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COMBINING ABILITY AND TYPE OF GENE ACTION FOR GRAIN YIELD AND SOME OTHER TRAITS USING LINE X TESTER ANALYSIS IN TEOSINTE INBRED LINES (*Zea mexicana L.*)

Sakr, H.O. and Mona M.F. Ghazy
Forage Research Program, FCRI, ARC, Egypt.

ABCTRACT

This investigation has been done to obtain information on the genetic behavior of grain yield components in teosinte × maize hybrid, in order to identify the desirable breeding program for the improvement of these traits. Four inbred lines of teosinte, L1, L2, L3 and L4 were crossed to three genotypes of maize, two inbred lines, Sd34 and Sd63, addition to a commercial (Sc, 30K8), at Serw Agricultural Research Station in 2007 growing season. The twelve crosses and their parents were evaluated during 2008 and 2009 seasons at Serw Agricultural Research Station. Results showed that significant differences among crosses for all studied traits. However, lines were significantly differed for 100-grains weight and grain yield per plot. While testers were varied significantly for green fodder yield per plot and grain yield per plot. On the other hand, the interaction between crosses × years interaction were highly significant for all studied traits except number of tillers per plant. In addition L × T × years interactions was significant for all studied traits except crude protein. The parent of inbred line -1 had highest positive and significant GCA effect for TND, 100- grain weight and grain yield per plot and exhibited desirable GCA effect for number of tassling date (toward earliness), line-3 had positive and significant GCA effect for green fodder yield per plot and 100-grain weight. Thus, these inbred lines (L1 and L3) could be recommended for advanced stage of evaluation through the breeding program. 30k8 (T1) tester was good general combiner for 100-grain weight, crude protein and grain yield per plot while (T2 and T3) was good general combiner for green fodder yield per plot, and TDN. The highest SCA effects were observed in the top crosses L1 × T3 for TDN, number of tillers per plant, tassling date (toward earliness), crude protein and grain yield per plot. Estimation of general combining ability variance components (σ^2GCA) was larger than the corresponding value of specific combining ability variance components (σ^2SCA) for green fodder yield per plot, 100-grain weight and grain yield per plot indicating that additive was found to be more important than non-additive gene action for these traits. While, the σ^2SCA was larger than σ^2GCA for TDN, number of tillers per plant, plant height, tassling date and crude protein percentage, indicating that the non-additive genetic variance played the major role in the inheritance of these traits. Generally, all topcrosses were superior to their parents of teosinte for green fodder yield per plot, tassling date (toward earliness), grain yield per plot, 100-grain weight, except (L2 × T2) and (L2 × T3), and crude protein except (L2 × T3). These top crosses for crude protein were L2 × T1, L3 ×T1 and L4× T1. However, in the case of grain yield per plot these topcrosses were L1 × T3, L1× T2, L4× T1, L1× T2, L2× T1 and L3× T1. Therefore, these top crosses can be used for improvement in green fodder yield and grain yield which can be used in silage in dough stage.

Keywords: Teosinte, *Zea mexicana,* maize, top crosses, line × tester, combining ability, gene action.

INTRODUCTION

In Egypt as well as other countries great efforts has been directed towards the improvement of summer fodder crops. Teosinte × maize hybrids could provide an answer to overcome the problem of shortage in production of summer fodder. The importance of teosinte × maize hybrids as a fodder crop can be judged from the fact that it has advantage of giving very high fodder yields, due to profuse tillaring capacity which is absent in fodder maize. Beside it can give three cuts against one cut obtained from fodder maize (Sakr, 2009). In addition, teosinte × maize hybrids like maize can be safely feed on at any stage of growth (Relwani, 1968). Teomaize crosses have been attempted in the past between teosinte and maize with partial success, but a concerned effort may produce a high yielding and a nutritious variety. In this respect, Chaugale and Chavan (1965) and Chaudhuri and Prasad (1969) reported the successful production of hybrids between maize and teosintes and considerable amount of heterosis was observed in most of the hybrids raised by them. On the other hand, Gill and Patil (1985) studied the forage production of maize, teosinte and their hybrids (maizente) and mentioned that teosinte entries proved to be significantly superior over maizente hybrids and maize for green fodder and dry matter production. During the last three decades, a great deal of information about the hybrids between maize and teosinte has been given by several authors (Smith *et al*. 1984, Abdel-Twab and Rashed 1985, Aulicino and Magoja 1991, Sohoo *et al*. 1993, Alan and Sundberg 1994, Jode and James 1996 and jode *et al*.1996) but all the available information has contributed to the relationships among teosintes and between teosinte and maize in addition to the characterization of teosinte for agronomic traits. Barriere *et al*. (1984) studied of protein content and agronomic value in progenies from the cross maize × teosinte and assessed that the topcross was high in fodder(silage) yield and protein yield/ha. Numerous researchers reported that the variance components of SCA for grain yield and other traits were larger than these due to GCA, indicating that the importance of non-additive gene action the inheritance of these traits; Mostafa *et al*.(1995), El-Shenawy *et al*. (2003), Aly and Amer (2008) and Brakat and Osman (2008) for grain yield in maize. On contrary, IIchovska *et al*.(1995), in maize × teosinte hybrids, Abd El-Maksoud *et al*. (2001), in teosinte, Amer *et al*. (2003), and Aly and Mousa (2008) in maize, reported that the additive genetic variance played an important role in the inheritance of plant height, grain yield and other traits.

