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Morphological Characterization of New Parental Lines (AxB) of Rice for their Production Potential (*Oryza sativa* L.)

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Abstract

In the present study, eight CMS lines and their isogenic maintainers in rice were evaluated for morphological characteristics to know their production potential in comparison with standard check CMS line (KCMS 62A). The results revealed that A lines took more number of days to 50 per cent flowering (95.37days) than the corresponding B lines (93.75 days). All the CMS lines were short statured (87.81 cm) than their corresponding maintainers (96.05 cm). Number of panicles per plant (14.84) was more in B lines than in A lines (13.12). Higher test weight was recorded in KCMS58A (25.97 g) and was lower in KCMS59A (16.19g). More number of spikelets per panicle was observed in KCMS53A (207). Higher seed yield per plant was recorded in KCMS57A (4.95 g) as compared to check KCMS62A (4.91 g) and higher panicle exertion was noticed in KCMS59A.

Keywords : Rice, CMS lines, Maintainer lines, Morphological traits, Panicle exertion

Rice (*Oryza sativa* L.) belongs to the family Poaceae, has been designated as a 'Millennium Crop' and is expected to contribute to global food security in the world, as it is one of the staple cereal crops and a primary source of food for more than half of the world's population. With the world's population growing at an alarming rate, the demand for rice is expected to rise further in the near future (Ramesh *et al*., 2020). It is thought to have originated in South East Asia. It is a healthy cereal crop that provides 20 per cent of calories and 15 per cent of protein and is consumed by half of the world's population. India is the world's second-largest producer and consumer of rice. Rice is the main source of food for more than half of the world's population (Allam *et al*., 2018). Rice is also the most important and dependable food crop in India, feeding more than two-third of the population. The slogan 'Rice is Life' is most appropriate for India because this crop provides a living for millions of rural households. The country grows rice in 43 million ha area with production of 118.43.

Million tonnes and average productivity of 2.75 t ha^{-1} (Anonymous, 2020). Currently, the world's population of around 6.5 billion is expected to exceed eight billion by 2030, necessitating a 40 per cent increase in rice productivity to meet the population boom (Bhavsar *et al*., 2017). In order to meet the challenge of producing additional rice from the available cultivable land, high yielding rice hybrids are to be developed for which potential CMS lines with greater yield stability are required so that self-sufficiency in food supply in rice-growing countries could be achieved. Rice hybrids provide an opportunity to increase rice yield potential because it has a yield advantage of 15-20 per cent over conventional high yielding varieties. In hybrid rice research, the most effective and stable system for developing rice hybrids is the CGMS or 3-line system. WA (Wild Abortive) male sterile cytoplasm has been used every year in more than 93 per cent to the total area under rice hybrids in China in the introduction of hybrid rice technology (Khush and Brar, 2002). In India, however, the majority of hybrids released are based on the WA-CMS lines. Due to their uniform, narrow genetic foundation, hybrid rice production issensitive to pests and diseases (Xiao *et al.,* 1998). Because rice is a self-pollinated crop, seed yield in hybrid seed production plots is very low (1.5 t/ha) and it is primarily determined by out crossing and out crossing is predicted by the morphological and floral characteristics of CMS lines. Currently, varietal identification based on morphological traits are considered as the most widely used for certain germplasm and genotype management applications (Pramila *et al.,* 2011). As a result, morphological characterization of new hybrid rice parental lines (AxB) for their production potential is important in order to increase seed yield and hybrid seed production.Therefore, the present research study was undertaken to evaluate the morphological and floral characteristics of new parental lines (AxB) of rice for their production potential.

