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GENETIC STUDIES ON SOME ANATOMICAL ATTRIBUTES OF YELLOW CORN

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ABSTRACT

This study was performed during the two summer seasons 1999 and 2000. Full diallel crosses of four yellow maize inbred lines were conducted. The aim of this study was to determine the relationship of various inbred anatomical characters with single cross performance, and high yielding inbred through its anatomical features as criteria to plan crosses for all single and double hybrid combinations. Inbred lines and hybrids mean performance and heterotic effects, general and specific combining ability, reciprocal effects, as well as variance components for anatomical characters were determined. Results suggested that flint inbred lines are characterized by high counts for number and size of bundles of the outer zone periphery to the epidermis, the size of bundles in the central region of the stem, thickness and number of cells of the sub-epidermal sclerenchymatous tissue and number of vascular bundles per microscopic field. While, dent inbred lines are characterized by large size of both metaxylem vessels and ground tissue parenchymatous cells. The cross L_1x D_1 showed heterosis over the better parent for most characters under investigation. Relative to inbred parents, the average dimension of the inner vascular bundles and the average size of parenchyma cells of the ground tissue were higher than those of parents. On the contrary, number of vascular bundles per microscopic field was greater in parental lines. The increase in bundle size that characterized hybrids led to the decrease in their number. As hybrids were characterized by grater sized vascular bundles and ground parenchymatus cells as compared with those of inbred lines. The thicker vascular bundles were accompanied by a considerable increase in vessel dimensions.

Reciprocal mean square of epidermis thickness, average diameter of ground tissue cells and vascular bundle dimensions at the outer zone were higher than that of general combining ability (GCA) and specific combining ability (SCA) indicating the importance of maternal effects in the inheritance of such traits. However, both GCA and SCA were more or less equals, suggesting that, both additive and dominance gene effects were involved in the inheritance of such character. On the other hand, the parental inbred line D_1 exhibited the highest value for general combining ability for sub-epidermal sclerenchymatous tissue, the average size of and ground tissue cells in the inner zone and number of vascular bundle per microscopic field. Thus, it would be preferable as a parent in breeding for such traits. The cross D_1 x L_2 were of highly significant values for the above mentioned characters. There was significant variance, due to additive alleles ($\check{D}$), for number of vascular bundles in a microscopic field, vascular bundle dimensions at the inner zone and average diameter of ground tissue. Dominance effects overall heterozigous loci (h^2) were highly significant. The estimated F values showed non-significant values revealing excess of dominant alleles related to inheritance of the following anatomical characters; vascular bundle dimensions, average diameter of ground tissue at the inner zone, vascular bundle dimensions at the outer zone and thickness of sub-epidermal sclerenchymatous tissue. Over dominance is suggested for average number of vascular bundles in both outer and inner zone of the stem.

Keywords: Zea mays L, stem anatomy, leaf anatomy, heterosis, general combining ability, specific combining ability.

INTRODUCTION

Hybrid varieties developed by crossing two or more inbred lines. Great efforts were developed to increase the productivity of maize through genetic improvement. Breeders must develop inbred lines that have high yield per se., and contribute high yields to the single cross combinations. The diversity of an inbred genotype is considered, according to all legitimate interpretation of hybrid vigour, the essence of developing superior hybrids. Hybrid vigour reflects on all quantitatively inherited characters, i.e., morphological, yield and its components as well as anatomical characters. Most corn breeding programs are planned to use inbred lines with high specific combining ability. The combining ability test is made to screen out this diversity, using the yield performance only as an indicator. Perhaps knowledge of relationship of various inbred anatomical characters to its yield and to single cross performance is needed to select high yielding inbred through its anatomical features and to plan crosses for all single and double hybrid combinations.

Kiesselbach (1922) noted that anatomical counts and measurements of hybrids were different from those of parental lines in terms of higher stalk diameter, 40% greater; number of vascular bundles in stem cross section, 45% greater; number of bundles in one square cm of stem cross section 34% less; number of bundles occurring along one diameter of stem cross section, 21% greater; number of bundles along one cm of stem diameter, 19% less; actual diameter of vascular bundles 15% greater; average diameter of medulla cells 10% greater.

This study aimed to find the relationship of various inbred anatomical characters with single cross performance and use high yielding inbred through its anatomical features as a criterion to plan crosses for all single and double hybrid combinations. To achieve these goals the following parameters of anatomical characters must be determined; mean performance of inbred lines and hybrids and its heterotic effects, general and specific combining ability and reciprocal effects, as well as variance components and their genetic ratios.

