Electronic Journal of Plant Breeding,
ISSN 0975-928X DOI : 10.5958/0975-928X.2016.00025.9

Heterosis response for green fodder yield and its quality traits in forage maize (Zea *mays* (L.))

J.I. NANAVATI, H.P. PARMAR, J.P. BHATT
Sheth M.C.Polytechnic in Agriculture, Anand Agricultural University,
Ananad-388110 (Gujarat), India

(Received: June 2015; Accepted: June 2015)

Abstract
Using Line x Tester mating design, 45 hybrids were produced and evaluated to know the extent of heterosis over better parent for green forage yield per plant and its quality traits in forage maize. The hybrids exhibited significant heterobeltiosis in desired direction for green forage yield per plant and its quality traits. Crosses African Tall x GWC-0319 and African Tall x GWC-0321 exhibited maximum significant positive hetero-beltiosis for green forage yield per plant with its quality traits, thus, strengthening the scope of heterosis breeding in forage maize. For dry matter content, the range of heterobeltiosis was from –26.33% (African Tall x IC-130643) to 24.74 % (GM-6 x GWC-0321). For dry matter yield per plant, the range of heterobeltiosis was from –50.80% (J-1006 x GWC-9603) to 122.79 % (African Tall x GWC-0319). For crude protein content, the range of heterobeltiosis was from –11.27% (J-1006 x GWC-0319) to 9.78 % (African Tall x GWC-0321). For crude protein yield per plant, the range of heterobeltiosis was from –53.10% (IC-130726 x GWC-0319) to 128.78 % (African Tall x GWC-0321).
Key wards: Forage Maize, Heterosis, Heterobeltiosis**,** Quality traits, Crosses

Introduction

Maize [*Zea mays* (L.)] is almost an ideal cereal forage crop because of its fast growing habit, high palatability and nutritious qualities and can be grown in any season. It has a relatively low cell wall content and high content of non-structural carbohydrates, and as a result it has a high digestibility and bio-energy value. Also, it has no toxic compounds and can be fed at any stage of growth. It is true that less number of hybrids released as forage maize. The present study is an attempt to assess the possibilities of commercial exploitation of heterosis for fodder yield along with certain quality traits of forage maize, through estimating extent of heterosis over better parent for various yield and quality traits.

Materials and Methods

The hybrids were developed by crossing 5 lines (IC-107121, IC-130726, GM-6, J-1006, African Tall) and 9 testers (IC-130643, IC-130693, GWC-0319, GWC-0320, GWC-0321, GWC-0401, GWC-0511, GWC-0512, GWC-9603) in line x tester mating design during *Rabi*-2013. The experimental material for the present investigation consisted of 14 parents (5 lines + 9 testers) and 45 hybrids. The experiment was conducted at the research farm of Main Forage Research Station, Anand Agricultural University, Anand (Gujarat). Each experimental plot consisted of two rows of 4.5 m length each. The inter-row and intra-row spacings were 30 and 15 cm, respectively. The experiment was evaluated in a randomized block design with three replications. The recommended agronomic practices were followed for raising a normal crop.

For recording observations, 5 competitive plants were randomly selected from each treatment in each replication and the average value per plant was computed for fodder yield and quality traits *viz.*, green forage yield per plant, dry matter content, dry matter yield per plant, crude protein content and crude protein yield per plant. The significance of the estimates of heterosis was tested as per Fonseca and Patterson (1968).

Results and Discussion

The analysis of variance revealed that parents and hybrids differed significantly for all the characters studied (Table 1). The mean squares due to females and males were significant for all the characters. This revealed the presence of great deal of diversity among the parents with respect to all the characters under study and hence pronounced different heterotic effects. The mean squares due to females *vs* males were significant for most of the characters. Further, the mean squares due to hybrids were significant for all the characters. Similarly, all the variances for parents *vs* hybrids except crude protein content were significant which suggested the existence of differences between parents and hybrids for most of the characters. The magnitudes of heterobeltiosis for different characters studied are presented in Table 2.

