

Evaluation of stable performance of cytoplasmic male sterile lines in rice

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ABSTRACT

The experiment was conducted to evaluate the stability of cytoplasmic genic male sterility of different male sterile lines for floral traits and same yield contributing characters. Total eight CMS lines including seven Indian and one IRRI, Philippines were raised during wet season 2007. All the eight CMS lines showed 100 percent pollen sterility. The highest angle of floret opening was recorded by KJT 2A. The maximum stigma exsertion was observed in the CMS line KJT 4 A while KJT 1 A, KJT 6A and KJT 7 A had predictability to perform in favorable environment. KJT 5 A had highest panicle exsertion. It was observed that KJT 4 A CMS line performed better in most of the desirable characters which offer scope of utilizing this male sterile lines for development of three line hybrid in rice.

Key words: rice CMS lines, pollen sterility, stigma exsertion

Successful development of hybrid rice depends on improvement of parental lines, A, B and R. Though the cytoplasmic male sterility has several advantages, it has some limitations too. These lines are highly sensitive to environmental conditions resulting in fertile pollen production which leads to selfing. Natural out crossing in CMS lines is also not satisfactory. Therefore emphasis has to be given to develop region specific indigenous male sterile lines hence an attempt was made to evaluate different cytoplasmic genic male sterile lines, for adaptability, stability of pollen and spikelet fertility, agronomic characteristics for developing three line hybrids in rice.

MATERIALS AND METHODS

The experimental material consisted of eight CMS lines of rice, viz. KJT 1A, KJT 2A, KJT 3A, KJT 4A, KJT 5A, KJT 6A, KJT 7A and IR 58025 A were collected from Regional Agricultural Research station, Karjat. The experiment was conducted during wet season 2007 at College of Agriculture, Dapoli, Maharashtra in randomized block design with four replications over five environments created through the transplanting of different age seedlings i.e. 15, 20, 25, 30 and 35 days old. Seedlings were transplanted by keeping 20 cm. distance between rows and 15 cm distance between plants. Each CMS line was transplanted in three rows

with twenty plants per row. Recommended dose of fertilizer i.e. 100 kg N, 50 kg P₂O₅ and 50 kg K₂O ha⁻¹ was applied. Observations were recorded for days to 50% flowering, plant height, panicle numbers plant⁻¹, length of filament, pollen sterility, angle of floret opening, stigma exsertion, panicle exsertion, spikelet sterility and total number of spikelet panicle⁻¹. About 10-15 spikelets from the fresh emerged panicle of all the plants of each CMS line were collected and examined under microscope with 1 % Iodine Potassium Iodide (IKI) solution. For pollen fertility assessment five panicles plant⁻¹ were evaluated for natural seed set per cent. Panicles emerging from the sheath were bagged with butter paper bag prior to anthesis to prevent cross pollination. Bagged panicles were harvested to assess spikelet sterility per cent. The data so collected were analyzed by using stability model of Eberhart and Russell (1966).

RESULTS AND DISCUSSION

Length of filament ranged from 5.22 mm. (KJT 1A) to 7.89 mm (IR-58025 A). Stability performance parameters showed that the lines KJT 2A (6.59 mm) and KJT 5A (6.32 mm) had recorded higher filament length over population mean with regression coefficient around unity and non-significant S²d_i component indicating average stability for this character (table 1).

Anand Kumar *et. al.* (1989) reported CMS lines in general had smaller stamens and pistil than their maintainers. All the CMS lines showed 100.0 percent pollen sterility under all the five environments. As there was no variability among the CMS lines for pollen sterility, stability parameters could not be worked out. In regards to angle of floret opening KJT 4 A (28.66°) recorded higher angle of floret opening than population mean with regression coefficient less than unity and non-significant S²di components indicating adaptability under unfavorable environment. The lines KJT1 A (28.52°), KJT 2 A (31.61°) and KJT 5A (29.22°) had recorded more angle of floret opening over population mean but unpredictability in performance due to significant S²di component. Parmar *et. al.* (1979)

75.32 cm (IR 58025 A) to 86-91 cm (KJT 1A). From the data it was seen that KJT 1 A and KJT 6 A had average stability. While KJT 7 A was suitable over favorable environment. Dushyanth and Shadakshar (2006) reported that both liner and non-linear components were significant for plant height. The mean of all population over environments in respect of panicle numbers per plant was found to be 15.64. The range of population mean for this trait was 14.58 (KJT 5A) to 17.39 (KJT 4 A). The highest number of panicle per plant was recorded by cms line KJT 4 A. KJT 1 A, and KJT 4 A are best suited to unfavorable environments. Even though KJT 3 A recorded less number of panicles, it had better stability over general environment. The pooled mean values for spikelets sterility per cent

Table 1. Stability performance of floral traits of CMS lines in rice.

