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COMBINING ABILITY ANALYSIS IN PEARL MILLET (*PENNISETUM GLAUCUM* L. R. BR.)

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ABSTRACT

Ten testers were crossed with four lines to develop 40 hybrids using line × tester design to study combining ability in pearl millet for thirteen different characters and evaluated at Agronomy Instructional Farm, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar in *kharif* 2023. It exhibited that the mean square observed due to female was significant for all the character under study. Whereas, mean square observed due to male was significant for all the character except panicle length. The mean square due to line × tester interaction was significant for all the characters except harvest index. Estimation of σ^2sca were greater than the corresponding σ^2gca for all the characters indicated the predominance of non-additive gene effects. Female parents JMSA 20101, JMSA 20156 and ICMA 93333 was good general combiner and male parents J-2296, J-2496, J-2553, J-2571 and J-2604 were found to be good general combiner for grain yield per plant and also some desirable traits. Hybrids *viz*., JMSA 20155 × J-2563, JMSA 20101 × J-2467 and ICMA 93333 × J-2296 showed maximum sca effect for grain yield per plant and other yield attributing traits.

***Keywords* :** Pearl millet, L × T, General combining ability, Specific combining ability

Introduction

Pearl millet [*Pennisetum glaucum* (L.) R. Br.] is the sixth most important cereal crop in the world next to maize, rice, wheat, barley and sorghum and India's fourth important cereal food crop after rice, wheat and maize. It is drought tolerant crop of tropical as well as subtropical region of the world originated from country Africa. It is important predominantly grown as a staple food grain and source of feed and fodder and other use also. It is a highly cross-pollinated crop with protogynous flowering and wind pollination, which meets one of the biological conditions for hybrid development. Pearl millet is commonly known as cat tail millet or spiked millet, bulrush millet in English and locally known as 'bajra' or 'bajri'. The grains of pearl millet or bajra have higher levels of protein content with balanced amino acids, carbohydrate and fat which are important in the human diet and its nutritive value is considered to be comparable or some times more to rice and wheat.

To bring millets into mainstream for exploiting the nutritional rich properties and promoting their cultivation. Govt. of India has declared Year 2018 as the "Year of Millets" and the Year 2023 was declared as "International Year of Millets" by Food and Agriculture Organization Committee on Agriculture (COAG) forum.

Pearl Millet is rightly termed as "nutri-cereal" as it is good source of energy and called as the "power house of nutrition" as it consists of most of the important nutrients in good quantity and quality which is required for maintaining healthy life. Carbohydrate, protein, fat, ash, dietary fibre, iron and zinc. Its grain contains 8.5 to 15.0 per cent protein, 5.03 to 6.00 per cent fat, 1.05 to 1.70 per cent crude fibre and 65 to 70 per cent carbohydrates. As a food crop, pearl millet grain possesses the highest number of calories per 100 grams (Burton *et al*., 1972) which is mainly supplied by carbohydrates, fats, and protein (Flech, 1981). Its grains have high densities of two most important micro-nutrients *viz*., iron (18 to 135 ppm) and zinc (22 to 92 ppm) (Rai *et al.,* 2012) for which spread deficiency in human population had been reported India as well as worldwide.

Materials and Methods

The experimental material comprising by four male sterile lines used as female (JMSA 20101, JMSA 20155, JMSA 20156, ICMA 93333), ten inbred lines or tester used as male (J-2296, J-2372, J-2467, J-2553, J-2566, J-2563, J-2571, J-2590, J-2604, J-2496), their resulting 40 crosses and one standard check GHB 1129 were evaluated in Randomized Block Design with three replications during *kharif* 2023. Observations were recorded on 13 characters and their mean values were subjected to analysis of variance and combining ability. The crosses were made during summer 2023 at Agronomy Instructional Farm, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar using line × tester mating design.

Result and Discussion

Combining ability analysis

The analysis of variance for combining ability (Table 1) showed significant difference among mean squares due to lines, testers and line × tester. The mean square observed due to female was significant for all the character under study. Whereas, mean square observed due to male was significant for all the character except panicle length. This concluded the presence of genetic diversity in both female and male parents included in the investigation. The mean square due to line × tester interaction was significant for all the characters except harvest index. Similar result was reported by Bhadalia *et al.* (2014), Katba (2017) and Badurkar *et al.* (2018).