For green forage yield per plant, the crosses IC-130726 x GWC-0319 and African Tall x GWC-0319 depicted minimum -42.68 % and maximum 104.87 % heterosis over better parent, respectively. Total 13 crosses showed desired significant positive heterosis over better parent. Crosses African Tall x GWC-0319 (104.87%) followed by African Tall x GWC-0321 (101.87%) exhibited maximum significant positive heterobeltiosis for green forage yield per plant. The results are in agreement with the results reported by Patel (2000), Patel *et al*. (2004), Parmar (2006) and Vaghela (2012).

For dry matter content, the range of heterobeltiosis was from -26.33 (African Tall x IC-130643) to 24.74 % (GM-6 x GWC-0321). Out of 45 hybrids, 6 hybrids over better parent expressed significantly positive heterosis for this trait. Crosses GM-6 x GWC-0321 (24.74%) followed by GM-6 x GWC-9603 (22.71%) exhibited maximum significant positive heterobeltiosis for dry matter content. The results are in agreement with those reported by Parmar (2006) and Vaghela (2012).

For dry matter yield per plant, the range of heterobeltiosis was from -50.80 (J-1006 x GWC-9603) to 122.79 % (African Tall x GWC-0319). Out of 45 hybrids, 13 hybrids over better parent expressed significantly positive heterosis for this trait. Crosses African Tall x GWC-0319 (122.79%) followed by African Tall x GWC-0321 (116.97%) exhibited maximum significant positive heterobeltiosis for dry matter content. Todorov (1981), Patel et al. (2004), Parmar (2006) and Vaghela (2012) reported the similar magnitude of heterosis for this trait.

For crude protein content, the range of heterobeltiosis was from -11.27 (J-1006 x GWC-0319) to 9.78 % (African Tall x GWC-0321). Out of 45 hybrids, 6 hybrids over better parent expressed significantly positive heterosis for this trait. Crosses African Tall x GWC-0321 (9.78%) followed by IC-107121 x IC-130643 (5.61%) exhibited maximum significant positive heterobeltiosis for crude protein content. A similar heterosis effect for crude protein content was also reported by Patel (2000), Parmar (2006) and Vaghela (2012).

For crude protein yield per plant, the range of heterobeltiosis was from -53.10 (IC-130726 x GWC-0319) to 128.78 % (African Tall x GWC-0321). Out of 45 hybrids, 11 hybrids over better parent expressed significantly positive heterosis for this trait. Crosses African Tall x GWC-0321 (128.78%) followed by African Tall x GWC-0512 (82.98%) exhibited maximum significant positive heterobeltiosis for crude protein content. Similar findings were also reported by Parmar (2006) and Vaghela (2012).

High dry matter content, dry matter yield per plant, crude protein content and crude yield per plant are better for good quality fodder. So, positive heterosis is desirable for these traits. In this experiment the hybrid African Tall x GWC-0319 showed the highest significant and positive heterosis effect over better parent for green forage yield per plant and also showed significant and positive heterosis effect over better parent for dry matter yield per plant and crude protein yield per plant followed by hybrid African Tall x GWC-0321 for green forage yield per plant and also showed significant and positive heterosis effect over better parent for dry matter yield per plant, crude protein content and crude protein yield per plant. Therefore, these two cross combinations may be advanced for isolation of superior genotypes and selected genotypes may be intermated to map up fixable genetic variance. These crosses would also be utilized for the exploitation of heterosis on commercial basis after necessary testing.

References

Fonseca, S. and F.Patterson (1968). *Crop Sci.*, **8**: 85-88.

Parmar, H. P. (2006). Heterosis, combining ability and stability analysis in forage maize (*Zea mays* L.). Unpublished Ph. D. thesis submitted to A.A.U., Anand.