MATERIALS AND METHODS

Plant materials include four inbred lines of dent and flint maize types which were secured from the Corn Breeding Programs at the Department of Maize Research, Field Crop Research Institute, Agriculture Research Center, Giza, ARE. Details of inbred lines characteristics and diallel crosses were reported in Essam (1999). The four yellow inbred lines were sown on summer season 1999. At anthesis, the four inbred lines were crossed in all possible combination by hand crossing. At the second growing summer season 2000, all genotypes were evaluated in field trial of Complete Randomized Block Design with four replications at two locations; Sids and Giza. At tassling stage specimens of the 6th inter-node from base of the four investigated maize inbred and the complete set of hybrids were anatomically investigated. Specimens were prepared for histological measurements and counts followed the microtehnique procedures described by (Nassar and El-Sahhr, 1998). Counts and measurements were subjected to convenient statistical analysis for testing mean performance significance, heterotic effects, general and specific combining ability, genetic and environmental variance as well as heritability estimates Falconer (1960), Hyman (1954), Griffing (1956), Waller and Duncan (1969) and Hyman and Mather (1995). Statistical analysis was performed and the various genetical parameters were obtained.

RESULTS

A- Mean performance and heterosis

Histological counts and measurements of the transverse sections of main stem of parents and their hybrids are given in Table (1) and Figures (1-4). Data proved that, flint parents are distinguished in some counts and measurements. Number and size of bundles at the stem periphery the epidermis, the size of bundles in the central region of the stem, thickness and number of cells of the sub-epidermal sclerenchymatous tissue and number of vascular bundle per microscopic field. Dent inbreds were characterized by large size of the metaxylem vessels of the bundles and in the size of cells of ground tissue. It was also evident that there were no major differences in counts and measurements of average dimensions of ground tissue parenchymatous cells either of the outer or inner zone of the transverse sections (figures 1 and 2).

The heterotic effects over both mid and better parents are presented in Table (3). It is evident that the cross L_1x D_1 showed heterosis over the better parent for most characters under investigation. Where, average dimension of the inner vascular bundles increased by 11%. The average size of parenchyma cells of the ground tissue in the inner zone was increased by 17% as compared with inbred parents. On the other hand, the numbers of vascular bundles per microscopic field were greater in parent lines by 21%. The increase in bundle size that characterized hybrids was reflected in a decrease in their number of bundles in the microscopic field. It is also evident that the hybrids are characterized by great sized vascular bundles and ground parenchyma's cells as compared with those of inbred lines. Consequently, it could be stated that, the thicker vascular bundles were accompanied by a considerable increase in vessel diameter.

Histologicl features of the leaf blade are presented in Table (2) and Figures (5-8). It is clear that dent lines D_1 and D_2 proved to be the best with regard to following counts and measurements:- thickness of both upper and lower epidermis, average size of mesophyll cells, average blade thickness, average diameter of vascular bundle, thickness of vascular bundle sheath and average diameter of metaxylem vessels. On the contrary, flint inbreds characterized by an increase in number of layers of both mesophyll and fiber-cells of vascular bundle sheath. Thereupon, the two inbreds showed equal number of bundles per microscopic field 6x6 magnifications (figures 5&6). The hybrid D_1XL_1 demonstrate a reduced number of bundles per microscopic field as well as a reduced amount of fiber- cells of vascular bundle sheath as compared with their parents. No changes were observed with regard to average number of mesophyll layers. Same trend was observed with regard to the hybrid D_2XL_2 (figure, 7). The other hybrid L_2xD_1 is characterized by great sized vascular bundles and mesophyll cells as compared with those of inbred lines.

Table (1): Counts and measurements of certain histologial features in transverse sections through the 6th internode of dent and flint yellow corn inbred lines and their hybrids.