Material and Methods

Studies on evaluation of new CMS lines and their maintainer lines in rice was conducted during *kharif* 2019 at Zonal Agricultural Research Station, V.C. Farm, Mandya, University of Agricultural Sciences, Bangalore. In the current study, 7 CMS lines and one check (KCMS62A) were evaluated for various morphological characteristics. To achieve synchronization, all CMS lines (A lines) were sown on 29th July 2019 and their corresponding maintainer lines were sown on 1st August 2019. On 22nd August 2019, seedlings of both lines were transplanted in spacing of 15 cm x 15 cm. The observations were made on five randomly selected CMS lines and their maintainers for various morphological characteristics, namely, days to 50 per cent flowering, plant height (cm), number of tillers per plant, flag leaf length (cm), flag leaf width (cm), number of panicles per plant, panicle length (cm), panicle weight (g), seed yield per plant, 1000-seed weight (g). The analysis of variance for all the characteristics was carried out as per

Table 1

List of CMS lines used for the study

A lines	B lines
KCMS57A	KCMS57B
KCMS53A	KCMS53B
KCMS58A	KCMS58B
KCMS59A	KCMS59B
KCMS60A	KCMS60B
KCMS61A	KCMS61B
KCMS54A	KCMS54B
KCMS62A	KCMS62B

Plate 1: General view of the experimental plot

Randomized Block Design with three replications (Panse and Sukathme, 1967).

Days to 50 per cent Flowering : Number of days from sowing day to the day when 50 per cent of plants in a row exerted their panicles is expressed in days to 50 per cent flowering.

Plant Height (cm) : The height of the plant from the base of the stem at ground level to the leaf tip of the panicle was recorded for five randomly selected plants at the time of maturity and the mean value was expressed in centimeters.

Number of Tillers per Plant : The total number of tillers produced in a plant including both productive and unproductive tillers was counted from five randomly selected plants in productive tillers at harvesting and mean values were calculated.

Number of Panicles per Plant : It is the total number of panicles in each plant was recorded at maturity.

Panicle Length : Length of the panicle was measured in centimeter from the tip of the panicleto the ciliate ring at the base.

Panicle Weight : Panicles of the main tillers of the five tagged plants were weighed in weighing balance and mean value was expressed in grams.

Days to Maturity : Number of days taken by each CMS lines and their respective maintainer lines from the date of sowing to its maturity was recorded and expressed in days.

Panicle Exertion : was recorded based on the total number of spikelets present in panicles and number spikelets present inside the flag leaves and calculated as per cent panicle exertion.

Number of Spikelets per Panicle : The total number of filled and unfilled spikelets per panicle were counted and expressed in numbers both in A line and B line.

Number of Filled Spikelets per Panicle : The total number of filled spikelets per panicle were counted and expressed in number.

Seed Yield per Plant (g) : Five randomly selected plants in each entry were cut above the soil surface and threshed individually. The seeds so obtained were weighed in the grams and mean was worked out.

Test Weight (g) : Weight of thousand randomly selected filled grains from CMS lines and B lines were recorded in grams.

Seed Setting per cent : The seed set per cent was calculated by using the following formula.

$$\text{Per cent seed setting} = \frac{\text{No.of filled spikelets}}{\text{No of filled + unfilled spikelets}} \text{ X } 100$$

Results and Discussion

Comparison of the mean performance of 7 CMS lines with their maintainers based on floral characteristics and morphological traits are shown in Table 2. In general, for 50 per cent flowering, CMS lines took more number of days (95 days) than their corresponding maintainers (93 days), the synchronization of flowering of A line and B line on the same day is the most desirable characteristic of CMS lines. Among the CMS lines KCMS62A and its maintainer line KCMS62B found early in flowering. It is speculated that sterile cytoplasm has resulted in delayed heading and impacted flowering. The present observations are consistent with the previous findings of Gireesh *et al.* (2010) and Tejbir (2016) in rice. Generally, the CMS lines had shorter plant height compared to maintainer lines. On an average B lines were taller than their respective A line. Among A lines, KCMS59A was taller (97.13 cm) followed by KCMS61A (94.27 cm) and KCMS60A (90.80 cm), while in check, KCMS62A (78.53 cm) was shorter than KCMS62B (88.13cm). Among B lines, KCMS57B was taller (104.07 cm) followed by KCMS61B (103.07 cm). Total number of tillers and