Estimates of genetic component of variance revealed that the variance due to lines (σ^2L) were higher than the variance due to testers (σ^2T) for all characters except days to 50% flowering, number of effective tillers, plant height, panicle length, panicle diameter, dry fodder yield per plant, harvest index and zinc content indicating the greater role of lines towards total additive genetic variance. Estimation of GCA variance and SCA variance revealed that the magnitude of SCA variance is greater than GCA variance for all the characters suggesting that these characters were predominately under the genetic control of non-additive gene action. The findings of the present investigation for grain yield per plant and its attributing traits are in close conformity with the findings of Kumawat *et al.* (2019), Solanki *et. al.* (2023) Rasitha *et. al.* (2023).

gca and *sca* effects

The best performing parents (females and males) and cross combinations on the basis of *gca* and *sca* effects revealed that none of the parents was found good general combiner for all the characters studied. However, among the female, JMSA 20156 was found to be good general combiner for eight characters *viz.,* days to 50% flowering, days to maturity, number of effective tillers per plant, plant height, panicle length, test weight, grain yield per plant, dry fodder yield per plant followed by JMSA 20101 for six characters *viz.,* days to maturity, number of effective tillers per plant, test weight, grain yield per plant, dry fodder yield per plant and harvest index. Among the males, J-2296 was good general combiner for eight characters *viz.,* number of effective tillers per plant, plant height, test weight, grain yield per plant, dry fodder yield per plant, protein content, iron content and zinc content followed by J-2604 for eight characters *viz.,* days to 50% flowering, days to maturity, number of effective tillers per plant, plant height, test weight, grain yield per plant, iron content and zinc content (Table 2). Thus, the parents were good general combiner for grain yield per plant also showed good general combining ability for one or more component traits. These findings are in concurrence with results of Badurkar *et al.* (2018), Kumawat *et al.* (2019) and Lenka *et al.* (2021). In the present investigation, among the parents, JMSA 20101, JMSA 20156, J-2296 and J-2604 manifested the maximum *gca* effect for the grain yield per plant which can be used in further breeding programme to improve yield and its component characters.

The best specific combination was observed in cross JMSA 20156 × J 2553 for grain yield per plant and involved good × good combining parents. This cross was also expressed good specific combining ability for days to 50% flowering, days to maturity, panicle length, panicle diameter, test weight, protein content, iron content, zinc content and grain yield per plant. The cross combination *viz.,* ICMA 93333 × J-2553, JMSA 20156 × J-2571, ICMA 93333 × J-2604 and ICMA 93333 × J-2296 also showed high significant and positive *sca* effects for grain yield per plant and some other yield attributing characters. This indicated that the high *sca* effect observed for grain yield per plant was associated with desirable *sca* effect manifested by its component characters like plant height, panicle length, panicle diameter, test weight.

Conclusion

The present investigation indicated that the female parent JMSA 20101, JMSA 20156 and ICMA 93333 was good general combiner and male parent J-2296, J-2496, J-2553, J-2571 and J-2604 were found to be good general combiner for grain yield per plant. The best specific crosses for grain yield per plant involved the combinations of either good × good, average × average or good × poor. Hybrid JMSA 20156 × J 2553, ICMA 93333 × J-2553, JMSA 20156 × J-2571 showed high significant and positive *sca* effects for grain yield per plant and some other yield attributing characters.

Table 1: Analysis of variance for combining ability and its component characters in pearl millet

Source of variation	df	Days to 50% flowering	Days to maturity	Number of effective tillers per plant	Plant height	Panicle length	Panicle diameter	Test weight
Replications	2	3.66	1.57	0.11	306.16	10.13	0.003	0.62
Hybrids	39	36.52**	102.73**	0.58**	1391.02**	21.78**	0.398**	6.00**
Lines	3	47.16**	319.73**	1.65**	2881.54**	13.77*	0.235*	16.02**
Testers	9	67.30**	105.30**	0.70**	1813.83**	7.47	0.635**	8.69**
Lines × Testers	27	25.08**	77.76**	0.43**	1084.47**	27.44**	0.337**	3.98**
Error	78	8.10	13.94	0.10	174.80	4.61	0.079	0.68
ESTIMATES								
σ^2 L		0.74	8.07	0.04*	59.90*	-0.46	-0.003	0.4*
σ^2 T		3.52*	2.29	0.05	60.78	-1.66	0.025	0.39
σ^2 gca		1.53**	6.42	0.04**	60.15	-0.8	0.005*	0.4*
σ^2 sca		5.66**	21.27**	0.11**	303.22**	7.61**	0.086**	1.1**
σ^2 gca/ σ^2 sca		0.27	0.30	0.4	0.20	-0.11	0.054	0.36

Table 1 Contd…….

Source of variation	df	Grain yield per plant	Dry fodder yield per plant	Harvest index	Protein content	Iron content	Zinc content
Replications	2	4.10	27.31	0.49	0.25	8.55	0.02
Hybrids	39	91.18**	168.30**	4.00	6.40**	346.45**	91.31**
Lines	3	366.47**	314.92**	9.44*	23.71**	1214.57**	141.79**
Testers	9	82.89**	92.52**	6.00*	5.26**	511.86**	131.07**
Lines × Testers	27	63.36**	177.27**	2.72	4.85**	194.86**	72.45**
Error	78	3.83	27.86	2.60	0.50	27.05	8.86
ESTIMATES							
σ^2 L		10.1*	4.59	0.22*	0.63**	33.99**	2.31
σ^2 T		1.63	-7.06	0.27	0.03	26.42*	4.89
σ^2 gca		7.68**	1.26	0.15	0.46**	31.83**	3.05**
σ^2 sca		19.84**	49.81**	0.23**	1.45**	55.94**	21.2**
σ^2 gca/ σ^2 sca		0.39	0.03	0.65	0.32	0.57	0.14

*, ** were significant at 5% and 1% levels of probability, respectively.

