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Genetic Analysis of Cyto-sterile Lines in Rice (Oryza sativa L)

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Abstract: ***The variability in floral traits of Cyto-sterile lines is very useful particularly for breeding CMS lines with high out crossing potential in rice. In the present study an attempt has been made to study variability and association among floral traits. Ten cyto-sterile lines and their maintainers, possessing "Wild Abortive" (WA) type of stable cytoplasm were studied for Heritability, Genetic Advance and Correlation among floral traits influencing out crossing in rice. Significant positive correlation were observed between stigma breath with anther breadth & anther size; percentage of stigma exsertion with stigma length, angle of opened florets and style length; angle of opened florets with style length; stigma length with anther length; duration of opening of floret with percentage of stigma exsertion, angle of opened florets, filament length and filament length after elongation; stigma breadth with stigma surface, anther breadth and anther size; anther breadth with anther size and filament length; filament length with filament length after elongation. Characters such as blooming, angle of florets, stigma exsertion, stigma breadth, stigma surface, style length, anther breadth and filament showed high broad sense heritability coupled with medium genetic advance, were useful trait for genetic improvement.***

Key words: Correlation, Cyto-sterile line, Genetic advance. Heritability, Rice

1. Introduction

The floral biology of CMS lines is important for out crossing and seed setting in hybrid seed production. Information regarding correlation among the floral traits, heritability and genetic advance is essential for effective selection. One of the major problems of low seed set in hybrid seed production plot is "very low out crossing" of CMS lines in rice. A cyto-sterile line with high out crossing potential will certainly economize the cost of hybrid seed production. The most important floral traits influencing out crossing is male sterility in rice (Virmani, 1996). Male fertile plant shows very little, if any out crossing due to self pollinating nature of rice flower. However in male sterile plants, extent of out crossing is further influenced by its floral traits which are stigma size and exsertion, duration of floret opening, anther size, pollen density per unit area, filament length and duration of spikelet blooming have been reported by Virmani (1994).

2. Materials and Methods

Ten cyto-sterile lines and their maintainers, possessing "Wild Abortive" (WA) type of cytoplasm, collected from DRR (Directorate of Rice Research), Rajendra Nagar, Hyderabad and NDUAT, Kumarganj, Faizabad (U.P.), constituted the materials for the present studies. The cyto-sterile lines and their maintainers were grown in Randomized Block Design with three replications during Kharif 2009 and 2010 in three meter rows and twenty centimeters apart. Plant to plant distance within the rows was 15 centimeters. Cyto-sterile (A) and Maintainers lines (B) were transplanted in 4:2 ratios. Recommended agronomic practices were adopted to raise a good crop. Duration of opening of florets (mm), angle of opened florets (degree), percentage of stigma exsertion, percentage of panicle exsertion, anther length (mm), anther breadth (mm), anther size (mm), fragment length (mm), filament length after elongation (mm), stigma length (mm), stigma surface and style length were recorded. Heritability estimates was worked out by using the formula suggested by Lush (1949) and Burton and De Vance (1953) and Genetic Advance as suggested by Lush (1949) and Johnson, Robinson and Comstock (1995a). The variability and correlation studies were performed as per by Panse and Sukhatme (1954).

3. Results and Discussion

Ten cyto-sterile lines having 'WA'cytoplasm and their respective maintainers for thirteen floral traits *viz;* duration of blooming, angle of opened florets, percentage of panicle exsertion, percentage of stigma exsertion, stigma length (mm), stigma breadth (mm), stigma surface (mm^2), style length (mm), anther length (mm), anther breadth (mm), anther size (mm^2), filament length (mm) and filament length after elongation (mm) were studied for different variability parameters such as mean, range, variance and coefficient of variation. Analysis of variance recorded highly significant treatment difference for all the traits indicating presence of variability for selection. Some of the most important floral traits *viz;* duration of opening of florets, angle of opened florets, percentage of stigma exsertion, percentage of panicle exsertion influencing out crossing substantially were predominant in cyto-sterile lines PMS2A/B, PMS6A/B, PMS7A/B, IR58025A/B and IR62829A/B. On the basis of variability studies, cyto-sterile line IR62829A/B expressed overall best values for stigma characteristics (stigma exsertion percentage, stigma length and stigma surface) followed by PMS3A/B, PMS10A/B and PMS2A/B. The most outstanding line IR58025A showed poor stigma characteristics as compared to other cytosterile lines. However, it possessed pronounced anther characteristics. For anther characteristics (anther length, anther breadth, anther size, filament length and filament length after elongation) cyto-sterile line PMS3A/B, PMS10A/B, PMS2A/B, IR62829A/B and NMS 1A/B were having floral traits contributing substantially to out crossing (Table1).