Recently, Sakr (2009) and sakr *et al*. (2009) presented information about the nature of gene action for green fodder yield in teosinte × maize hybrids, virtually no data exist on the nature of gene action for grain yield components and crude protein percentage.

Therefore, this investigation aims to contribute to our knowledge by gather information on the genetic behavior of grain yield components in addition to crude protein percentage. Then, the desirable breeding program for improvement of these traits could be determined.

MATERIALS AND METHODS

Four teosintes inbred lines derived through selection from segregating generations of four crosses (Local teosinte with Central plateau race, Local teosinte with Balsas race, central plateau race with Balsas race Central plateau race with guatemale race). These lines were crossed with three entries of maize i.e. inbred line 34(T2) and inbred line 63(T3) from national maize research program, Field Crop Research Ins, Agricultural Research Center and single cross 30k8(commercial), (T1). These crosses were made at Serw Agricultural Research Station during 2007 growing season. The produced from crosses and their parental lines were evaluated at Serw Agricultural Research Station in two years 2008 and 2009. The experiment was arranged in a randomized complete block design with three replications, plot size was one row, 4 m long and 80 cm a part. Seeds were planted in hills (in case of maize entries seeds were planted in two plots for each replicate one was cut to estimate green fodder yield / plot and (TDN) and the other was left to estimate grain yield and it's components). Evenly, spaced at 25 cm along the row at the rate of three kernels per hill. Seeds were thinned to one plant per hill after 21 days from planting. All agronomic field practices were applied as recommended. Data were recorded on 10 plants chosen at random from each plot in the first cut at two seasons for green fodder yield per plot and total digestible nutrients (TDN) were calculated by, TDN = 50.41 + 1.04 CP (%) - 0.07 CF(%), according to Wheeler and Mochrie (1981), where CP% are crude protein percentage which was calculated by multiplying the total nitrogen by a factor of 5.75, where the total nitrogen was determined by Micro-Keldahl method (A.O.A.C.1990). While (CF %) are crude fiber percentage, which were determined according to (A.O.A.C.1990). After the first cut all entries left to seed production stages. Data were recorded on number of tillers per plant (NT/p), plant height (Ph), number of days from planting to 50% tassel (50% tassling), 100-grain weight in gm, crude protein percentage (CP%)and grain yield per plot. Statistical analysis were performed for each year then combined over the two years according to Steel and Torrie (1980). The combining ability analysis was done using the line×tester procedure as suggested by Kempthorne (1957). Combined analysis among the two years was done on the based of homogeneity test.

RESULTS AND DISCUSSION

Analyses of variance were made separately for each year and the data combined over two years for all studied traits. The obtained results are presented in Table 1. Combined analysis for variance revealed significant differences among crosses and for all studied traits. In addition, lines (L) mean squares were significant for 100-grain weight and grain yield per plot, while testers (T) mean squares were significant for green fodder yield per plot and grain yield per plot. These results indicated that both inbred lines and testers were significantly different from one each to another in top crosses.

Significant line × tester interaction suggests that inbred lines may have different combining ability patterns and performed differently in crosses depending on type of tester used. Similar results were reported by Sakr (2009), Sakr *et al*. (2009) in teosinte × maize hybrids, Abd El- Maksoud *et al*. (2001), in teosinte, and Aly and Amer (2008) in maize.On the other hand, the interactions between crosses × years were highly significant for all studied traits except number of tillers per plant. In addition, L × T × years interactions mean squares were significant for all studied traits except crude protein (CP %). While, tester × years interaction mean squares were significant for number of tillers per plant and crude protein (CP %). Similar results were recorded by Sakr *et al*. (2009) in teosinte × maize hybrids, Abd El-Maksoud *et al*. (2001) in teosinte, Barakat and Osman (2008) in maize.

Table 1: The results of the analysis of variance for all studied traits for the two years and over both years.

