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COMBINING ABILITY OF ERGOT RESISTANT MUTANTS OF THE RESTORER K 560- 230 IN PEARL MILLET

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ABSTRACT

Combining ability of twenty mutants of restorer line K 560-230 was studied in line x tester mating design with three male sterile lines as testers MS 5054, MS 5141 and MS 81 and the performance of cross combinations was compared with those of restorer K 560-230. The mutant lines were only those which have recorded below 10% incidence of ergot in contrast of 50% incidence in control under artificial inoculation for two consecutive years. The combining ability analysis of variance revealed the prevalence of both additive and nonadditive gene effects. The mutant lines 50-1 and 45-1 were good general combiners for number of productive tillers, days to flowering and grain yield, and 39-1 for grain yield and days to maturity. The specific crosses 5141 A x 90-1, 5141 A x 142-1, 5141 A x 145-1 and 5141 A x 147-1 showed superior sca effects over the control hybrid MS 5141 A x K 560-230. The present study indicated that mutagens can be used to quickly improve the parents of hybrids for specific traits with an added advantage of induced disease resistance.

Key words: *Pennisetum americanum*, pearl millet, combining ability, yield components.

A number of high yielding hybrids in pearl millet (*Pennisetum americanum* L.) have been developed owing to the use of new male sterile lines (A lines) and the pollen parents (R lines). Mutation induction can be one of the tools to alter and to further improve the breeding value of the parents which have already gone into the production of popular hybrids, without loss of fertility restoring genes, agronomic desirability with an added advantage of induced disease resistance. This possibility was explored in the present investigation and the combining ability of the desirable induced mutant lines was studied.

MATERIALS AND METHODS

The material comprised 20 variable mutant lines derived from the promising inbred line K 560-230, check K 560-230 and three testers, i.e. the B lines of MS 5054, MS 5141 and MS 81 male steriles. Mutant lines were obtained by treating dry seeds of K 560-230 with 0.2%, 0.4%

and 0.6% EMS for 8 and 12 h and 20, 30, 40 and 50 kR gamma rays. The mutagenic treatments were effective in producing a wide array of morphological mutants. The mutants were isolated in M_2 generation and the mutant lines were established. Only 20 true breeding agronomically desirable mutant lines which have recorded low ergot incidence under artificial inoculation for two consecutive years were used in the present investigation in M_5 generation. Line x tester design was followed to cross the mutant lines with the testers. For L x T design the material comprised 63 crosses of 21 mutant lines with 3 testers and 24 parents, making a total of 87 entries.

All the 24 parents and their 63 F_1s were grown in randomized block design with three replications. The material was space planted at the distance of 15 cm within the rows in 5m long two-row plots. The row-to-row spacing was 60 cm. Data for 11 characters were recorded on five random plants from each plot. Combining ability analysis was done as per [1].

RESULTS AND DISCUSSION

The analysis of variance exhibited highly significant differences among the entries for all the characters under study.

The combining ability analysis of variance (Table 1) revealed that both additive and nonadditive gene actions were important in the expression of different characters. The magnitude of nonadditive components was much higher than that of additive components in respect of ear length, plant height, 1000-grain weight, ear density and grain yield per plot. However, for number of productive tillers, days to flowering and days to maturity, additive type of gene action was important. The presence of considerable amount of nonadditive

Table 1. Analysis of variance (M.S.S.) for combining ability in pearl millet

Source	d.f.	No. of productive tillers	Ear length	Plant height	1000-grain weight	Days to flowering	Days to maturity	Ear length	Grain yield
Replications	2	1.1	47.8	597.5	0.3	4.9	2.9	0.6	77624.0
L x T (pooled)	62	1.9**	20.2**	321.3**	3.2**	16.1**	14.15**	12.6**	4370.6**
(a) Lines (L)	20	1.9**	20.5**	172.1**	7.0**	5.0**	4.9**	15.8**	90048.7**
(b) Testers (T)	2	23.3**	91.5**	721.5**	2.6**	293.6**	341.5**	24.1**	219804.8**
(c) L x T	40	0.8	16.5**	375.8	1.3**	2.8*	2.4	10.4**	75760.0**
Error	124	0.3	1.7	64.7	0.10	0.7	1.0	1.9	25743.6
Total	188	0.8	8.3	155.0	1.1	5.98	5.3	5.4	3289.5

*, **Significant at 5% and 1% levels, respectively.

genetic effects suggests the possibility of improvement through hybridization with respect to grain yield and certain other characters. The findings, in general, were in conformity with earlier reports [2–5].