Correlation studies among floral traits revealed interesting results. It was observed that stigma breadth was positively correlated with anther breadth and anther size at genotypic as well as phenotypic level (Table 2). In cyto-sterile line, percentage of stigma exsertion was positively correlated with stigma length (0.498 and 0.442), angle of opened florets (0.437 and 0.295) and style length (0.179 and 0.226) at genotypic as well as phenotypic level, respectively. Similar results were observed by Patil and Sarawgi (2005), Khan *et al.* (2009) and Singh (2012, 2014). Another significant negative correlation was observed between percentage of panicle exsertion with stigma breadth, anther breadth and anther size at both genotypic and phenotypic levels. Angle of opened florets was significantly and positively correlated with style length (0.666) at genotypic level, whereas another positive correlation was observed with stigma length (0.148 and 0.129) and anther length (0.440 and 0.183). Duration of opening of florets was positively correlated at both genotypic as well as phenotypic level with percentage of stigma exsertion (0.170) and (0.104), angle of opened florets (0.057 and 0.080), filament length (0.285 and 0.058) and filament length after elongation (0.542 and 0.375), respectively, whereas another negative significant correlation was observed with stigma surface (0.795) at phenotypic level. Stigma breadth was positively and significantly correlated with stigma surface, anther breadth and anther size at genotypic level, this result indicated that stigma breadth was much more influenced by environment. Another correlation coefficient in case of anther breadth was significant and positively correlated with anther size (0.959 and 0.946) at genotypic and phenotypic level and it was also positively and significantly correlated with filament length (0.690) at genotypic level only. Further correlation was observed between filament length and filament length after elongation, which was positive at genotypic as well as phenotypic level but significant at genotypic level only. These results are in general agreement with the findings of Chaudhary and Motiramani, (2003); Khedikar *et al*. (2004); Nayak *et al*. (2004) and Jaiswal *et al*. (2007).

In general higher estimates of heritability were observed in A-lines than their respective B- lines for duration of opening of florets, angle of opened florets, percentage of stigma breadth, stigma surface, style length, anther breadth and filament length (Table 3). Higher estimates of heritability indicate preponderance of additive gene action as suggested by Subramaniam and Rathinam (1984). Higher percentage of heritability was recorded for exserted stigma, spikelet length, anther length, stigma length by Virmani and Athwal (1973), Singh (1995) and Singh (2014). Sahoo *et al.*(1997) observed heritability over 90% for the characters like duration of floret opening, angle of opened florets, percentage of exserted stigma, spikelet length, anther length, stigma length, etc. These findings support the present observations. Present findings contradict the observation made by Virmani and Athwal (1973) for percentage of exserted stigma, stigma length who observed high heritability. Highest values (50.04%) of genetic advance observed for blooming of florets followed by stigma exsertion, stigma breadth and stigma surface. In general heritability estimates was high for these characters, but to arrive a reliable conclusion high estimates of heritability should be accompanied by high genetic advance (Johnson *et al.* 1955a). Mahalingam *et al.* (2013) also observed high heritability coupled with high genetic advance as percent of mean for five traits *viz.*, anther length, stigma length, style breadth, glume opening angle and stigma exsertion rate**.** It may be suggested on the basis of present study style length, anther breadth and filament length showed high broad sense heritability coupled with medium genetic advance and most of these having high genotypic coefficient of variation, may be advocated for selection as traits with high out crossing potential.

It was observed that there is presence of floral variability for different out crossing influencing traits among the ten cyto-sterile lines and their maintainers studied during the course of present investigation. Duration of opening of florets and angle of opened florets are two important traits influence out crossing, were positively correlated and can be improved together. In general stigma and anther floral traits were negatively correlated but with in stigma/ anther floral parts were positively correlated, indicating that male and female organs should be improved separately. On the basis of overall analysis, IR62829A was best followed by PMS10A, PMS2A and IR58025A for having out crossing influencing traits. In general cyto-sterile have better floral traits than there maintainers, influencing outcrossing.