			GFY plot^{-1}	TDN %	NT/P	Ph m	50% Tussling	100Gw in gm	C.P.%	Gy plot^{-1}
Replication	2	Y_1	0.005	0.5	0.07	0.04	2.73	0.11	0.16	0.03
		Y_2	0.07	0.26	0.09	0.08	2.95	0.05	0.07	0.001
Crosses(C)	11	Y_1	13.09**	6.74**	0.95**	0.52**	254.5**	6.5**	2.94**	2.38**
		Y_2	11.93**	12.5**	1.06**	0.12**	95.33**	8.71**	1.33**	3.1**
Lines(L)	3	Y_1	15.74	6.20	1.47	1.05	392.41	17.16*	0.26	5.46**
		Y_2	11.45	16.73	0.34	0.12	26.65	19.45*	0.14	8.31**
Testers(T)	2	Y_1	37.2*	3.63	0.4	0.10	186.4	4.31	9.5	3.27*
		Y_2	33.4*	8.07	1.44	0.19	246.54	9.54	3.93	2.35
LXT	6	Y_1	3.74**	8.05**	0.88*	0.39**	208.32**	1.9**	2.1**	0.54**
		Y_2	5.03**	11.74**	1.29**	0.09	79.3**	3.07**	1.07**	0.74**
Error	22	Y_1	0.11	0.21	0.27	0.01	5.63	0.2	0.16	0.03
		Y_2	0.16	0.42	0.24	0.06	3.04	0.08	0.04	0.03
			Combined Analysis							
Location(Loc)	1		0.002	8.92**	0.836	0.104	46.77**	0.03	0.39	0.33**
Reps/loc	4		0.04	0.32	0.078	0.66	2.820	0.08	0.116	0.01
Crosses (C)	11		24.3**	17.8**	1.38**	0.264**	249.72**	14.15**	3.935**	5.22**
Lines (L)	3		25.9	19.73	1.00	0.232	306.82	35.21*	0.082	13.5**
Testers(T)	2		70.19*	11.26	0.17	0.27	425.68	12.12	12.44	5.47*
Lines×Testers	6		8.19**	19.02	1.97**	0.277**	162.52**	4.3**	3.02**	1.00**
C x Loc.	11		0.73**	1.45**	0.634	0.371**	100.2**	1.06**	0.34**	0.256**
Line × Loc.	3		1.28	3.44	0.80	0.94	112.37	1.40	0.32	0.28
Testers x Loc	2		0.39	0.45	1.66*	0.016	7.13	1.73	0.95*	0.15
LXT × Loc.	6		0.57**	0.78*	0.21*	0.204**	125.09**	0.67**	0.15	0.28**
Pooled error	44		0.14	0.32	0.254	0.037	4.34	0.141	0.101	0.03

***, ** significant at 0.05 and 0.01 levels of probability, respectively.**

The performances of the studied genotypes appeared to be varied from year to another with respect to their means for most of studied traits. Therefore, the means which combined over both years would be more suitable to represent the data. The seven parental lines means from the combined data over both years were determined and the obtained results are presented in Table 2. In addition, mean performances of the crosses for all studied traits from the combined data over both years were determined and the obtained results are presented in Table 3. The means showed that although, there was no specific parents of teosinte exhibited highest mean with respect to most of studied traits, the line-1 was the best in TDN, tassling date (toward earliness), crude protein and grain yield, while the line-4 was the best green fodder yield per plot, number of tillers per plant and plant height. These results are in agreement with those of Aulicino and Magoja (1991), and Abd El-Maksoud *et al*. (2001). The tester-30K8 was the best testers in green fodder yield, tassling date (toward earliness), 100-grains weight and grain yield. The comparison of parental lines with their topcrosses, the results revealed that all topcrosses were superior to their parents of teosinte for green fodder yield per plot, tassling date (toward earliness), grain yield per plot, 100-grain weight except (L2 × T2) and (L2 × T3), and crude protein except (L2 × T3) . On the other hand, the most of topcrosses were superior to their parents of maize for green fodder yield per plot, number of tillers per plant, plant height, crude protein and grain yield per plot..

Table 2: Mean performances of the parents of teosinte and maize for all studied traits from the Combined datas.

	GFY plot^{-1}	TDN	NT/Plot	ph	Days 50%	Weight 100g	CP	Gy plot^{-1}
Line-1	1.07	64.55	4.97	3.3	177.00	7.27	8.37	2.33
Line-2	0.76	62.33	6.92	2.9	182.33	5.39	7.95	1.38
Line-3	0.95	64.33	6.5	2.68	177.33	7.53	8.18	1.12
Line-4	1.2	64.01	8.67	3.72	187.83	7.06	7.94	1.85
T1	0.90	65.6	1.00	2.44	57.5	28.02	9.72	3.11
T2	0.73	65.7	1.00	1.42	67.33	14.83	8.12	1.71
T3	0.68	64.71	1.00	1.2	72.83	14.17	8.11	1.56
LSD	0.14	0.65	1.05	0.24	2.38	1.28	0.44	0.13
	0.19	0.88	1.42	0.32	3.23	1.73	0.60	0.17

Table 3: Mean performances of the topcrosses for all studied traits (combined over the two years).