Entry	Epidermis thickness (µ)	Thickness Of sub-epidermal layer (µ)	Vascular bundle dimension (LXW)	Average diameter of ground cell (µ)	Vascular bundle dimension (µ)	Average diameter of ground cell (µ)	Number of bundles in microscopic field 6X4
	Outer zone				Inner zone		
D_1	64.86	52.94	367.29	101.80	435.09	124.20	29.81
D_2	49.70	48.86	350.44	126.36	524.93	154.16	13.18
L_1	67.39	84.24	385.69	126.36	572.83	154.16	15.12
L_2	57.28	58.97	307.48	126.21	380.98	153.98	17.06
DXD	56.44	66.55	343.28	130.57	561.46	159.30	16.42
L_1XL_2	58.13	59.81	304.95	118.78	499.54	144.91	12.10
D_1XL_1	81.71	64.02	414.46	192.07	639.69	234.33	17.28
D_1XL_2	42.12	66.55	349.60	149.95	570.73	182.94	13.39
D_2XL_1	66.55	48.86	301.16	124.68	386.89	152.11	12.96
D_2XL_2	55.60	56.44	327.69	151.63	541.66	184.99	17.28
$D2XD_1$	49.70	58.13	304.53	121.31	483.12	148.00	13.61
L2XL1	57.28	52.47	339.91	132.27	574.75	161.37	14.69
L1XD1	48.02	45.49	292.73	96.03	460.37	117.16	15.77
L2XD1	79.19	93.51	434.47	169.94	566.94	207.33	12.96
L1XD2	86.77	77.50	344.54	136.47	490.28	166.49	16.85
L2XD2	64.86	63.18	410.67	154.16	513.44	188.08	12.96

Table (2): Counts and measurements of certain histologial features in transverse sections through the 6th leaf of dent and flint yellow corn inbred lines and their hybrids.

Entry	Upper epidermis thickness (μ)	Lower epidermis thickness (μ)	Blade thickness	Number of mesophyll layers	Vascular bundle dimension LXW (μ)	Metaxylm vessel diameter (μ)	Number of bundles in microscopic field 6X6
	Outer zone				Inner zone		
D_1	9.73	8.53	777.5	9.98	335.02	27.0	6.5
D_2	8.21	8.13	760.7	12.39	404.20	33.5	2.9
L_1	9.98	11.66	795.9	12.39	441.08	33.5	3.3
L_2	8.97	9.14	717.7	12.37	293.35	33.5	3.7
DXD	8.88	9.90	753.5	12.80	432.32	34.6	3.6
L_1XL_2	9.05	9.22	715.2	11.65	384.65	31.5	2.6
D_1XL_1	11.41	9.64	824.7	18.83	492.56	50.9	3.8
D_1XL_2	7.45	9.90	759.8	14.70	439.46	39.8	2.9
D_2XL_1	9.90	8.13	711.4	12.22	297.91	33.1	2.8
D_2XL_2	8.80	8.88	737.9	14.87	417.08	40.2	3.8
$D2XD_1$	8.21	9.05	714.8	11.89	372.00	32.2	3.0
L2XL1	8.97	8.49	750.2	12.97	442.56	35.1	3.2
L1XD1	8.04	7.79	703	9.41	354.48	25.5	3.4
L2XD1	11.16	12.59	844.7	16.66	436.54	45.1	2.8
L1XD2	11.92	10.99	754.8	13.38	377.52	36.2	3.7
L2XD2	9.73	9.56	820.9	15.11	395.35	40.9	2.8

Fig 1&2

Fig 3&4

Fig 5&6

Fig 7&8

Table(3)

B- Combining ability
1:Epidermis thickness

General and specific combining ability and reciprocal mean squares were highly significant (Table, 4). Reciprocal mean square was more than that of GCA and SCA indicating the importance of maternal effects for the inheritance of such traits. However, both GCA and SCA were more or less equals, suggesting that, both additive and dominance gene effects were involved in the inheritance of such character. L_1 parent exhibited highest value for general combining ability. This would be effective as parent in breeding for this trait. So, the progeny involved L_1 and D_2 was of highly significant breeding value, which was the highest value among other progenies.

Table (4):General and specific combining ability and reciprocal effects of different genotypes for anatomical characters.