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Table 1: Classification of Male Sterile and Maintainers lines based on the *per se* performance and variability studies of floral trait influencing out crossing

A.	Duration of floret opening (min) -		Range	S.E.	C.D.
		A-lines - PMS2A, PMS6A, PMS7A, IR58025A B-lines - PMS6B, NMS2B, IR58025B, IR62829B	(61.67 - 146.67) (47.50 - 84.17)	13.86 7.12	29.12 14.95
B.	Angle of Opened Florets (0°) -				
		A-lines - PMS7A, IR62829A, NMS 1A, PMS6A B-lines - PMS7B, IR62829B, NMS1B, PMS3B	(22.89 - 32.45) (19.67 - 27.67)	1.31 1.31	2.75 2.75
C.	Percentage of Panicle Exsertion (%)				
		A- lines - NMS1A, IR58025A, IR62829A, PMS2A B-lines - PMS6B, NMS1B, PMS7B, PMS8B	(58.45-69.01) (77.90-100.0)	2.79 3.23	5.86 4.68
D.	Stigma Characters				
	(i)	Percentage of Exserted Stigma (%) A- lines - PMS6A, PMS8A, IR62829A, NMS1A B-lines - PMS8B, IR62829B, PMS10B, PMS6B	(7.88-66.71) (29.45-75.19)	1.41 2.06	2.96 4.33
	(ii)	Stigma Length (mm) A- lines - IR62829A, NMS1A, PMS8A, PMS10A B-lines - IR62829B, NMS1B, PMS8B, PMS10B	(1.19-1.97) (1.19-2.02)	0.073 0.75	0.153 0.157
	(iii)	Stigma Breadth (mm) A- lines - NMS2A, PMS10A, PMS3A, PMS8A B-lines - NMS2B, PMS10B, PMS3B, PMS8B	(0.36-0.63) (35.35-0.64)	0.032 0.039	0.067 0.082
	(iv)	Stigma Surface (mm^2) A- lines - IR62829A, NMS2A, PMS3A, PMS10A B-lines - NMS2B, PMS10B, PMS3B, PMS8B	(0.47-0.80) (0.45-0.94)	0.057 0.081	0.119 0.170
	(v)	Stigma Length (mm) A- lines - PMS7A, PMS2A, PMS3A, PMS10A B-lines - PMS7B, PMS2B, PMS3B, PMS10B	(0.82-1.23) (0.85-1.23)	0.081 0.080	0.170 0.168
E.	Anthers characters				
	(i)	Anther Length (mm) A- lines - PMS7A, PMS10A, NMS1A, PMS3A B-lines - IR62829B, PMS7B, PMS10B, NMS1B	(1.72-2.04) (1.72-2.19)	0.087 0.185	0.185 0.183
	(ii)	Anther Breadth (mm) A- lines - NMS2A,IR62829A, PMS10A, PMS3A B-lines - NMS2B, IR62829B, PMS2B, PMS10B	(0.23-0.44) (0.29-0.55)	0.032 0.079	0.079 0.067
	(iii)	Anther Size (mm^2) A- lines - NMS2A, PMS10A, PMS3A, NMS1A B-lines - IR62829B, NMS2B, PMS10B, PMS2B	(0.42-0.89) (0.54-1.13)	0.071 1.689	1.689 0.149
	(iv)	Filament Length (mm) A- lines - PMS10A, PMS6A, NMS2A, IR8025A B-lines - PMS3B, IR62829B, PMS10B, PMS2B	(0.79-1.33) (1.17-1.53)	0.171 0.260	0.260 0.359
	(v)	Filament Length after elongation (mm) A- lines - PMS10A, PMS6A, IR8025A, PMS3A B-lines - PMS10B, PMS6B, IR8025B, PMS3B	(6.75-8.47) (6.76-8.50)	0.379 0.775	0.775 0.796

S.E.: Standard Error and C.D.: Critical Differences

Table 2: Estimation of genotypic and phenotypic correlation coefficient among various floral traits in ten cyto-sterile lines of rice