	GFY plot^{-1}	TDN %	NT/P	Ph (m)	Tusseling 50%	100 G.W(gm)	CP %	Gy plot^{-1}
L_1xT_1	2.37	61.19	3.15	3.21	105.22	9.86	8.61	5.062
L_1xT_2	4.02	65.79	2.54	2.64	94.11	12.12	8.45	3.64
L_1xT_3	5.29	66.02	3.88	3.07	90.4	9.52	9.59	5.16
L_2xT_1	1.34	61.58	3.28	3.22	99.17	8.85	10.32	3.25
L_2xT_2	3.23	62.24	3.57	3.04	105.91	7.35	8.3	2.52
L_2xT_3	1.93	63.79	2.53	2.96	108.12	7.17	8.22	2.64
L_3xT_1	1.62	61.92	2.94	3.67	111.48	10.6	10.23	3.13
L_3xT_2	7.03	62.56	3.88	3.28	104.41	11.53	8.53	2.80
L_3xT_3	6.58	62.62	3.49	3.5	102.55	9.97	8.45	2.82
L_4xT_1	1.82	63.38	2.99	3.14	110.33	9.43	10.02	3.76
L_4xT_2	4.23	62.24	2.99	3.49	98.77	8.92	8.43	2.42
L_4xT_3	5.61	60.30	2.6	3.42	100.61	7.74	8.5	2.69
LSD	0.620	0.93	0.83	0.26	3.43	0.59	0.520	0.28
	0.830	1.24	1.1	0.35	4.60	0.80	0.70	0.37

These topcrosses for crude protein were L2 × T1, L3× T1 and L4 ×T1with values of 10.32, 10.22 and 10.02 respectively. However, in the case of grain yield per plot these topcrosses were L1 × T3, L1× T2, L4× T1, L1 ×T2, L2× T1 and L3× T1 with values of 5.16, 5.06, 3.76, 3.76, 3.64, 3.25 and 3.13 Kg/Plot respectively Therefore, these topcrosses can be used for improvement in green fodder yield and grain yield which can be used in silage in dough stage. These results are in agreement with Barriere, *et al*. (1984). In addition it could be recommended these hybrids which required almost the same period to flower as that of its early male parent. Early flowering is of great importance and is very highly appreciated by the growers as it enables them to take a second crop on the same land and per fadden productions increased to a very great extent. The same results assisted by Chaugale and Chavan (1965).

General combining ability (GCA) effects for the parental inbred lines and the three testers were estimated for each year and from the data combined over the two years. The obtained results are presented in Tables 4 and 5, respectively. Results indicated that the inbred line L-1 had the highest positive and significant GCA effect for TDN, 100-grain weight and grain yield per plot and exhibited desirable GCA effect for tassling date (toward earliness). Inbred line L-3 had positive and significant GCA effect for green fodder yield per plot, and 100- grain weight. Generally, these inbred lines (L-1 and L-3) could be recommended for advanced stage of evaluation through the breeding program. Results showed that the favorable GCA effects were recorded when T1 was used for 100-grain weight, crude protein and grain yield per plot, while T2 and T3 for green fodder yield per plot and TDN. These results are in agreement with those by IIchovska *et al*. (1995) in maize x teainte hybrids, Abd EL-Maksoud *et al*. (2001) in teosinte and Aly and Mousa (2008) in maize.

Estimates of specific combining ability effects (SCA) for 12 topcrosses for green fodder yield per plot, TDN, number of tillers per plant, plant height, tassling date, 100-grain weight, crude protein and grain yield per plot in two years are presented in Table 6. In addition, the results from the combined data over both years for all studied traits are presented in Table 7. The results showed that the best SCA effects were obtained in the topcross L1× T3 for TDN, number of tillers per plant, tassling date (toward earliness), crude protein and grain yield per plot. Similar results obtained Abd EL-Maksoud *et al.* (2001) in teosinte, Barakat and Osman (2008) in maize.

Estimates of genetic variance components for all studied traits over the two years and their interaction with years are illustrated in Table 8. Results revealed that estimates of σ^2GCA for lines were higher in magnitude than those of σ^2GCA for tester for TDN, number of tillers per plant 100-grain weight and grain yield per plot, indicating that most of the total σ^2GCA variances were due to the inbred lines and the contribution of lines were higher than the contribution of the testers for these traits. General combining ability variance components (σ^2GCA) was larger than that of specific combining ability (σ^2SCA) for green fodder yield per plot, 100-grain weight and grain yield per plot, indicating that additive was more important than non-additive gene action for these traits.

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Table 5: General combining ability (GCA) effects for the four inbred lines of teosinte and the three testers for all studied traits combined analysis over both years.