Entry	Epidermis thickness (μ)	Thickness Of sub-epidermal layers (μ)	V. bundle dimensions (LXW) Outer zone	Diameter of ground cell (μ) Outer zone	V. bundle dimensions (μ) Inner zone	Average Dia of ground cell (μ) Inner zone	Nmber of bundles in microscpic field 6X4
General combining ability							
D_1	-0.737**	0.172**	10.529**	0.282 ns	6.391**	0.382 ns	2.916**
D_2	-1.685**	-3.797**	-7.087**	1.292 ns	-9.330**	2.605 ns	-1.161**
L_1	5.054**	2.235**	-2.539**	-5.524**	11.980**	-9.344**	-0.729**
L_2	-2.632**	1.392**	-0.900**	-3.951**	-9.041**	-4.430**	-1.026**
CD_{gi}	0.551	0.759	1.215	3.943	1.477	7.327	0.193
$CD_{(gi-gj)}$	0.899	1.241	1.984	6.439	2.413	9.085	0.315
Specific combining ability							
$D1XD_2$	-6.164**	3.653 ns	-28.477**	-8.361**	12.673**	16.677**	-2.480**
D_1XL_1	-1.063 ns	-10.087	-3.097 ns	16.796**	19.168**	16.252**	-1.390 ns
D_1XL_2	2.444 ns	-16.269**	34.041**	23.270**	59.355**	25.430**	-4.469**
D_2XL_1	11.796**	2.421 ns	-16.354**	2.175 ns	-77.446**	20.645**	1.090 ns
D_2XL_2	2.976 ns	-0.130 ns	28.762**	15.142**	33.563**	24.100**	1.608 ns
L_1XL_2	-6.377**	-9.923**	-23.023**	23.774**	21.740**	20.699***	-0.572 ns
CD_{Sij}	1.015	1.400	2.239	7.266	2.723	5.679	0.355
$CD_{(Sij-ik)}$	1.572	2.169	3.469	11.902	4.218	10.770	0.552
Reciprocal effects							
D_2 X D_1	3.120	4.251	19.555	4.676	39.534**	3.547	1.417
L_1X D_1	17.004	9.352	61.427	48.461	90.494**	-40.563	0.763
L_2XD_1	-18.704	-13.603	-42.832	-10.086	1.913	-10.499	0.218
L_1XD_2	-10.202	-14.453	-21.893	-5.951	-52.171	-6.398	-1.962
L_2XD_2	-4.676	-3.401	-41.872	-1.275	14.241	-10.758	2.180
L_2XL_1	0.425	3.706	-17.642	-23.990	-37.954	-27.999	-1.308
CD_{rji}	1.177	1.625	2.589	8.432	3.16	6.44	0.413

2: Sub epidermal sclerenchymatous tissue

Data presented in Table (4) for general and specific combining ability and reciprocals effects for sub-epidermal sclerenchymatous tissue proved that, general combining ability mean square was greater than specific combining ability. This revealed that, additive gene action effects played the major role in the inheritance of this trait than non-additive effects. The parental inbred line D_1 represented highest value for general combining ability. So, it would be gainful as a parent in breeding for such trait. The cross D_1 x L_2 were of highly significant values. Thus, the maternal effects were clearly at the crosses L_1 x D_1.

3: Average diameter of ground tissue cells

General and specific combining ability and reciprocal effect mean squares were of highly significant as shown in Table (4). Specific combining ability means square were extended above that of general combining ability and reciprocal effect denoting the importance of dominance. However, the reciprocal effect showed greater value reflecting the importance of the maternal effect of these inbred lines. These results suggest that the additive effect is involved in inheritance of this character. The highest value for GCA was recorded for L_1. This pointed the advantage of this line in breeding for this trait. It is also evident that D_1xD_2 and D_2xL_1 crosses were of highly significant values. Thus, it is preferred to use D_1 as a donor when crossed with D_2 and L_1 lines.

4: Vascular bundle dimensions at the outer zone

General combining ability, specific combining ability and reciprocal mean squares were highly significant (Table 4). Reciprocal mean square was higher than that of general combining ability and specific combining ability indicating the importance of maternal effect. However, specific combining ability was more than the general combining ability, reflecting that the dominance played the major role in the inheritance of this character, while the additive effect had the minor role. The D_1 parent exhibited highest value for general combining ability would be useful as parent in breeding for this character. So, the progeny involving D_1, L_2 was of high breeding importance, as it possesses the highest specific combining ability among other progenies.

5: Average diameter of ground tissue at the inner zone

Specific combining ability value for such character was greater than general combining ability specifying that dominance effects were more important than additive one. From Table (4) it could be noticed that L_1 parent recorded the highest value of general combining ability which revealed the usefulness of this parent in breeding of this trait. The cross D_1 x L_2 were of highly significant followed by the cross D_2xL_2, which was the highest among other progenies. However, the maternal effects were clearly evident in the crosses L_1 x D_1 and D_2x D_1.

6: Vascular bundle dimensions at the inner zone

Mean squares of general combining ability and specific combining ability as well as reciprocal effects for this trait are given in Table (4). Both

GCA and SCA were highly significant. Data revealed that both additive and non-additive, gene effects control this trait with the greater role in the inheritance of this trait is due to non-additive effects. Reciprocal effect also was highly significant revealing the presence of maternal effect in controlling such trait. These results revealed that L_1 parent was the virtuous combinor followed by D_1. However, D_1xL_2 cross presents the highest value for specific combining ability, which showed the highest value among other progenies followed by D_2xL_2. Whereas, the crosses L_1xD_1, D_2xD_1 and L_2xD_2 recorded high and positive significant of reciprocal effects revealing the importance of the maternal effect in inheritance of such trait.