Table 2

Mean performance of new cytoplasmic male sterile lines and their maintainers of rice on days to 50 per cent flowering, plant height (cm), total number of tillers and number of panicles per plant

CMS LINES	B lines	Days to 50 % flowering		Plant height (cm)		Total number of tillers		Total number of panicles/plant	
		A	B	A	B	A	B	A	B
KCMS57A	KCMS57B	94	93	89.20	104.07	20.93	21.57	15.77	15.22
KCMS53A	KCMS53B	96	94	81.73	91.53	16.00	17.05	13.30	13.80
KCMS58A	KCMS58B	95	94	89.33	97.47	15.25	16.30	8.47	13.67
KCMS59A	KCMS59B	97	96	97.13	97.00	19.26	18.60	15.10	14.57
KCMS60A	KCMS60B	95	94	90.80	93.80	18.23	18.67	14.47	15.67
KCMS61A	KCMS61B	96	94	94.27	103.40	18.26	17.19	12.80	16.00
KCMS54A	KCMS54B	97	94	81.47	93.00	16.53	17.52	13.30	14.00
KCMS62A	KCMS62B	93	91	78.53	88.13	18.86	20.37	11.73	15.80
GRANDMEAN		95.37	93.75	87.81	96.05	17.91	18.41	13.12	14.84
SEM +/-		1.060	0.177	0.85	1.28	1.44	0.83	0.77	0.74
CD (P=0.05)		3.544	0.591	2.59	3.90	4.36	2.53	2.32	2.24
CV (%)		3.102	0.532	2.32	3.19	19.11	10.79	13.89	11.85

the mean number of panicles were higher in KCMS57A (20.93) and lower in KCMS58A (15.25), similar results were observed by Salgotra *et al*. (2009).

In general, number of panicles was higher in B lines than A lines. Among A lines, KCMS59A had the longest panicle (23.26 cm) followed by KCMS57A (23.10 cm), KCMS62A (22.84 cm), KCMS54A (22.63 cm) and KCMS61A (22.60 cm), while, KCMS58A had shortest panicle length (21.08 cm). Among all the B lines longer panicle length was seen in KCMS60B (23.64 cm) followed by KCMS59B (23.33 cm), KCMS57B (23.11 cm) while; KCMS58B had recorded shorter (21.17 cm) panicle length (Table 3).

Higher panicle weight was recorded by B lines compared to A lines. Among the B lines KCMS58B (3.80 g) has recorded highest panicle weight followed by KCMS57B (3.38 g), KCMS61B (3.29 g) while; KCMS53B had lower (3.03 g) panical weight. Among the CMS lines, higher (2.78 g) panicle weight was recorded in KCMS58A and was lower (2.19 g) in KCMS 53A. Standard check KCMS62A and B lines had (2.37 and 3.12 g) panicle weight, respectively (Table 3). Similar trend was noticed by Gireesh *et al.* (2010) in rice.

The higher flag leaf length and flag leaf width was observed in KCMS59A is (23.26 cm) and KCMS58A (2.78 cm), respectively followed by KCMS57A (23.10 and 2.69 cm, respectively). Flag leaf length and width found shorter in KCMS58A (21.08 cm) and KCMS53A (2.19 cm), respectively. In maintainer lines higher flag leaf length and width was recorded by KCMS60B (23.64 cm) and KCMS58B (3.80 cm) and was lower with KCMS58B (21.17 cm) and KCMS53B (3.03 cm), respectively (Table 3).

In A lines, the number of spikelets per panicle ranged from 207.00 to 157.33, while in B lines, which ranged from 231.33 to 162.00 (Table 4). The findings are in agreement with the findings of Gopinath and Raghava Reddy (2005) and Gireesh *et al*. (2010).