		GFY plot^{-1}	TDN %	NT/P	Ph (m)	Tusseling 50%	100G.W (gm)	CP %	Gy plot^{-1}
Line-1		0.14	1.52**	0.04	-0.14	-5.8**	1enral.07**	-0.06	1.29**
Line-2		-1.59**	-0.24	-0.03	-0.033	0.25	-1.6**	-0.03	-0.52**
Line-3		1.32**	-0.44*	0.28	0.13*	3.78**	1.26**	0.09	-0.41**
Line-4		0.13	-0.84**	-0.29	0.043	1.77*	-0.73**	0.00	-0.36**
T-1		-1.97**	-0.79**	-0.06	0.08	4.85**	0.25*	0.81**	0.47**
T-2		0.87**	0.4*	0.09	-0.12*	-2.23**	0.55**	-0.53**	-0.47**
T-3		1.10**	0.39*	-0.03	0.04	-2.62**	-0.80**	-0.28**	0.00
LSD	0.05	0.252	0.38	0.34	0.129	1.4	0.253	0.214	0.117
	0.01	0.337	0.51	0.45	0.173	1.87	0.337	0.286	0.156
LSD	0.05	0.22	0.33	0.30	0.11	1.215	0.22	0.185	0.101
	0.01	0.29	0.44	0.40	0.15	1.62	0.30	0.25	0.135

***, ** significant at 0.05 and 0.01 levels of probability, respectively.**

While the σ²SCA was larger than σ²GCA for TDN, number of tillers per plant, plant height, tassling date and crude protein percentage indicating that the non-additive genetic variance played the major role e in the inheritance of these traits. These results are in agreement with IIchovska *et al*, 1995 in maize × teosinte hybrids, Abd El-Maksoud *et al*.(2001) in teosinte. Moreover, results indicating that variances interactions of σ²GCA l × years was higher than σ²GCA t × years for green fodder yield per plot, TDN, plant height, tassling date and grain yield per plot, indicating the σ²GCA for lines was affected more by environment than by testers for these traits. Combined data revealed that the variance of σ²GCA × years interaction was either smaller or negligible than the variance of σ²SCA × years interaction for green fodder yield per plot, TDN, tassling date, 100-grains weight and grain yield per plot. These results indicated that non-additive type of gene action was more affected by environment conditions than additive effects. Therefore, from the previous results it could be recommend recurrent selection program for improvement fodder and grain yield with respect to these genotypes.

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القدرة علي الائتلاف وطبيعة الفعل الجيني لصفة حاصل الحبوب وبعض الصفات الأخري باستخدام تحليل السلالة × الكشاف لسلالات الذرة الريانة (*Zea mexicana L.*)

حسام الدين عثمان صقر و منى محمد فتحي غازى
مركز البحوث الزراعية – معهد بحوث المحاصيل الحقلية – برنامج بحوث العلف

يهدف هذا البحث إلي معرفة السلوك الوراثي لبعض مكونات حاصل الحبوب في هجن الذرة الريانة × الشامية ومن ثمة تحديد برنامج التربية المناسب لتحسين هذه الصفات . تم التهجين بين أربعة سلالات من الذرة الريانة وثلاث تراكيب من الذرة الشامية منها السلالتان ٣٤ ، ٦٣ من قسم بحوث الذرة الشامية وهجين فردي 30k8 (تجاري) في محطة بحوث السرو موسم صيفي ٢٠٠٧ ، كما تم تقييم الآباء (سبعة آباء) + الهجن القمية ١٢ هجين في نفس المحطة علي مدار موسمي ٢٠٠٨و٢٠٠٩ تم أخذ الحشة الأولي بعد ٤٥ يوم وقدرت حاصل العلف الأخضر (كجم / قطعة) وكذلك صفة العناصر الغذائية المهضومه الكليه ثم تركت كل التراكيب لإنتاج البذرة وتم التحليل الوراثي للقدرة علي التآلف باستخدام تصميم السلالة × الكشاف للصفات

التالية: محصول العلف الأخضر، قيمة العناصر الغذائية المهضومه الكليه، عدد الخلفات للنبات ، طول النبات، عدد الأيام حتى ظهور ٥٠% نورات مذكرة، وزن مائة حبه، نسبة البروتين الخام في الحبوب وحاصل الحبوب للقطعة.