Characters		2	3	4	5	6	7	8	9	10	11	12	13
1. Duration of opening of florets	G	0.170	-0.105	0.057	-0.502	-0.391	-0.795**	0.348	-0.380	-0.082	-0.020	0.285	0.542
	P	0.104	-0.133	0.080	-0.376	-0.334	-0.596	0.140	-0.307	0.054	-0.067	0.058	0.375
2. Percentage of stigma exsertion	G		-0.901**	0.437	0.498	-0.984**	0.455	0.179	-0.445	-0.845**	-0.905**	-0.353	-0.182
	P		-0.784**	0.295	0.442	-0.812**	0.338	0.226	-0.264	-0.698*	-0.634*	-0.225	-0.137
3. Percentage of panicle exsertion	G			-0.195	-0.291	0.816**	0.376	-0.383	0.256	0.918**	0.911**	0.344	0.002
	P			-0.183	-0.261	0.702**	0.344	-0.226	0.114	0.581	0.562	0.245	-0.069
4. Angle of opened florets	G				0.148	-0.397	-0.246	0.666*	0.440	-0.298	-0.175	-0.178	-0.252
	P				0.129	-0.265	-0.161	0.367	0.183	-0.271	-0.199	0.037	-0.230
5. Stigma length	G					-0.265	0.572	0.010	-0.222	-0.050	-0.126	-0.262	-0.437
	P					-0.270	0.551	0.028	-0.168	0.096	0.015	-0.165	-0.338
6. Stigma breadth	G						0.632*	-0.342	0.400	0.916**	0.955**	0.434	0.124
	P						0.579	-0.269	0.325	0.431	0.512	0.264	-0.039
7. Stigma surface	G							-0.163	0.291	0.689*	0.701*	0.035	-0.203
	P							-0.120	0.123	0.451	0.446	0.055	-0.281
8. Style length	G								0.733	-0.020	0.138	0.004	0.283
	P								0.372	-0.106	-0.005	-0.165	0.052
9. Anther length	G									0.208	0.477	0.258	-0.009
	P									0.191	0.493	0.142	0.131
10. Anther breadth	G										0.959**	0.690*	0.312
	P										0.946**	0.412	0.334
11. Anther size	G											0.677*	0.274
	P											0.423	0.327
12. Filament length	G												0.988**
	P												0.535

2. %age of stigma exsertion 3. % age of panicle exsertion 4. Angle of opened florets 5. Stigma length 6. Stigma breadth 7. Stigma surface 8. Style length 9. Another length 10. Another breadth 11. Another size 12. Filament length 13.Filament length after elongation G = Genotypic, P= Phenotypic * and ** Significant at 5% and 1% probability level respectively.

Table 3: Heritability and Genetic Advance of thirteen floral traits in cyto-sterile lines and their maintainers

	Heritability (h^2) (%)		G.A.		G.A.(% of mean)	
Parameters/ Trails	A	B	A	B	A	B
1. Duration of opening of florets(min)	71.20	57.00	46.33	15.62	50.04	24.21
2. Angle of opened florets(O°)	70.90	66.30	4.63	3.79	18.33	16.41
3. Percentage of stigma exsertion	91.70	84.10	22.41	17.22	44.01	32.33
4. Percentage of panicle exsertion	88.20	92.30	9.18	17.34	14.20	19.25
5. Stigma length(mm)	86.10	86.40	0.42	0.45	29.57	31.47
6. Stigma breadth (mm)	78.30	50.10	0.14	0.16	32.56	32.65
7. Stigma surface (mm^2)	72.10	65.90	0.20	0.23	32.78	37.09
8. Style length(mm)	62.30	60.10	0.21	0.19	20.78	18.45
9. Anther length(mm)	44.50	60.80	0.12	0.21	6.35	10.77
10. Anther breadth (mm)	81.40	80.40	0.07	0.15	21.21	34.88
11. Anther size(mm^2)	51.30	81.70	0.15	0.34	23.80	40.47
12. Filament length(mm)	44.00	34.90	0.19	0.19	17.92	14.84
13. Filament length after elongation	51.90	52.30	0.70	0.73	9.07	9.32

A, B= Cyto-sterile lines and their maintainers, respectively, GA= Genetic Advance