Patel, D. A. (2000). Genetic studies in interspecific hybrids of forage maize (*Zea mays* L.) Unpublished Ph. D. (Agri.) thesis submitted to G.A.U., Sardar Krushinagar.

Patel, D. A.; Jadeja, G. C.; Patel, D. B. and Patel, J. S. (2004). Heterosis for forage yield and its components in maize x teosinte hybrids. Forage Res., **30(3)** : 145-148

Vaghela, P. (2012). Heterosis, combining ability and stability analysis in forage maize (*Zea mays* L.). Unpublished Ph.D. (Agri.) thesis submitted to A.A.U., Anand.

Todorov, G. (1981). Expression of heterosis in F_1 maize for plant growth, photosynthesizing leaf area and dry matter accumulation. *Rasteniev dni Nauki*, **18** : 30-36.

Electronic Journal of Plant Breeding,
ISSN 0975-928X DOI : 10.5958/0975-928X.2016.00025.9

Table 1: Analysis of variance for different characters

Source of variation	df	Mean sum of square				
		Green forage yield per plant	Dry matter content	Dry matter yield per plant	Crude protein content	Crude protein yield per plant
Replications	2	416.90	1.41	1.42	0.00132	0.058 *
Genotypes	58	32563.08 **	6.48 **	987.77 **	0.045 **	2.11 **
Parents	13	25934.92 **	6.23 **	669.93 **	0.082 **	1.49 **
Females (Lines)	4	23456.67 **	11.77 **	665.73 **	0.060 **	1.78 **
Males (Testers)	8	10022.14 **	3.87 **	305.70 **	0.10 **	0.93 **
Females Vs Males	1	163150.20 **	2.87	3600.59 **	0.016	4.86 **
Hybrids	44	33628.32 **	6.41 **	1034.79 **	0.035 **	2.21 **
Parents Vs Hybrids	1	71852.00 **	12.48 **	3052.20 **	0.000122	5.73 **
Error	116	266.846	0.94	20.41	0.00898	0.107

Electronic Journal of Plant Breeding,
ISSN 0975-928X DOI : 10.5958/0975-928X.2016.00025.9

Table 2: Magnitude of heterosis over better parent for different characters

Crosses	Green forage yield per plant		Dry matter content		Dry matter yield per plant		Crude protein content		Crude protein yield per plant	
	B.P. %		B.P. %		B.P. %		B.P. %		B.P. %	
IC-107121 x IC-130643	-42.22	**	-20.86	**	-49.20	**	5.61	**	-41.08	**
IC-107121 x IC-130693	-18.51	**	-4.92		-19.38	**	0.44		-18.81	*
IC-107121 x GWC-0319	-40.23	**	-10.38	*	-44.55	**	-10.46	**	-20.33	*
IC-107121 x GWC-0320	-23.17	**	9.56		-11.62	*	0.79		-6.36	
IC-107121 x GWC-0321	-30.43	**	-12.19	*	-36.37	**	4.81	**	-20.19	
IC-107121 x GWC-0401	-25.43	**	-6.01		-27.31	**	-3.04		-25.94	**
IC-107121 x GWC-0511	-10.97	**	-7.10		-13.39	*	2.11		18.67	*
IC-107121 x GWC-0512	-28.17	**	7.49		-21.68	**	-0.18		-26.83	**
IC-107121 x GWC-9603	-15.15	**	-9.67		-22.02	**	-1.02		-8.85	
IC-130726 x IC-130643	-30.60	**	-23.59	**	-36.87	**	-4.76	**	-9.67	
IC-130726 x IC-130693	-30.33	**	0.36		-31.23	**	-2.72		-39.86	**
IC-130726 x GWC-0319	**-42.68**	******	-3.95		-47.04	**	-7.22	**	**-53.10**	******
IC-130726 x GWC-0320	-34.41	**	-2.96		-36.32	**	-3.74	*	-32.58	**
IC-130726 x GWC-0321	-5.19	*	19.20	**	9.81		-4.51	**	7.04	
IC-130726 x GWC-0401	-31.65	**	-0.55		-28.93	**	-4.17	*	-41.29	**
IC-130726 x GWC-0511	-36.31	**	14.67	*	-23.78	**	-2.89		-42.96	**
IC-130726 x GWC-0512	33.29	**	7.24		40.84	**	-3.15	*	41.53	**
IC-130726 x GWC-9603	-17.86	**	-15.39	**	-29.74	**	-6.80	**	-13.13	
GM-6 x IC-130643	-35.96	**	8.26		-10.05		-3.26	*	-27.51	**
GM-6 x IC-130693	2.33		9.60		39.89	**	0.88		20.77	*
GM-6 x GWC-0319	-21.62	**	10.32		1.83		-7.54	**	-14.09	
GM-6 x GWC-0320	-17.98	**	7.22		5.12		-2.10		-9.79	
GM-6 x GWC-0321	-38.64	**	**24.74**	******	-15.79	*	-2.55		-25.96	**
GM-6 x GWC-0401	-12.83	**	5.49		15.89	*	-1.22		0.00	
GM-6 x GWC-0511	-28.83	**	0.00		-11.17		-2.02		-23.29	*
GM-6 x GWC-0512	15.65	**	17.09	**	49.12	**	-0.35		59.64	**
GM-6 x GWC-9603	-11.39	**	22.71	**	38.91	**	-2.82		33.68	**
J-1006 x IC-130643	-15.55	**	-17.97	**	-29.42	**	0.00		-15.67	*