Table 2: Estimates of general combining ability effect of parents and its component characters in pearl millet

Parents	Days to 50% flowering	Days to maturity	Number of effective tillers per plant	Plant height	Panicle length	Panicle diameter	Test weight
Lines							
JMSA 20101	-0.94	-0.87	0.18**	8.41**	-0.44	0.01	0.41**
JMSA 20155	1.53**	3.73**	-0.30**	8.11**	-0.63	0.08	-0.96**
JMSA 20156	-1.11*	-4.00**	0.20**	-5.49*	0.86*	0.03	0.69**
ICMA 93333	0.53	1.13	-0.08	-11.03**	0.22	-0.13**	-0.14
SE (gi)	**0.49**	**0.66**	**0.06**	**2.28**	**0.40**	**0.05**	**0.15**
Testers							
J-2296	1.88**	5.22**	0.14*	-6.81**	-0.05	-0.05	0.74**
J-2372	1.29	0.05	-0.04	2.44	-1.11	-0.03	-0.84**

J-2467	-1.63*	-2.53*	-0.13	-7.89*	-0.90	0.10	-0.70**
J-2496	1.13	0.88	-0.03	-14.48**	0.67	-0.29**	-0.34
J-2553	-4.46**	-4.37**	0.42**	-5.23	1.26*	0.32**	1.20**
J-2566	1.54*	-0.20	-0.28**	15.94**	0.71	-0.16*	-0.40
J-2563	3.04**	3.72**	-0.36**	16.44**	0.17	-0.37**	-1.13**
J-2571	-1.54*	0.55	0.19*	-14.56**	-0.97	0.31**	1.12**
J-2590	1.21	0.05	-0.13	-2.23	0.15	0.14	-0.31
J-2604	-2.46**	-3.37**	0.22*	16.36**	0.07	0.03	0.66**
SE (gi)	**0.77**	**1.05**	**0.09**	**3.60**	**0.63**	**0.08**	**0.24**
Total +^{ve} significant	**4**	**3**	**6**	**5**	**2**	**2**	**6**
Total -^{ve} significant	**5**	**4**	**3**	**6**	**0**	**4**	**4**

Table 2 Contd……

Parents	Grain yield per plant	Dry fodder yield per plant	Harvest index	Protein content	Iron content	Zinc content
Lines						
JMSA 20101	1.34**	3.23**	0.55*	0.05	0.89	0.00
JMSA 20155	-5.07**	-3.39**	-0.78**	1.14**	8.66**	0.68
JMSA 20156	2.91**	2.26**	0.19	-1.02**	-4.86**	-2.94**
ICMA 93333	0.83**	-2.11*	0.04	-0.18	-4.69**	2.26**
SE (gi)	**0.32**	**0.86**	**0.27**	**0.12**	**0.92**	**0.49**
Testers						
J-2296	0.63*	3.29**	0.01	0.88**	3.49**	1.08*
J-2372	-1.06*	1.66	0.52	0.92**	4.95**	6.02**
J-2467	-2.46**	-2.50	-0.46	-1.26**	-6.30**	1.81*
J-2496	2.66**	-1.64	1.55**	-0.11	-2.73	-5.00**
J-2553	3.67**	1.05	-0.10	0.26	9.70**	-1.95*
J-2566	-3.51**	1.23	-0.03	-0.53**	-3.82**	-3.96**
J-2563	-3.85**	-5.94**	-0.86*	-0.17	-12.55**	-1.86*
J-2571	2.27**	1.77	0.48	-0.03	-0.80	-0.49
J-2590	0.40	2.16	-0.69	0.44*	4.68**	2.30**
J-2604	1.26*	-1.09	-0.42	-0.40*	3.38*	2.06**
SE (gj)	**0.51**	**1.36**	**0.43**	**0.19**	**1.45**	**0.78**
Total +^{ve} significant	**8**	**3**	**2**	**4**	**7**	**6**
Total -^{ve} significant	**5**	**3**	**2**	**4**	**5**	**5**

*, ** were significant at 5% and 1% levels of probability, respectively.

Table 3: The best five specific cross combinations with their resulting *sca* effects for grain yield and other component characters including *gca* effects of their parents for grain yield per plant

Hybrids	Grain yield per plant (g)	*sca* effect	*gca* effect		Better Parent Heterosis	Standard heterosis
JMSA 20156 × J-2553	41.95	1.87	2.91**	3.67**	18.41**	14.69**
ICMA 93333 × J-2553	41.17	3.16**	0.83**	3.67**	12.55**	12.56**
JMSA 20156 × J-2571	41.12	2.43*	2.91**	2.27**	10.04**	12.41**
ICMA 93333 × J-2604	40.56	4.95**	0.83**	1.26*	10.87**	10.88**
ICMA 93333 × J-2296	40.51	5.53**	0.83**	0.63*	10.73**	10.74**

*, ** were significant at 5% and 1% levels of probability, respectively.

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