The differences were observed among the CMS lines for days to maturity. Among the CMS lines, KCMS57A (117 days) took less number of days to maturity; While, KCMS59A more (121 days) number of days. Where as in B lines KCMS59B took more (118 days) number of days to maturity and KCMS60B took less (115 days) number of days taken to maturity (Table 4). In general, number of filled seeds per panicle was more in B lines than A lines. Among 7 CMS lines, more number of

TABLE 3

Mean performance of new cytoplasmic male sterile lines and their maintainers of rice on panicle length (cm), panicle weight (g), flag leaf length (cm) and flag leaf width (cm)

CMS LINES	B lines	Panicle length (cm)		Panicle weight (g)		Flag leaf length (cm)		Flag leaf width (cm)	
		A	B	A	B	A	B	A	B
KCMS57A	KCMS57B	23.10	23.11	2.69	3.38	23.10	23.11	2.69	3.38
KCMS53A	KCMS53B	22.41	22.29	2.19	3.03	22.41	22.29	2.19	3.03
KCMS58A	KCMS58B	21.08	21.17	2.78	3.80	21.08	21.17	2.78	3.80
KCMS59A	KCMS59B	23.26	23.33	2.43	3.08	23.26	23.33	2.43	3.08
KCMS60A	KCMS60B	21.97	23.64	2.48	3.11	21.97	23.64	2.48	3.11
KCMS61A	KCMS61B	22.60	22.19	2.21	3.29	22.60	22.19	2.21	3.29
KCMS54A	KCMS54B	22.63	22.58	2.23	3.07	22.63	22.58	2.23	3.07
KCMS62A	KCMS62B	22.84	22.93	2.37	3.12	22.84	22.93	2.37	3.12
GRANDMEAN		22.48	22.66	2.42	3.24	22.48	22.66	2.42	3.24
SEM +/-		0.38	0.64	0.12	0.17	0.38	0.64	0.12	0.17
CD (P=0.05)		1.15	1.95	0.36	0.51	1.15	1.95	0.36	0.51
CV (%)		4.03	6.76	11.66	12.38	4.03	6.76	11.66	12.38

TABLE 4

Mean performance of new cytoplasmic male sterile lines and their maintainers in rice on days to maturity, number of spikelets, panicle exertion (%) and number of filled seeds

CMS LINES	B lines	Days to Maturity		No. of Spikelets per panicle		Panicle Exertion (%)		No. of filled seeds	
		A	B	A	B	A	B	A	B
KCMS57A	KCMS57B	117	116	199.67	231.33	77.56	92.12	43.67	174.33
KCMS53A	KCMS53B	119	116	207.00	218.33	74.23	89.12	38.33	159.00
KCMS58A	KCMS58B	118	116	157.33	162.00	73.21	88.23	24.33	129.00
KCMS59A	KCMS59B	121	118	199.00	218.67	76.32	91.30	39.00	159.67
KCMS60A	KCMS60B	118	115	196.00	184.67	76.23	90.23	37.33	145.00
KCMS61A	KCMS61B	119	117	167.33	170.33	75.67	92.67	28.00	138.33
KCMS54A	KCMS54B	119	116	190.00	184.00	75.12	90.56	34.00	135.67
KCMS62A	KCMS62B	118	116	168.33	174.33	76.45	91.20	28.67	146.00
GRANDMEAN		119.63	117.5	185.58	192.96	75.60	90.68	34.17	148.38
SEM +/-		1.060	1.075	2.54	1.96	0.456	0.490	0.70	2.91
CD(P=0.05)		3.544	3.596	7.70	5.94	1.525	1.637	2.13	8.82
CV (%)		2.506	2.588	3.26	2.42	1.706	1.527	4.90	4.67

filled seeds per panicle was noticed in KCMS57A (43.67) followed by KCMS59A (39) and KCMS59A (39), where as KCMS58A had less (24.33) number of filled seeds per panicle. Among B lines, KCMS57B had number of (231.33) filled seeds per panicle (Table 4) followed by KCMS59B (218.67) and less number of filled seeds per panicle were seen in KCMS58B (162). Similar observations were also reported by Gireesh *et al.* (2010).