Among the mutant lines, 50-1, 39-1 and 45-1 exhibited highly significant positive gca effects for grain yield as compared to parent line K 560-230, which expressed negative gca effect. The mutant line 50-1 was the best general combiner as, besides yield, it showed significant favourable gca effects of higher order than other lines for number of productive tillers and days to flowering (Table 2). The mutant line 45-1 also exhibited highly significant

Table 2. Lines and testers possessing significant gca estimates for different characters in pearl millet

Parent	Productive tillers	Ear length	Plant height	1000-grain weight	Days to flowering	Days to maturity	Ear density	Grain yield per plot
Lines								
K 560-230			-9.05^{*}	-0.91^{**}	0.78^{*}	0.85^{*}		
17-1		1.30^{**}		-0.75^{**}	1.22^{**}			-155.47^{**}
28-1		1.66^{**}		-1.15^{**}		-0.71^{**}		
34-1	0.71^{**}			0.26^{**}	-0.67^{*}	-0.93^{**}	-1.13^{*}	
35-1	0.60^{**}		-6.49^{*}	-1.33^{**}	1.22^{*}	1.40^{**}		-193.80^{**}
36.1	0.49^{**}	-1.21^{*}		-0.54^{**}		-0.93^{**}		-109.92^{*}
39-1				-0.36^{**}		-1.38^{**}	-1.19^{*}	143.41^{**}
45-1	0.49^{**}			0.62^{**}	-0.89^{**}		-2.84^{**}	97.85^{*}
50-1	0.71^{**}				-0.78^{*}			236.74^{**}
54-1	0.49^{**}			0.87^{**}	-1.44^{**}	-0.71^{*}		
61-1	0.48^{**}						1.18^{*}	
75-1		1.50^{**}		-0.31^{**}				
90-1							-2.11^{**}	
103-2				-0.76^{**}		1.18^{**}	2.72^{**}	
118-1		-1.21^{*}		0.49^{**}			1.87^{**}	
123-1		1.09^{*}		0.89^{**}	0.78^{*}	0.96^{**}	1.32^{**}	
134-1	-0.39^{*}	4.64^{**}	7.37^{*}	2.69^{**}			-1.15^{*}	
138-1	-0.62^{**}	-1.61^{**}	-6.00^{*}					
142-1	-0.84^{**}						-1.28^{**}	
145-1	-0.73^{**}	-1.06^{*}		0.26^{*}				
147-1	-0.39^{*}	-2.58^{**}		0.56^{**}				
SE $(\hat{g}_i)$	0.18	0.48	2.86	0.11	0.30	0.35	0.49	49.24
Se $(\hat{g}_i-\hat{g}_j)$	0.25	0.68	4.05	0.16	0.43	0.49	0.68	69.64
Testers								
5054 A	0.70^{**}			0.23^{**}	-1.00^{**}	-1.41^{**}	0.44^{*}	46.98^{*}
5141 A	-0.29^{**}	-1.28^{**}	2.38^{**}	0.09^{*}	-1.84^{**}	-1.28^{**}		198.88^{**}
81 A	-0.41^{**}	1.11^{**}		0.15^{**}	2.84^{**}	2.69^{**}	-0.71^{**}	-245.87^{**}
Se $(\hat{g}_i)$	0.07	0.18	1.08	0.04	0.11	0.13	0.18	18.61
SE $(\hat{g}_i-\hat{g}_j)$	0.09	0.26	1.53	0.06	0.16	0.19	0.26	26.32

*,**Significant at 5% and 1% levels, respectively.

positive gca for productive tillers and 1000-grain weight. The original parent line K 560-230 showed unfavourable gca effects for all the characters except plant height. The change in gca effects from that of parent in mutant lines might occur due to the changed genetic make up of the mutants.

For number of productive tillers, the mutant lines 34-1, 35-1, 36-1, 45-1, 50-1, 54-1 and 61-1 were good general combiners, whereas the original line K 560-230 was a medium general combiner. Mutant lines 17-1, 28-1, 75-1 and 134-1 for ear length, 134-1 for plant height and 54-1, 118-1, 123-1, 134-1, 145-1 and 147-1 for 1000-grain weight were good general combiners, whereas their parent line K 560-230 was a very poor general combiner for these characters. The mutant lines used in crosses were selected for ergot resistance and agronomic desirability as well as these had the morphology different from their parent. The altered genetic make up of the mutants might be responsible for the change in combining ability.

Amongst the testers, 5054 A and 5141 A were good combiners for grain yield. 5141 A was the best combiner for yield components, such as, plant height, 1000-grain weight, days to flowering, and days to maturity. 5054 A was the best combiner for number of productive tillers, 1000-grain weight, days to flowering, days to maturity and ear density. Tester 81A had high gca for ear length and 1000-grain weight.