7: Number of vascular bundles in a microscopic field

Number of vascular bundles in a miroscopic field showed that general combining ability mean square was greater than specific combining ability revealing that, additive gene effects played the major role in the inheritance of this trait than non-additive effects. The parental inbred line D_1 represented highest value for general combining ability as shown in Table (4). Therefore, it would be profitable as parent in breeding for such trait. Negative SCA values were recorded for most crosses. However, the two crosses that had positive value of specific combining ability were D_2xL_2 and D_2xL_2. The maternal effects could be noticed in the hybrids L_{2x} D_2, D_2 x D_1 and L_1 xD_1.

C- Variance components and heritability estimates

Variance components for the studied anatomical characters are presented in Table (5). Data showed significant values for variance due to additive alleles ($\check{D}$) for number of vascular bundles in a microscopic field**, v**ascular bundle dimensions at the inner zone and average diameter of ground tissue. This significant variance indicated the importance of additive gene effects controlling these characters. Moreover, variance due to the dominance effect of genes ($\hat{H}_1$) was also significant so the magnitude of dominance was larger than that of additive variance in the inheritance of these traits. The dominant effects correlated to gene distribution ($\hat{H}_2$) was significant accordingly asymmetrical distribution of genes with positive and negative effects controlling vascular bundle dimensions, average diameter of ground tissue at the inner zone**,** vascular bundle dimensions at the outer zone and thickness of sub-epidermal sclerenchymatous tissue.

It is clear from Table (5) that estimated value of dominance effects overall heterozigous loci (h^2) were highly significant. This indicates that, dominance was unidirectional and variability is mainly due to heterozygosity. In the mean time, the estimated F values showed non-significant values revealing excess of dominant alleles related to inheritance of the following anatomical characters; vascular bundle dimensions, average diameter of ground tissue at the inner zone**,** vascular bundle dimensions at the outer zone and thickness of sub-epidermal sclerenchymatous tissue. The values of the mean degree of dominance ($\hat{H}_1/D$) were greater than unity, suggesting over dominance in respect to the genetic picture of average number of vascular bundles in both outer and inner zone of the stem.

Table(5)

Regarding the proportion of genes with positive and negative effects ($\hat{H}_2$ / $4\hat{H}_1$) data proved that, their values for thickness of epidermis and average diameter of ground tissue parenchymatous cells were quit small and could be neglected , so positive and negative alleles were not equally distributed. Moreover, number of gene groups controlled most of the studied characters was about two as shown by (K) value Table, (5). Estimated r^2 was positive for the following characters; vascular bundle dimensions, average diameter of ground tissue at both the outer and inner zone**,** vascular bundle dimensions at the outer zone. While, K values were negative and very near to unity. So, it is possible to predict the measurements of the completely dominant and recessive parents and suggesting the possible limits of selection among genes showing dominance for the following anatomical traits; thickness of sub-epidermal sclerenchymatous tissue and number of vascular bundles per miroscopic field magnifications (6X6).

Table (5) showed the values of heretability for all studied characters. Results revealed that estimates of broad sense heritability were very high for all attributes ranging from (90.48% for average diameter of ground tissue cells (Inner zone) and 99.64 % for vascular bundle dimensions. The heritabiliy in narrow sense had different values as it differed from character to another. However, it was of minute magnitude in respect to averge diameter of ground tissue cells.

Intermediate values were also recorded for thickness of epidermis (32.99%), and number of vascular bundles at microscopic field (38.47). High values for narrow sense heritabilities were detected for stem diameter (65.21). As known before the low narrow sense heritability for any character indicated that, phenotypic selection for this character would be ineffective or don't make large gain. Hence, these traits still need many cycles of selection for improvement.

DISCUSSION

The parental lines are distinguished in some counts and measurements. In terms of, number and size of bundles at the stem periphery the epidermis thickness, the size of bundles in the central region of the stem, thickness and number of cells of the sub-epidermal slerenchymatous tissue and number of vascular bundle per microscopic field. As long as, dent inbred were marked by large size of the metaxylem vessels of the bundles and in the size of cells of ground tissue. It is also evident that, there are no major differences in counts and measurements of average dimensions of ground tissue parenchymatous cell either of the outer or inner zone of the transverse sections. These results are in agreement with those produced by El-Kady (1974), Essam (1999).