Among the CMS lines, better seed setting percentage was observed in KCMS57A (21.87 %) followed by KCMS59A (19.60 %) and was lower (15.47 %) in KCMS58A (Table 5). In B lines, higher (83.75 %) seed setting percentage was recorded in KCMS62B, followed by KCMS61B (81.21 %), whereas, lower (72.82 %) seed setting percentage was observed in KCMS53B. Higher test weight was recorded in KCMS58A (25.97 g) while, lower (16.19 g) test weight was recorded in KCMS59A, among the B lines, higher test weight was recorded in KCMS58B (27.39 g) while, lower (15.16 g) was observed in KCMS53B (Table 5). The standard check KCMS62A and its maintainer line KCMS62B recorded test weight of 17.33 and 16.11g, respectively. In general, seed yield of B lines were more than A lines. Among the CMS lines, higher (4.95 g) seed yield was recorded in KCMS57A followed by KCMS60A (4.89 g). Among B lines higher (15.03 g) seed yield in was recorded in KCMS61B and was lower (10.18 g) in KCMS53B. The standard check KCMS62A and B line recorded (4.91 g) and (14.45 g) seed yield per plant, respectively (Table 5). Similar results were also reported by Gireesh *et al.* (2010) in rice. Panicle exertion was more in B lines compared to A lines indicating that the influence of sterile cytoplasm on panicle exertion. Among A lines, KCMS57A exhibited higher per cent of panicle exertion of (77.56), followed by KCMS62A (76.45), KCMS59A (76.32) and KCMS60A (76.23) (Table 4). Among B lines KCMS61B recorded the highest (92.67 %) of panicle exertion whereas, lowest (88.23 %) was observed in KCMS58B findings of the present study with respect to panicle exertion are in agreement with the reports published by Ingale *et al.* (2004), Gireesh *et al.* (2010) and Tejbir (2016) in rice.

Seed yield in hybrid seed production plots depends on morphological and floral traits of CMS lines and other agronomic and seed production packages to facilitate higher out crossing. The desirable traits of CMS lines

TABLE 5

Mean performance of new cytoplasmic male sterile lines and their maintainers of rice on seed yield per plant (g), seed setting (%) and test weight (g)

CMS LINES	B lines	Seed yield / plant (g)		Seed Setting (%)		Test weight (g)	
		A	B	A	B	A	B
KCMS57A	KCMS57B	4.95	10.34	21.87	75.36	17.13	15.85
KCMS53A	KCMS53B	4.22	10.18	18.52	72.82	16.23	15.16
KCMS58A	KCMS58B	4.40	10.93	15.47	79.63	25.97	27.39
KCMS59A	KCMS59B	4.21	12.89	19.60	73.02	16.19	15.41
KCMS60A	KCMS60B	4.89	13.01	19.05	78.52	17.40	15.63
KCMS61A	KCMS61B	4.00	15.03	16.73	81.21	17.53	16.40
KCMS54A	KCMS54B	4.17	11.37	17.89	73.73	17.33	15.30
KCMS62A	KCMS62B	4.91	14.45	17.03	83.75	17.33	16.11
GRANDMEAN		4.47	12.28	18.27	77.26	18.14	17.16
SEM +/-		0.20	0.49	0.52	1.58	0.25	0.26
CD (P=0.05)		0.60	1.48	1.59	4.80	0.75	0.80
CV (%)		10.48	9.45	6.84	4.88	3.24	3.66

are complete and stable male sterility, good panicle exertion and high number of spikelets per panicle, erect plant type with short and narrow flag leaf, strong and synchronized flowering ability, high receptivity of stigma, early initiation of flowering and concentrated blooming and good combining ability for yield and yield contributing traits (Ramesha *et al.,* 2003). The most important criteria to be considered while selecting promising CMS lines are seed setting percentage and other parameters like more number of panicles and productive tillers per plant and seed yield. Out crossing rate are most ideal characters of good CMS lines. In the present study based on the performance of 8 CMS lines compared with standard check KCMS62A, four CMS lines *viz*., KCMS57A, KCMS60A and KCMS59A were identified as promising ones as they showed higher panicle exertion, numbers of panicles, seed setting percentage and seed yield. Therefore, these CMS lines could be used for hybrid development has they possess better seed production potential.

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