وقد أظهرت النتائج ما يلي :-

- وجود اختلافات معنوية بين الهجن القمية وكذلك تفاعل السلالات × الكشافات لكل الصفات المدروسة وأيضًا وجود اختلافات معنوية للسلالات بصفة وزن ١٠٠ حبة وصفة حاصل الحبوب وكذلك اختلافات معنوية للكشافات لصفة حاصل العلف الأخضر وحاصل الحبوب .
- كماً كان هناك اختلافات معنوية لتفاعل الهجن مع السنين لكل الصفات المدروسة ماعدا صفة عدد الخلفات للنبات وكذلك تفاعل السلالات × الكشافات × السنين لكل الصفات ماعدا صفة نسبة البروتين الخام للحبوب .
- كانت أفضل السلالات التي تمتلك قدرة عامة ومرغوبة علي الإئتلاف هي السلالة L–1 لصفات TDN – وزن المائة حبة – حاصل الحبوب كما أظهرت قدرة إئتلافية سالبة ومعنوية ومرغوبة تجاة التبكير، كما أظهرت السلالة L-3 أنها تمتلك قدرة عامة ومرغوبة علي الإئتلاف لصفة حاصل العلف الأخضر ووزن المائة حبة .
- كما تشير النتائج الى أن الكشاف T1 (30k8) أظهرأحسن قدرة تآلف عامة لصفات وزن المائة حبة، نسبة البروتين الخام للحبوب، حاصل الحبوب بينما الكشاف T3, T2 كانا أحسن كشافات ذات قدرة تآلف عامة لصفات حاصل العلف الأخضر و قيمة العناصر الغذائية المهضومه الكليه.
- أحسن قدرة تآلف خاصة كانت للهجين L1×T3 لصفات قيمة العناصر الغذائية المهضومه الكليه، عدد الخلفات – تاريخ ظهور النورة المذكرة (في اتجاه التبكير)، نسبة البروتين الخام للحبوب – حاصل الحبوب .
- أشارت النتائج إلي أهمية الفعل الجيني الغير مضيف في وراثة صفات عدد الخلفات للنبات، طول النبات، تاريخ تزهير النورة المذكرة ونسبة البروتين الخام بينما كان الفعل الجيني المضيف يلعب الدور الأكبر والأكثر أهمية في وراثة صفات حاصل العلف الأخضر، وزن المائة حبة وحاصل الحبوب كما أن الفعل الجيني الغير مضيف كان أكثر تأثير وتفاعلاً بالمواقع من الفعل الجيني المضيف لصفات حاصل العلف الأخضرو قيمة العناصر الغذائية المهضومه الكليه ، تاريخ ظهور النورة المذكرة، وزن المائة حبة و حاصل الحبوب .
- أوضحت النتائج تفوق الهجن القمية علي آبائها من الذرة الريانة (التيوسنتي) لصفات حاصل العلف الأخضر، تاريخ ظهور النورة المذكرة (اتجاه التبكير) ووزن المائة حبة ماعدا الهجين L2×T2 والهجين L2×T3 وكذلك نسبة البروتين ماعدا الهجين L2×T3 وكذلك محصول الحبوب .
- كذلك تفوق الهجن القمية علي الآباء من الذرة الشامية لصفات حاصل العلف الأخضر، عدد الخلفات، طول النبات، نسبة البروتين للهجن (L4×T1, L3×T1, L2×T1) وكذلك حاصل الحبوب للهجن (L3×T1, L2×T1, L1×T2, L4×T1, L1×T2, L1×T3) لذا يمكن استخدام هذه الهجن القمية بطريقة مزدوجة الغرض وهي إعطاء علف أخضر كحشة أولي بعد ٤٥ يوم ثم نترك هذه الهجن لاستعاده نموها وانتاج البذرة إما للتغذية عليها وهي جافة حيث أنها عالية البروتين الخام أو استخدامها كسيلاج في الطور العجيني للحبوب.

قام بتحكيم البحث

أ.د / ممدوح محمد عبد المقصود	**كلية الزراعة – جامعة المنصورة**
أ.د / توكل يونس رزق	**كلية الزراعة – جامعة عين شمس**

Table 4: General combining ability (GCA) effects for the four inbred lines of teosinte and three testers for all studied traits at the two years.

	GFY plot^{-1}		TDN		NT/P		Ph (m)		Tusseling 50%		100G.W(gm)		CP %		Gy plot^{-1}	
	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2
Line-1	0.24*	0.03	1.15**	1.9**	-0.02	0.10	-0.39**	0.11	-9.47**	-2.12**	1.3**	0.86**	-0.25	0.12	1.15**	1.43**
Line-2	-1.61**	-1.57**	-0.02	-0.46*	-0.24	0.18	-0.15**	0.08	0.84	-0.35	-1.72**	-1.48**	0.06	-0.12	-0.51**	-0.53**
Line-3	1.59**	1.05**	-0.80**	-0.09	0.57**	-0.01	0.39**	-0.13	5.55**	2.01**	0.95**	1.62**	0.08	0.1	-0.24**	-0.57**
Line-4	-0.22*	0.49**	-0.33*	-1.35*	-0.31	-0.27	0.15**	-0.06	3.08**	0.46	-0.49**	-0.98**	0.11	-0.1	-0.4**	-0.33**
T-1	-2.03**	-1.91**	-0.63**	-0.95**	0.11	-0.24	0.05	0.11	4.5**	5.22**	-0.04	0.55**	1.02**	0.61**	0.47**	0.47**
T-2	1.02**	0.72**	0.35*	0.45*	-0.21	0.4**	-0.11**	-0.13	-1.6*	-2.86**	0.62**	0.48**	-0.54**	-0.52**	-0.56**	-0.4**
T-3	1.010**	1.18**	0.28*	0.5*	0.10	-0.16	0.06*	0.03	-2.9**	-2.36**	-0.58**	-1.03**	-0.48**	-0.09	0.08	-0.07
LSD 0.05	0.22	0.27	0.31	0.45	0.36	0.34	0.07	0.17	1.16	1.2	0.3	0.19	0.27	0.13	0.12	0.12
LSD 0.01	0.3	0.37	0.43	0.61	0.49	0.46	0.09	0.23	2.23	1.6	0.42	0.26	0.37	0.18	0.16	0.16
LSD 0.05	0.19	0.23	0.27	0.38	0.31	0.29	0.06	0.14	1.4	1.04	0.26	0.16	0.23	0.12	0.1	0.1
LSD 0.01	0.27	0.32	0.37	0.52	0.42	0.39	0.08	0.19	1.9	1.4	0.36	0.23	0.32	0.16	0.14	0.14