Table 3. Superior crosses showing significant sca effects for different characters in pearl millet

Character	Cross	Sca estimate	Character	Cross	Sca estimate
No. of productive tillers	5141 A x K 560-230	0.06	Days to flowering	5141 A x K 560-230	1.39**
	5141 A x 147-1	1.06**		5141 A x 138-1	-1.60**
	5054 A x 50-1	0.63*		5054 A x 35-1	-1.56**
	81A x 36-1	0.63*		5141 A x 103-2	-1.38**
Ear length	5141 A x K 560-230	2.50**	Days to maturity	5141 A x K 560-230	0.17
	5054 A x 134-1	4.81**		81 A x 28-1	-2.57**
	81 A x 28-1	3.51**		5054 A x 36-1	-1.59**
	5054 A x 103-2	3.50**			
Plant height	5141 A x K 560-230	-15.04**	Ear density	5141 A x K 560-230	-0.15
	81 A x 28-1	18.15**		81 A x 103-2	3.79**
	5141 A x 103-2	15.64**		5141 A x 35-1	2.47**
	5141 A x 123-1	13.73**		81 A x 138-1	2.46**
1000-grain weight	5141 A x K 560-230	0.53**	Grain yield	5141 A x K 560-230	-267.77**
	5054 A x 35-1	1.74**		81 A x 28-1	304.20**
	5141 A x 54-1	0.97**		5141 A x 145-1	241.66**
	81 A x 65-1	0.92**		5141 A x 147- 1	201.11**

*, **Significant at 5% and 1% levels, respectively.

A comparison of gca of the original parent line K 560-230 with its mutant lines for important agronomic traits revealed distinct superiority of some of the mutants over the control.

The sca effects of some promising crosses are presented in Table 3. The crosses 81 A x 28-1, 5141 A x 145- 1 and 5141 A x 147-1 showed significant positive and superior sca effects for grain yield, while cross 5141 A x K 560-230 exhibited negative sca effects. The crosses with high sca effects were the combinations of either high x low or low x low gca parents. This suggested the importance of epistasis and the sca represented dominance and epistatic effects.

The sca of K 560-230 in contrast to the sca of its mutant lines in crosses with 5141 A, 5054 A and 81 A male sterile lines for grain yield is presented in Table 4. Out of 21 crosses four crosses 5141 A x 90-1, 5141 A x 142-1, 5141 A x 145-1 and 5141 A x 147-1 exhibited significant positive and superior sca effects compared to original cross 5141 A x K 560-230, which showed negative sca effects. All these crosses involved high x low combinations in respect with their gca. High x low gca effects played an important role in the expression of positive and significant sca effects. The cross combinations 5141 A x 90-1, 5141 A x 142-1, 5141 A x 145-1 and 5141 A x 147-1 involved one parent with desirable and significant gca effect and other with poor or even negative gca effect. The change in sca value from −267.8 (5141 A x K 560-230) to +241.7 (5141 A x 147-1) is attributable to the mutation of K 560-230 as the derived mutant lines had the altered morphology and hence the different genetic makeup compared with their parent. The experiments of [6–11] also showed that gca and sca changed in induced mutant lines. The effect of recurrent thermal neutron and ethyl methane sulphonate seed treatment on gca

Table 4. Sca of the crosses of K 560-230 compared with the sca of the crosses of its mutant lines with 5141 A, 5054 A and 81 A male sterile lines for grain yield

Parent	Gca effects	Sca estimates with		
		5141 A	5054 A	81 A
Lines:				
K 560-230	−38.2	−267.8**	−97.5	365.3**
17-1	−155.5**	−52.2	191.3*	−139.1
28-1	−85.5	−63.9	−240.3	304.2**
34-1	−45.5	−113.9	83.0	30.9
35-1	−193.8**	−197.2**	151.3	45.9
36-1	−109.9*	−132.8	110.8	22.0
39-1	143.4**	−177.8	90.8	27.0
45-1	97.8*	−65.5	68.0	−2.5
50-1	236.7**	73.9	55.8	−129.7
54-1	52.3	−36.7	−73.1	109.8
61-1	51.2	−85.5	99.7	−14.1
75-1	−41.0	−68.3	20.2	48.1
90-1	48.4	188.9*	7.5	−196.3*
103-2	71.2	146.1	−55.3	−90.8
118-1	−26.0	38.3	−24.8	−13.6
123-1	−73.2	22.2	107.5	−129.7
134-1	46.2	59.4	11.3	−70.8
138-1	−38.8	51.1	−105.3	54.2
142-1	−8.2	178.9*	−124.2	−54.7
145-1	−2.7	241.7**	−168.1*	−73.6
147-1	71.2	201.1*	−108.6	−92.5
Testers:				
5141 A	198.9**			
5054 A	47.0*			
81 A	−245.9**			

*, **Significant at 5% and 1% levels, respectively.

and sca were studied by [12]. They indicated that mutagenic agents increased the percentage of nonadditive genetic variance affecting sca.

Of the crosses with 5054 A male sterile line only one cross 5054 A x 17-1 exhibited significant positive and superior sca effect, where 5054 A was a good general combiner and 17-1 was poor. A cross of 28-1 mutant line with 81 A male sterile line (81 A x 28-1) also showed significant positive and superior sca effect (Table 4). It was a poor x poor cross in respect to their gca.

The results of the present investigation prove that mutagenesis can be used to improve the parents of hybrids to obtain improvement for grain yield and yield components with an added advantage of disease resistance over the existing hybrids. The combining ability can also be altered in the course of mutagenesis.

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