As hybrids are characterized by great sized vascular bundles and ground parenchymatus cells as compared with that of inbred line. So, the thicker vascular bundles were accompanied by a considerable increase in vessel diameter. This was discussed previously by Ashby (1930) in which the corn hybrid did not differ from its more vigorous parent as regarded cell size. Sass (1951) suggested that, bundle shape and size is fairly constant in the lines and hybrids that have been studied. Weaver (1946) attributed considerable significant characters of the vascular system as manifestation of hybrid vigour on corn. Parents were more extensively vascular bundles than the hybrid, but the hybrid soon gained an advantage and all other ages showed a greater percentage of vascular system than both parents. The hybrid exhibited an accelerated rate of differentiation, with vascular strands present in younger internodes than either parents did and with differentiation of conducting tissues within the bundles more nearly complete in the hybrid than in the inbred parents at comparable level. Metaxylem cells showed a greater average cross sectional area in the hybrid as compared with parents. At maturity both parents and hybrid possessed metaxylem elements of approximately the same size and the medulla cell size was of no relationship between hybrid and their parents. Medulla cells of the hybrid were larger while at other levels they were intermediate or somewhat smaller than those of the parents. The above mentioned results were reported by Treat and Tracy (1993) and Essam (1999).

It was evident that, GCA and SCA values were more or less equal. This suggesting that, both additive and dominance gene effects were involved in the inheritance of the following characters; number and size of vascular bundles at the stem periphery the epidermis, the size of bundles in the central region of the stem, thickness and number of cells of the sub-epidermal sclerenchymatous tissue and number of vascular bundle per microscopic field. On the other hand, the parental inbred line D_1 represented highest value for general combining ability for sub-epidermal slerenchymatous tissue, the average size of the ground tissue cells in the inner zone and number of vascular bundle per microscopic field. So, it would be gainful as a parent in breeding for such traits. The cross D_1 x L_2 were of highly significant values for the above mentioned characters. General combining ability variance is mainly attributed to additive gene effects, while specific combining ability variance is mainly due to non-additive gene effects as dominance and / or epistasis. Reciprocal mean square of epidermis thickness, average diameter of ground tissue cells and vascular bundle dimensions at the outer zone were more than that of GCA and SCA indicating the importance of maternal effects for the inheritance of such traits. It’s well known the importance to investigate also the role of maternal or cytoplasmic effect, for these reason reciprocals effects was studied (Falconer, 1960). This was confirmed previously by El-Kady (1974) who, studied variability, correlation and heterosis in two dent and two flint inbred of maize and their hybrid combination. He stated that, dent and dent lines are variable with no constant differences in the number and dimensions of cell and bundles. The hybrids showed general heterotic effects or reduced number of bundles and cells of ground tissue per microscopic field, but the size of bundles, vessels and ground cells is larger than those of the better parent. It is likewise noticed that, hybrid is characterized by thicker sub-epidermal sclerenchymtous layer which is of more thicker than its better parents. This was confirmed by Heimsch *et al*, (1950) suggested that hybrids showed nearly advantage over the inbred in number and size of vascular bundles and the size of protoxylem and metaxylem elements. In the mean time, Treat and Tracy (1993) clarified that the effects due to hybrids were highly significant for stalk diameter and thickness.

Significant values for variance were fond to be due to additive alleles (Ď) were recorded for number of vascular bundles in a microscopic field, vascular bundle dimensions at the inner zone and average diameter of ground tissue. Dominance effects overall heterozigous loci (h^2) were highly significant. The estimated F values showed non-significant values revealing excess of dominant alleles related to inheritance of the following anatomical characters; vascular bundle dimensions, average diameter of ground tissue at the inner zone, vascular bundle dimensions at the outer zone and thickness of sub-epidermal sclerenchymatous tissue. Over dominance were suggested for average number of vascular bundles in both outer and inner zone of the stem. Savic (1984) reported that stem diameter and number of vascular bundles were the most stable features and most anatomical features were inherited on the basis of dominance. The above mentioned results are in agreement with those previously reported by El-Kady (1974) and Essam (1999).

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دراسات وراثية على بعض الصفات التشريحية للذرة الصفراء

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تمت هذه الدراسة خلال موسمي صيف ١٩٩٩ و ٢٠٠٠ حيث اشتمل البحث على عمل تهجينات أليلية كاملة لأربعة سلالات من الذرة الصوانية و المنغوزة وذلك بهدف تحديد العلاقات الوراثية لمختلف الصفات التشريحية المميزة للسلالات و بين مظهرها في الهجن الفردية مع ربطها بصفات المحصول للتخطيط للهجن الفردية والزوجية. وكانت أهم النتائج كالتالي

تميزت السلالات الصوانية متميزة بزيادة عدد و حجم الحزم الوعائية خاصة في المنطقة الخارجية من الساق .