***, ** significant at 0.05 and 0.01 levels of probability, respectively.**

Table 6: Specific combining ability (SCA) effects for the 12 top crosses for the two years for all studied traits.

		GFY plot-1			TDN%			NT/P			Ph(m)			Tusseling50%			100GW(gm)			CP%			Gyplot-1		
		T_1	T_2	T_3	T_1	T_2	T_3	T_1	T_2	T_3	T_1	T_2	T_3	T_1	T_2	T_3	T_1	T_2	T_3	T_1	T_2	T_3	T_1	T_2	T_3
Line-1	Y_1	0.18	-0.34	0.16	-2.08**	0.57**	1.51**	0.06	-0.6	0.54	0.37**	-0.37**	0.00	-0.42	1.91	-1.49	-0.72**	0.83**	-0.11	-1.26**	0.10	1.16**	0.09	-0.6**	0.51**
	Y_2	0.71**	-1.15**	0.44	-2.62**	1.53**	1.08**	-0.02	0.88**	0.9**	0.05	-0.15	0.10	7.99**	-2.36*	-5.63**	-1.07**	1.33**	-0.26	-0.97**	0.2	0.77**	-0.16	-0.41**	0.57**
Line-2	Y_1	1.08**	0.03	-1.11**	-0.42	-0.41	0.84**	0.19	0.22	-0.41	0.00	0.11	-0.11	-12.62**	3.46*	9.16**	0.68*	-0.67*	-0.01	0.7**	-0.13	-0.57*	0.08	0.3**	-0.37**
	Y_2	1.2**	0.35	-1.55**	0.04	-1.02*	0.98*	0.24	0.49	-0.73*	-0.03	0.26	-0.23	-4.00**	2.25*	1.75	0.85**	-1.39**	0.54**	0.41**	-0.09	-0.32**	-0.13	0.09	0.04
Line-3	Y_1	-1.5**	1.17**	0.32	0.62*	-0.26	-0.36	-0.63*	0.47	0.16	0.18**	-0.01	-0.17**	3.58*	-1.4	-2.18	-0.72**	0.30	0.42	0.46	-0.04	-0.42	-0.21	0.38	-0.17
	Y_2	-1.48**	0.99**	0.49*	0.06	-0.15	0.09	-0.24	0.23	0.01	-0.05	-0.06	0.11	-2.62*	2.4*	0.22	0.01	0.26	-0.27	0.22	0.02	-0.24*	-0.32**	0.35**	-0.03
Line-4	Y_1	0.23	-0.86**	0.63**	1.89**	0.10	-1.99**	0.37	-0.09	-0.29	-0.54**	0.27**	0.27**	9.47**	-3.98**	-5.49**	0.76**	-0.45	-0.31	0.10	0.07	-0.17	0.04	-0.08	0.04
	Y_2	-0.43	-0.19	0.62*	2.51**	-0.36	-2.15**	0.02	0.16	-0.18	0.03	-0.04	0.01	-1.38	-2.28*	3.66**	0.2	-0.2	0.00	0.34	-0.12	-0.22	0.61**	-0.03	-0.58**
LSD	Y_1 0.05	**0.39**			**0.54**			**0.62**			**0.12**			**2.83**			**0.53**			**0.47**			**0.21**		
	Y_2 0.05	**0.54**			**0.74**			**0.84**			**0.16**			**3.86**			**0.72**			**0.65**			**0.28**		
LSD	Y_1 0.1	**0.47**			**0.77**			**0.58**			**0.29**			**2.08**			**0.33**			**0.23**			**0.21**		
	Y_2 0.1	**0.65**			**1.05**			**0.79**			**0.40**			**2.83**			**0.46**			**0.32**			**0.28**		

***, ** significant at 0.05 and 0.01 levels of probability, respectively.**

Table 7: Specific combining ability effects for the 12 top crosses for all studied traits as combined analysis over both years.

