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Heterosis Studies for Yield and Yield Attributing Traits in Forage Maize (*Zea mays* L.)

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ABSTRACT: The utility of heterosis *per se* may not be of much use, but cross combinations showing excellent hybrid vigour can be used in developing high yielding forage hybrids in maize crop. The present investigation was conducted at B.A. College of Agriculture, Anand Agricultural University, Anand. The experimental material consisted of 50 F_1 and their10 parents (5 females and 10 males). Material was sown in randomized complete block design with three replications. The hybrids were evaluated to know the extent of heterosis over better parent. The maximum heterobeltiosis for the most important character green forage yield per plant observed in the hybrid IC 130882 × GDRFG 1644 (36.98). This hybrid can be identified as potential hybrid for wide spread cultivation and commercial exploitation after necessary testing. This cross can also be advanced for isolation of superior genotypes and selected genotypes may intermated to map up fixable genetic variance.

Keywords: Forage Maize, Heterosis, Heterobeltiosis, Hybrid, Parents.

INTRODUCTION

Maize (*Zea mays* L.) ranks second in position after sorghum among the cereal fodder crops. It is one of the most important dual purpose crops grown in *kharif, rabi* and summer for grain and fodder purpose. Its quick growth and high palatability of fodder for cattle and wider adaptability over a wide range of environmental conditions and cropping seasons signifies as a good forage crop. It has no toxins and can be fed to the cattle at all growth stages in any quality. Indeed, maize green fodder has some lactogenic properties resulting in increased milk production. Hybrid vigor can be exploited in quantitative and quality traits in maize (Jogdande *et al.,* 2024). Single cross hybrids also show good heterotic response (Sawan *et al.,* 2022). Crosses made in Line × Tester fashion helps to predict heterotic response (Bichewar *et al.,* 2023). It is also fact that very few hybrid varieties have been released in forage maize. Information available on heterosis breeding in forage maize is limited; hence, this attempt was made to investigate the extent of heterosis for forage yield and its attributing traits.

MATERIALS AND METHODS

The field experiment was conducted at B. A. College of Agriculture Farm, Anand Agricultural University, Anand during *rabi*-2023 season. The experiment was laid out in randomized block design (RBD) with three replications having a plot size of 4.5 m × 0.60 m. The present study consisted of a set of 5 lines (female parents) and10 testers (male parents). Parents were crossed in a line × tester mating design (5 × 10) in. Seeds of each entry were grown in two rows of 4.5 m length with 30 cm spacing between rows and 15 cm within rows. Recommended agronomic practices were followed for raising the crop. Observations were recorded on five randomly competitive plants for fodderyield and related traits. The data obtained for each character were analyzed by the statistical procedure given by Panse and Sukhatme (1989).

RESULTS AND DISCUSSION

Heterobeltiosis (superiority over better parent) for all the characters were estimated while interpreting the results, positive heterobeltiosis effects were considered as favourable effect for the traits *viz.,* plant height, number of leaves, leaf length, leaf width, leaf : stem ratio and green forage yield per plant.

A. Plant height
Positive heterosis is desirable for plant height. Heterobeltiosis ranged from -11.93 to 26.31 (Table 1). Total five crosses were found significantly positive for heterobeltiosis in this character. The cross combination IC 130882 × IC 130987 (26.31) had significantly the highest estimate of heterobeltiosis. Similar results were also reported by Shete *et al.* (2011).

Table 1: Heterosis in F_1 hybrid over better parent (BPH) in forage maize.