CMS lines	Length of Filament (mm)			Pollen sterility (%)	Angle of floret opening (°)			Stigma exertion (%)			Panicle exertion (%)		
	Mean	bi	S ² di		Mean	bi	S ² di	Mean	bi	S ² di	Mean	bi	S ² di
KJT 1A	5.22	0.626	0.011	100	28.52	0.711	1.141 *	46.17	1.152	0.169	80.41	0.375	0.116
KJT 2A	6.59	1.461	-0.005	100	31.66	0.138	0.391*	44.15	1.089	0.744	80.44	0.99	1.333*
KJT 3A	5.63	0.655	0.005	100	28.03	1.397	-0.02	42.50	0.717	0.168	81.36	0.742	0.007
KJT 4A	5.30	-0.672	-0.003	100	28.66	0.413	-0.03	47.70	1.578	1.777**	81.96	1.432	4.323*
KJT 5A	6.32	1.955	-0.009	100	29.22	0.443	0.581**	44.44	0.221	0.145	82.09	0.735	-0.392
KJT 7A	5.73	1.432*	-0.008	100	27.16	1.103	0.091	46.43	1.659	-0.562	80.91	-0.004	-0.01
KJT 7A	6.41	7.282*	0.001	100	27.91	0.822	-0.092	45.89	1.309	0.805	80.64	0.82	-0.461
IR 58025A	7.89	-1.874	-0.002	100	26.62	1.974	1.158**	43.99	0.276*	-0.918	78.34	2.903	2.196**
CD at 5 %	0.10	-	-		0.77	-	-	1.20	-	-	1.21	-	-

*Significant at 5 % level, ** significant at 1% level.

reported angle of floret opening varied from 25° to 35°. The pooled mean values of stigma exertion ranged from 42.59 per cent (IR-58025 A) to 47.70 per cent (KJT 4A). The maximum stigma exertion was noticed in KJT 4 A (47.70%) cms line followed by KJT 6A (46.43%). Stability performance revealed that the line KJT 1A (46.70 %) and KJT 7 A (45.89%) had recorded higher stigma exertion over population mean with bi value around unity and non-significant S²di indicated average stability for this trait over all the environments. Stigma exertion is the most important trait that influences the rate of natural out crossing in cms line. As the stigma exertion is higher, ultimately increases the hybrid rice seed production. Jayanani and

Rangaswamy *et. al.* (1999) reported 28.33 per cent stigma exertion in IR 66077 A cms line and Sahai *et. al.* (1984) reported stigma exertion 25 to 35 per cent.

Stability performance of yield contributing characters are presented in table 2. From the data it was observed that the pooled mean values for days to 50% per cent flowering ranged from 86.6 days (KJT 4A) to 101.65 days (KJT 6A and KJT 7 A) KJT 1 A (88.3 days) had earlier days to 50 per cent flowering as compared to population mean with unit regression coefficient and non significant S²di components therefore selection should be done for general environment and showed average stability. In regards to plant height mean values of cms lines ranged from

Table 2. Stability performance of yield components of CMS lines in Rice.