	GFY plot^{-1}			TDN %			NT/P			Ph (m)			Tusseling50%			100G.W(gm)			CP %			Gy plot^{-1}		
	T_1	T_2	T_3	T_1	T_2	T_3	T_1	T_2	T_3	T_1	T_2	T_3	T_1	T_2	T_3	T_1	T_2	T_3	T_1	T_2	T_3	T_1	T_2	T_3
Line-1	0.44*	-0.74**	0.30	-2.35**	1.05**	1.3**	0.02	-0.73*	0.71	0.20	-0.26*	0.05	3.78**	-0.22	-3.56**	-0.9**	1.08**	-0.18	-1.11**	0.15	0.96**	-0.03	-0.5**	0.53**
Line-2	1.14**	0.19	-1.33**	-0.18	-0.72*	0.9**	0.22	0.35	-0.57	-0.02	0.18	-0.16	-8.31**	2.86	5.45**	0.76**	-1.02**	0.26	0.55**	-0.11	-0.44*	-0.02	0.19	-0.17
Line-3	-1.48**	1.08**	0.40	0.34	-0.21	-0.13	-0.43	0.35	0.08	0.06	-0.03	-0.03	0.47	0.5	-0.97	-0.35	0.28	0.07	0.34	-0.01	-0.33	-0.26*	0.36**	-0.1
Line-4	-0.10	-0.52*	0.62**	2.19**	-0.12	-2.07**	0.20	0.03	-0.23	-0.25*	0.11	0.14	4.04**	-3.13*	-0.91	0.48*	-0.33	-0.15	0.22	-0.02	-0.2	0.32**	-0.05	-0.27**
LSD 0.05	0.43			0.65			0.58			0.22			2.42			0.43			0.37			0.2		
LSD 0.01	0.58			0.88			0.78			0.29			3.24			0.58			0.49			0.27		

***, ** significant at 0.05 and 0.01 levels of probability, respectively**

Table 8: Estimate of genetic variance components for grain yield and other traits at two and over years and their interaction with years

	Gfy plot^{-1}	**TDN%**	**NT/p**	**Ph. (m)**	**Tussling 50%**	**100 G.W(gm)**	**c.p %**	**Gy plot^{-1}**
Year I								
σ^2 l = GCA of lines	1.33	- 0.2 @	0.06	0.07	20.45	1.69	-0.2 @	0.21
σ^2T = GCA of testers (T)	2.78	-0.37 @	-0.04 @	-0.02 @	-3.32 @	0.2	0.62	0.23
σ^2 l× T = σ^2SCA L×T	1.21	2.6	0.2	0.13	67.56	0.57	0.65	0.17
Year II								
σ^2l = GCA of lines	0.71	0.55	-0.11 @	0.00	-5.85 @	1.82	-0.1 @	0.84
σ^2T = GCA of testers	2.36	-0.03 @	0.01	0.01	13.94	0.29	0.24	0.13
σ^2 L× T = σ^2 SCA L×T	1.62	3.77	0.35	0.01	25.42	0.99	0.34	0.24
Combined								
σ^2 = σ^2 GCA (lines)	0.98	0.04	-0.05 @	-0.002 @	8.01	1.72	-0.16 @	0.69
σ^2 **T =** σ^2 **GCA (Testers)**	2.58	-0.32 @	-0.07 @	0.00	10.96	0.32	0.39	0.19
σ^2**GCA =** σ^2 **GCA (Aver.)**	1.78	-0.14 @	-0.06 @	-0.001 @	9.48	1.02	0.115	0.44
σ^2 **L×T =** σ^2 **SCA (Aver)**	1.34	3.12	0.3	0.04	26.37	0.69	0.48	0.16
σ^2GCA/σ^2 SCA=σ^2 GCA(Aver.)/σ^2GCA SCA (Aver.)	1.33	- **0.04** @	- 0.2	-0.02 @	0.36	1.48	0.24	2.75
σ^2 L×y = σ^2GCA (L)×y	0.08	0.3	0.06	0.10	- 1.41 @	0.08	0.02	0.00
σ^2 T×y = σ^2GCA(T) ×y	-0.01 @	- **0.03** @	0.12	-0.01 @	- 9.83 @	0.09	0.07	-0.01 @
σ^2GCA ×y=σ^2GCA(A aver.×y)	0.03	0.13	0.09	0.05	- 5.62 @	0.08	0.04	- 0.005 @
σ^2 L×T×y = σ^2 SCA aver.×y	0.14	0.15	- 0.01 @		40.25	0.18	0.02	0.08
Contribution of lines (L)	29.1	**30.23**	20.0	23.96	33.51	67.87	0.56	70.47
Contribution of testers(T)	52.5	11.5	0.02	18.8	30.29	15.58	57.5	19.03
Contribution of L×T	18.4	**58.27**	78.00	57.24	35.5	16.54	41.94	10.5

@ variance estimate proceeded by negative sign is considered zero(Robinson *et al.*, 1955).