Crosses	Plant height (BPH)	No. of leaves/plant (BPH)Bio	Leaf length (BPH)	Leaf width (BPH)	Leaf : stemratio (BPH)	Green forage yield/plant (BPH)
African Tall × IC 130976	-1.61	**7.32***	1.65	-6.06	8.39	**-16.55***
African Tall × IC 130987	**-8.5***	2.44	0.81	-5.19	17.34	4.13
African Tall × IC 131016	-2.25	-1.46	**12.21****	3.9	-4.27	8.99
African Tall × MA 4207	0.64	-0.98	3.38	**-14.29****	**21.14***	**14.62***
African Tall × NP96K 2415	-3.54	**7.32***	**8.86***	**9.52***	-9.11	5.24
African Tall × OM 6345	**-11.76****	**-12.2****	2.9	-1.3	-3.03	-1.9
African Tall × OM 6354	-4.41	-2.93	1.28	-3.46	1.37	-11.59
African Tall × OM 6357	**-10.85****	**-8.78***	0.55	-8.23	-5.44	1.48
African Tall × OM 6377	-2.35	-0.49	0.4	-2.6	-11.27	-0.6
African Tall × GDRFG 1644	-4.51	-5.37	-0.73	-3.46	-10.86	-9.95
IC 7701 × IC 130976	-1.33	**14.1****	**-8.56***	**-14.85****	**83.05****	5.31
IC 7701 × IC 130987	3.93	**8.47***	-4.8	**-11.87***	**47.24****	5.96
IC 7701 × IC 131016	-2.58	4.35	3.34	2.22	-18.43	5.29
IC 7701 × MA 4207	-4.96	-1.69	6.84	-1.83	**56.46****	7.46
IC 7701 × NP96K 2415	8.52	**22.35****	2.12	-8.97	17.1	3.68
IC 7701 × OM 6345	**-11.93****	**-8.7***	6.03	-0.91	-19.49	-11.94
IC 7701 × OM 6354	-4.98	-0.56	0.48	3.65	7.65	**17.55***
IC 7701 × OM 6357	**14.81****	**31.14****	-1.66	**-10.05***	10.61	**16.91***
IC 7701 × OM 6377	-2.37	-0.56	0.57	5.94	9.06	-11.31
IC 7701 × GDRFG 1644	-1.37	7.74	-3.09	0.91	9.71	-4.52
IC 130882 × IC 130976	**-10.38***	-3.19	-0.63	0	16.26	**-17.88***
IC 130882 × IC 130987	**26.31****	**18.08****	5.95	-8.8	16.96	-2.06
IC 130882 × IC 131016	4.81	2.72	6.84	-2.67	-21.44	-6.55
IC 130882 × MA 4207	**20.74****	**12.92****	0.33	5.71	-13.66	13.52
IC 130882 × NP96K 2415	6.38	**8.47***	-1.75	-5.83	7.69	7.86
IC 130882 × OM 6345	-0.04	0	4.82	0.95	-17.48	**22.01***
IC 130882 × OM 6354	**9.29***	6.78	6.88	5.53	0.4	15.81
IC 130882 × OM 6357	3.75	7.91	0.55	4.21	-4.79	12.19
IC 130882 × OM 6377	**21.18****	5.08	-1.39	**10.48***	16.2	14.62
IC 130882 × GDRFG 1644	4.58	**20.9****	-0.16	**18.1****	1.6	**36.98****
IC 130913 × IC 130976	2.31	**8.51***	0.63	-7.86	3.6	-5.96
IC 130913 × IC 130987	-2.25	5.46	0.17	-8.33	14.17	**-20.43***
IC 130913 × IC 131016	-7.47	0	1.35	1.78	-21.27	-8.23
IC 130913 × MA 4207	-4.53	0	-2.87	-6.67	**-23.86***	10.71
IC 130913 × NP96K 2415	-7.93	0	-5.32	-6.28	**21.32***	-4.93
IC 130913 × OM 6345	-5.79	-2.17	**12.08****	**11.27***	-12.3	-2.87
IC 130913 × OM 6354	-4.13	0.55	-5.04	0	-5.92	5.02
IC 130913 × OM 6357	-2.94	-1.64	-7.89*	0.47	-11.29	**25.91****
IC 130913 × OM 6377	**-10.55***	-3.83	-5.56	-6.86	18.55	8.03
IC 130913 × GDRFG 1644	-5.95	1.64	0.49	6.86	-19.47	12.81
IC 130950 × IC 130976	**-8.42***	-3.72	-5.73	8.73	-13.95	-8.02
IC 130950 × IC 130987	6.61	**10.73****	**11.34****	7.41	-1.99	-7.44
IC 130950 × IC 131016	-6.6	-3.8	2.19	-0.89	-10.21	-4.2
IC 130950 × MA 4207	0.17	5.06	2.46	2.86	**-22.25***	6.65
IC 130950 × NP96K 2415	2.09	**14.2****	6.4	2.24	**-31.48****	15.33
IC 130950 × OM 6345	3.65	-2.17	**8.77***	**12.56***	**-37.79****	**25.78****
IC 130950 × OM 6354	1.11	7.91	0.16	5.53	**-31.86****	**26.05****
IC 130950 × OM 6357	-1.11	1.14	5.44	7.48	-20.57	4.07
IC 130950 × OM 6377	-0.52	2.82	6.62	**11.56***	-9.82	14.32
IC 130950 × GDRFG 1644	-6.61	-1.7	-1.71	8.82	**-24.74***	**20.21***
Range						
Min.	-11.93	-12.20	-8.56	-14.85	-37.79	-20.43
Max.	26.31	31.14	12.21	18.10	83.05	36.98
S.E ±	8.48	0.48	3.11	0.36	0.06	25.39
No. of significant crosses	12	16	7	10	11	12
Positive	5	13	5	6	5	9
Negative	7	3	2	4	6	3