CMS lines	Days to 50% flowering			Plant height (cm)			Panicles plant ⁻¹			Spikelet Sterility %			Spikelets panicle ⁻¹		
	Mean	bi	S ² di	Mean	bi	S ² di	Mean	bi	S ² di	Mean	bi	S ² di	Mean	bi	S ² di
KJT 1A	88.30	0.979	0.02	86.91	0.944	0.555	16.38	-1.519*	0.162	100	0.227*	-0.005	359.6	2.496	91.06
KJT 2A	93.20	1.088	0.35*	78.03	1.675	6.591*	14.99	1.693	0.605	100	0.227*	-0.005	223.5	0.624	4.763
KJT 3A	100.60	1.077	1.283**	83.78	0.787	1.447	15.01	1.084	-0.026	100	0.227*	-0.005	250.8	-0.53	-25.3
KJT 4A	86.60	0.821	0.368*	85.21	0.094*	-1.963	17.39	-0.082	-0.171	100	0.227*	-0.005	360.7	0.577	-39.4
KJT 5A	88.15	1.213	0.873**	85.44	0.68	0.46	14.58	1.206	-0.013	99.6	5.601	0.006	262.8	0.009	-45.6
KJT 6A	101.65	0.981	0.117	84.42	0.924	2.818	15.16	2.375	0.574	100	0.227*	-0.005	234.7	1.318	-10.0
KJT 7A	101.65	1.032	0.213	83.76	1.591*	-2.244	14.90	1.981	0.368	99.6	2.052	0.001	245.1	0.941	-32.3
IR 58025A	89.95	0.809	0.543*	75.32	1.307	0.445	16.72	1.262	1.132*	99	1.024	0.002*	256.5	2.571	7.049
CD at 5 %	0.84	-	-	1.98	-	-	0.97	-	-	0.077	-	-	7.55	-	-

*Significant at 5 % level, ** significant at 1% level.

ranged from 99 (IP-58025 A) to 100 percent. All the CMS lines showed 100 per cent spikelets sterility except IR-58025 A. In regards to IR- 58025 A cms line one can not predict the performance due to significant non-linear component. Sawant *et. al.* (2006) reported that IR 54755 A, D 297 A and IR 66707 A, were completely pollen sterility and had zero spikelet fertility and hence highly stable. The maximum total number of spikelets per panicle was recorded by line KJT 4 A (360.7) followed by KJT 1 A (359.9). From the data it was seen that KJT 1 A had well adaptability in good environment while KJT 4 A had better adaptability in poor environment. Ahmed *et. al.* (1998) reported that IR 58025 A and IR 62829 A showed better performance for this character. Panicle exertion is the most important trait that affects the rate of out crossing in male sterile lines. The pooled population mean for panicle exertion in CMS line was 80.77 per cent, while it was ranged from 78.34 (IR 58025 A) to 82.09 (KJT 5A) per cent. The CMS lines KJT 5 A and KJT 3 A had average stability for this trait. Pradhan and Jachuk (1993) reported panicle exertion varied from 64.30 per cent in PMS 1 A to 97.00 per cent in PMS 5 A. From the present investigation it was concluded that none of the line showed general adaptability for all the floral attributes, flowering characters and yield contributing characters over pooled environments. However KJT 4 A CMS line performing better in most of the desirable characters and in most of the environment also, hence this line may be utilize for development of hybrid rice breeding programme.

REFERENCES

- Ahmed MI, Singh S, Virakthmath BC, Ramesh MS and Vijaykumar CHM 1998. Studies on comparative stability of CMS lines. *Int. Rice Res. Newsl.* 23(1):5
- Anandkumar CR, Sundrappa G and Subramaniyam M 1989. Floral character of CMS and maintainer lines in hybrid rice. *Int. Rice. Res. Newsl.* 14(2):6
- Dushyanth B and Shadakshar Y 2006. Stability analysis for grain yield and yield components of rice (*Oryza sativa* L.) in low land of hill zone of Karnataka. *Indian J. Genet.* 66(2):141-142
- Eberhart SA and Russell WA 1966. Stability parameters for comparing varieties *Crop Science.* 6: 36-40
- Jayanani PK, Rangaswamy P, Latha P, Suthamathi P and Thiagarajan K 1999. Stability of cytoplasmic male sterile lines in rices. *J. Agric. Issues.* 10(2):35-40
- Parmar KS, Siddiq EA and Swaminathan MS 1979. Variation in components of flowering behavior of rice (*Oryza sativa* L.) *Indian J. Genet.* 39(3):542-550
- Pradhan SB and Jachnk PJ 1993. Line for shallow rainfed lowland condition. *Int. Rice Res. Newsl.* 18(1):15
- Sahai VN, Saran S and Chaudhary RC 1984. Hybrid rice reaserch in Bihar. *INT. Rice Res. Newsl.* 12(2):23.
- Sawant DS, Shetye VN and Desai SS 2006. Studies on relative stability of cytoplasmic male sterile lines and their floral traits influencing out-crossing in rice (*Oryza sativa* L.) *International Journal of Plant Science.* 1(2): 150-153.