Manila, Philippines.

Salgotra, R.K., Gupta, B.B. and Ahmed, M.I. 2012. Characterization of thermosensitive genic male sterility (TGMS) rice genotypes(*Oryza sativa* L.) at different altitudes. Aust J. of crop sci. 6(6):957-962.