B. Number of leaves per plant

Estimates of heterobeltiosis for number of leaves per plant varied from -12.20 to 31.14 (Table 1). Out of 50 crosses, 13 crosses had shown significant positive heterobeltiosis. The cross combination IC 7701 × OM 6357 (31.14) depicted the highest significant positive heterobeltiosis. These results were akin with reports of Patel *et al.* (2004).

C. Leaf length

Estimates of heterobeltiosis for leaf lengthvaried from -8.56 to 12.21 (Table 1). Total 7 crosses were found significantly positive for heterobeltiosis in this character. The cross combination African Tall × IC 131016 (12.21) recorded significantly the highest heterobeltiosis in desirable direction for this trait. Similar results were also reported by Patel *et al.* (2004).

D. Leaf width

For leaf width, the estimates of the range of heterobeltiosis was -14.85 to 18.10 (Table 1). Out of 50 crosses, 6 crosses had shown significantlypositive heterobeltiosis. The cross combination IC 130882 × GDRFG 1644 (18.10) recorded significantlythe highest heterobeltiosis effect among all crosses. Appreciable levels of heterobeltiosis for this character had been reported earlier by Choi *et al.* (1995); Patel *et al.* (2004).

E. Leaf : stem ratio

Positive heterosis is desirable for leaf : stem ratio. More leaves may increase the palatability of fodder. The estimates of heterobeltiosis ranged from -37.79 to 83.05 (Table 1). Total 5 crosses were found significantly positive for heterobeltiosis in this character. Among the cross combinations, IC 7701 × IC 130976 (83.05) showed significantly the highest heterobeltiosis in desired direction. Similar results were also reported by Patel *et al.* (2004).

F. Green forage yield per plant

For most important character green forage yield per plant, the values of heterobeltiosis ranged from -20.43 to 36.98 (Table 1). Out of 50 crosses, 9 crosses exhibited significantly positive heterobeltiosis. Among the cross combinations, IC 130882 × GDRFG 1644 (36.98) depicted significantly the highest heterobeltiosis suggesting as good cross combination for this important character. Similar results were also reported by Mistry and Patil (1994); Santos *et al.* (1994); Patel *et al.* (2004).

CONCLUSIONS

It was concluded that the cross combinations *viz.,* IC 130882 × GDRFG 1644 depicted significantly thehighest heterobeltiosis and considered as good cross combination for green forage yield. This hybrid can be identified as potential hybrids for wide spread cultivation and commercial exploitation after necessary testing. This cross can also be advanced for isolation of superior genotypes and selected genotypes may intermated to map up fixable genetic variance.

FUTURE SCOPE

The promising hybrids identified in this study can be exploited commercially to increase fodder yield in maize.

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