1- أظهرت السلالات الصوانية مقارنة بالسلالات المنغوزة زيادة في حجم الحزم الوعائية و سمك وعدد طبقات الخلايا الإسكلرنشيمية.
2- السلالات المنغوزة متميزة بكبر حجم كل من أوعية الخشب التالي و خلايا النسيج الأساسي البارنشيمية .
3- الهجين (D1 X L1)أظهر تباين هجينى أعلى من أفضل الأباء لأغلب الصفات تحت الدراسة .
4- بصفة عامة كان متوسط الهجن فى صفات أبعاد الحزم الوعائية الداخلية و حجم الخلايا البارنشيمية للنسيج الأساسي أعلى من متوسط الأباء بينما كان عدد الحزم الوعائية في الحقل الميكروسكوبي (٤x ٦) أعلى في الأباء من الهجن .
5- كانت الزيادة في حجم الحزم الوعائية ملازمة للنبات الهجينية و انعكس ذلك على النقص في عددها.
6- قيم متوسط مربعات الهجن العكسية أعلى من قيم متوسط مربعات القدرة العامة و الخاصة على الإتلاف لصفات سمك البشرة , متوسط قطر الخلية البارنشيمية , متوسط أبعاد الحزم الوعائية مما يدل على أهمية تأثير الأم على وراثة تلك الصفات .
7- أظهرت السلالة D1 قيم مرتفعة للقدرة العامة و الخاصة على الائتلاف لصفات سمك النسيج الإسكلرنشيمي و متوسط حجم خلايا النسيج الأساسي و عدد الحزم الوعائية في الحقل الميكروسكوبي مما يعطى قيمة تربوية عالية لهذا الأب في برامج التربية .
8- أظهرت الدراسة على وجود سيادة متفوقة لصفة عدد الحزم الوعائية و على العكس كانت هناك غياب للسيادة الأليلية في وراثة أبعاد الحزم الوعائية , متوسط حجم خلايا النسيج الأساسي , عدد الحزم الوعائية في الحقل الميكروسكوبي .

Table (3): Heterosis Percentages of stem anatomical characters of mid and better maize parents over two locations.

Char-acters	Epidermis thickness		Thickness Of sub-epidermal layer (μ)		Average diameter of ground cell (μ)		Vascular bundle dimension (LXW)		Average diameter of ground cell (μ)		Vascular bundle dimension (LXW)		Number of bundles in micrscopic field 6X6	
	Outer zone								Inner zone					
%	Over M.P	Over A- B .P	Over M.P	Over B.P	Over M.P	Over B.P	Over M.P	Over B.P	Over M.P	Over B.P	Over M.P	Over B.P	Over M.P	Over B.P
D_1XD_2	-1.7	-14.8*	8.4*	7.0*	35.1*	29.3*	-4.9*	-7.5*	16.5*	3.8	19.3*	7.9*	-26.9*	-51.2*
L_1XL_2	-7.7*	-15.7*	-4.5*	-7.9*	-18.8*	-33.1*	-13.7*	-23.9*	-39.2*	-39.3*	5.4*	-14.6*	-28.3*	-33.2*
D_1XL_1	26.9*	24.2*	-1.8	-6.6*	-7.6*	-27.4*	11.5*	8.5*	77.9*	59.3*	30.7*	13.3*	-26.3*	-47.9*
D_1XL_2	-35.4*	-40.0*	5.2*	3.5*	21.6*	14.7*	4.1*	-5.5*	36.0*	21.6*	45.5*	35.5*	-48.9*	-62.8*
D_2XL_1	15.6*	-12.8	-7.3*	-11.5*	-30.3*	-47.9*	-20.7*	-25.0*	-1.5*	-1.5	-33.6*	-37.0*	-9.6*	-16.3*
D_2XL_2	4.5*	-3.4	1.3	-1.2	5.3	-4.9	-0.4	-7.4*	23.0*	22.8*	22.3*	3.6*	16.3*	1.4
D_2XD_1	-15.1*	-26.7*	3.9*	2.7	16.2*	11.2	-17.3*	-19.5*	7.2	-4.6	0.7	-9.1*	-41.8*	-62.0*
L_2XL_1	-9.2*	-17.1*	-7.3*	-10.3*	-30.5*	-43.0*	-2.2*	-13.5*	54.7*	5.3*	23.4*	0.4	-10.0*	-15.9*
L_1XD_1	-31.2*	-32.8*	-9.2*	-12.6*	-38.4*	-52.4*	-25.4*	-27.5*	-18.0*	-27.4*	-9.9*	-22.4*	-34.0*	-53.7*
L_2XD_1	33.8*	25.2*	18.4*	16.0*	76.5*	66.8*	32.8*	-20.9*	56.1*	44.3*	44.4*	34.5*	-51.0*	-64.4*
L_1XD_2	54.9*	32.8*	4.5*	-2.2	18.8*	-9.1	-7.3*	-12.2*	9.1	9.1*	-12.2*	-16.4*	21.8*	13.0*
L_2XD_2	24.2	15.1*	4.9*	-1.9	20.4*	-8.1	28.3*	19.6*	25.3*	25.1*	15.2*	-2.5	-16.3*	-27.4*
LSD 5%	2.0	2.7	0.7	0.8	2.8	3.2	4.5	5.2	15.1	17.4	5.4	6.3	0.7	0.8