Electronic Journal of Plant Breeding,
ISSN 0975-928X DOI : 10.5958/0975-928X.2016.00025.9

J-1006 x IC-130693		12.13	**	-1.42		11.52	*	-1.50		9.71	
J-1006 x GWC-0319		-1.10		-13.52	**	-12.94	**	**-11.27**	**	-11.59	
J-1006 x GWC-0320		-30.26	**	-11.24	*	-36.99	**	0.96		-46.58	**
J-1006 x GWC-0321		7.48	**	-14.28	**	-7.08		-2.73		10.93	
J-1006 x GWC-0401		25.16	**	11.54	*	44.97	**	1.39		38.19	**
J-1006 x GWC-0511		0.65		-4.56		-1.86		-2.19		-4.86	
J-1006 x GWC-0512		-4.26		-24.41	**	-26.86	**	3.79	*	-6.73	
J-1006 x GWC-9603		-40.84	**	-16.61	**	**-50.80**	**	-2.99		-50.77	**
African Tall x IC-130643		14.83	**	**-26.33**	**	-11.59		1.37		2.62	
African Tall x IC-130693		22.53	**	-9.28		22.61	**	-2.82		22.68	*
African Tall x GWC-0319		**104.87**	**	7.06		**122.79**	**	-7.62	**	42.30	**
African Tall x GWC-0320		20.74	**	7.06		31.89	**	1.75		17.13	
African Tall x GWC-0321		**101.87**	**	7.06		116.97	**	**9.78**	**	**128.78**	**
African Tall x GWC-0401		13.53	**	-14.83	**	2.21		1.74		-23.48	**
African Tall x GWC-0511		48.01	**	0.72		55.25	**	5.18	**	71.14	**
African Tall x GWC-0512		42.46	**	-11.67	*	39.48	**	4.41	**	82.98	**
African Tall x GWC-9603		-18.22	**	0.39		-14.73		-4.69	**	-6.31	
Range :	Min.	-42.68		-26.33		-50.80		-11.27		-53.10	
	Max.	104.87		24.74		122.79		9.78		128.78	
SE (±)		13.34		0.97		4.52		0.09		0.33	
No. of significant crosses		41		20		35		19		28	
Positive		13		6		13		6		11	
Negative		28		14		22		13		17	

***, ** Significant at 5 % and 1 % levels, respectively. R.H. – Relative heterosis and B.P. – Better parent**