*** Significant at 5% level**

Table (5):Genetical and environmental components of variation for stem anatomical characters of maize over two locations

Characters	Epidermis thickness (μ)		Thickness Of sub-epidermal layer (μ)		V. bundle dimensions (LXW)		Diameter of ground cell (μ)		V. bundle dimension (μ)		Average Diameter of ground cell (μ)		Number of bundles in microscpic field 6X6	
	Outer zone								Inner zone					
Location	**Giza**	**Sids**	**Giza**	**Sids**	**Giza**	**Sids**	**Giza**	**Sids**	**Giza**	**Sids**	**Giza**	**Sids**	**Giza**	**Sids**
$\check{D}$	278.1	42.4	0.9	1.1	6.4	0.2	10.0	12.1	0.0	0.1	3.0	3.4	92.9	36.4
$\hat{F}$	316.7	59.0	0.7	0.9	6.0	0.1	131.9	32.9	0.0	0.0	-0.2	-0.1	37.5	19.8
$\hat{H}_1$	4925.3	3302.4	3.3	3.3	14.1	0.7	1587.6	2392.5	0.0	0.2	5.2	2.2	7474.7	7133.8
$\hat{H}_2$	4827.4	3282.0	3.1	3.2	11.6	0.5	1502.0	2365.2	0.0	0.2	5.1	2.0	7460.6	7051.3
h^2	10417.6	7273.4	5.7	24.6	60.6	0.1	2954.8	20471.8	0.0	0.2	11.1	3.1	16705.3	1791.9
$\hat{E}$	7.7	1.2	0.0	0.0	0.0	0.0	2.0	0.7	0.0	0.0	0.0	0.0	1.7	3.9
$(\hat{H}_1 / \check{D})^{½}$	4.4	9.2	2.0	1.8	1.5	1.7	5.3	14.6	4.0	2.0	1.4	0.8	9.3	14.6
$(\hat{H}_1 / 4\hat{H}_1)$	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.3	0.2	0.2	0.3	0.2	0.3	0.3
KD/KR	1.4	1.2	1.5	1.7	2.0	0.8	1.6	1.3	0.9	1.6	1.0	1.0	1.1	1.1
K	2.2	2.3	1.9	2.0	1.4	0.0	2.0	2.3	1.0	1.1	2.2	1.7	2.3	2.1
R	-1.0	-1.0	-1.0	-1.0	-0.9	-0.4	-1.0	-1.0	0.1	0.8	-1.0	-0.9	-1.0	-1.0
R^2	1.0	1.0	1.0	1.0	0.8	0.1	1.0	1.0	0.0	0.6	1.0	0.8	1.0	0.9
OR_1	3-1-2-4	1-3-2-4	3-2-1-4	2-3-1-4	3-1-2-4	3-2-4-1	3-2-1-4	1-3-2-4	1-3-4-2	1-4-2-3	1-3-4-2	1-3-4-2	1-2-4-3	3-4-1-2
OR_2	3-1-2-4	1-3-2-4	2-3-1-4	2-3-1-4	3-1-2-4	3-1-4-2	2-3-1-4	1-3-2-4	4-3-2-1	3-4-2-1	1-3-4-2	3-1-4-2	1-4-2-3	1-2-3-4
t^2	39.80	339.7	0.96	3.37	1.85	1.09	8.83	246.5	7.18	0.42	0.00	0.06	1.71	0.47