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CORRELATION STUDIES AND RELATIVE IMPORTANCE OF SOME PLANT CHRACTERS AND GRAIN YIELD IN MAIZE SINGLE CROSSES

[14]

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ABSTRACT

A diallel cross set of 28 maize single crosses was made using 8 different inbred lines. These crosses were evaluated under twelve different environments to estimate the phenotypic correlation coefficients among some plant characters and their contributions in the variation of grain yield/plant. Results showed that grain yield/plant was correlated positively and significantly with each of ear length, ear diameter, number of kernels/row, 100-kernel weight, plant height, ear height, stem diameter and days to silking. Path coefficient analysis estimates indicated that number of kernels/row as well as 100-kernel weight can be considered as the most important sources of plant yield variation, whether according to their direct and indirect effects, followed by ear diameter through its indirect effects via each of these two traits. It was concluded that each of 100-kernel weight, number of kernels/row and ear diameter may be the most effective selection criteria in maize breeding programs for high yielding hybrids.

Key Words: Maize, Correlation, Path coefficient analysis

INTRODUCTION

The association between characters is very important and gives very useful information to the crop breeders. If two characters are significantly correlated either positively or negatively, the selection for any of them will cause a change in the other depending on the correlation strength. When two desirable characters are associated to each other, it is an advantage, but the association between desirable and undesirable characters represents a problem in the breeding program especially if the correlation is a result of genetic linkage.

In addition, the magnitude of association between yield contributing characters in terms of their direct and indirect effects on maize grain yield per plant is of a great value for maize breeding programs. The path coefficient analysis indicates the most promising yield attributes which contribute directly to the final yield.

Grain yield was reported to be significantly and positively correlated with each of plant height, ear height, ear diameter, number of kernels/row and 100-kernel

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weight (**El-Banna, 2001**). Significant positive correlation was recorded between grain yield and each of ear length and 100-kernel weight (**Hassan, 2000**). **Dora *et al* (1999)** indicated that grain yield correlated positively and significantly with each of ear length, ear diameter, number of rows/ear, number of kernels/row, plant height and ear height. **Abdel-Sattar and Motawea (1999)** revealed that grain yield was mainly determined by number of kernels/row followed by 100-kernel weight. **Nawar *et al* (1995 b)** concluded that 100-kernel weight had significant direct effect on grain yield. **Sary *et al* (1990)** reported that the most important sources of plant yield variation were the direct effect of number of kernels/row and its indirect effects through number of rows/ear and 100-kernel weight.

The aims of this work were to investigate the phenotypic correlation coefficients between grain yield per plant and its contributing characters as well as to determine the relative importance for each of ear diameter, number of rows/ear, number of kernels/row and 100-kernel weight to grain yield variation in 28 maize single crosses overall 12 different environments (combinations between two plant densities and three nitrogen fertilization levels over two seasons).

MATERIAL AND METHODS

The field trials were started in the 1997 growing season in the Experimental Farm, Faculty of Agric., Ain Shams Univ. at Shoubra El-Kheima and lasted in 1998 and 2000 growing seasons in the Agric. Res. Station of the Faculty at Shalakan, Kalubia Governorate, Egypt. Eight inbred lines of maize (*Zea mays*, L.) were used in a half diallel cross set in this study. Five of which are local, i.e. G507 A (P_2), Mo 2 RF (P_3), Rg-16 (P_6), Rg- 25 (P_7) and Rg- 38 (P_8). These lines were provided by the Maize Research Department, Field Crops Institute, Agricultural Research Center, Giza, Egypt. The remaining three inbreds are introduced, where the two inbred lines Ita. 50 (P_4) and Ita. 52 (P_5) were introduced from Italy and the inbred line Ger. 21 (P_1) was introduced from Germany. These parental inbred lines were chosen on the basis of the presence of sufficient differences between them concerning certain plant characteristics such as earliness, grain yield per plant and some yield components.

In 1997 growing season, all possible cross combinations, without reciprocals, were made among the parental lines giving a total of 28 F_1 hybrids. However, in 1999 season, re-hybridization was made to obtain hybrid seeds to be used in the next growing season (2000) because the hybrid seeds in some cross combinations carried out in 1998 season were not enough, because the environmental conditions in this season were not suitable for seed set (during flowering stage) especially for the introduced inbreds. In both growing seasons of 1998 and 2000, the twenty eight F_1 hybrids were grown in three separate experiments representing three different nitrogen fertilization rates of 50, 100 and 150 kg N/fed. The three experiments were planted in three adjacent fields to avoid the differences in soil productivity. The nitrogen fertilization in form of urea (46.5% N) was applied in two doses before the second and the third irrigation. Each experiment was designated in a split plot design with three

replicates in which the two plant densities were allocated to the main plots and the sub-plots included the 28 maize entries. The two plant spaces were 25 and 20 cm between hills, which give plant densities of 24000 and 30000 plants/fed., respectively. Each plot consisted of one ridge four meters long and 70 cm width. Hills were thinned at one plant for each. Planting took place on May 28th and May 26th in the two seasons, respectively. The recommended cultural practices for maize production were followed during both growing seasons. Observations and measurements were recorded on ten guarded plants chosen at random from each plot for the following characteristics: 1- Silking date, 2- Plant height (cm), 3- Ear height (cm), 4- Stem diameter (cm), 5- Ear length (cm), 6- Ear diameter (cm), 7- Number of rows/ear, 8- Number of kernels/row, 9- 100-kernel weight (g) and 10- Grain yield per plant (g).

The phenotypic correlation coefficients were calculated as described by **Snedecor and Cochran (1981)** for all possible pairs of the studied characters including grain yield/plant using the combined data from the 12 different environments (all conditions between three nitrogen fertilization levels and two plant densities over two seasons). To obtain more information about the relative contribution of a specific character to grain yield/plant and the remaining characters, the path coefficient analysis was performed for all hybrids. The partitioning of correlation coefficient into direct and indirect effects at the phenotypic level was made by determining the path coefficient using the method mentioned by **Dewey and Lu (1959).**

RESULTS AND DISCUSSION

A- Correlation studies

The phenotypic correlation coefficients provide important informations about interrelationships between two or more of earliness, agronomic and/or main yield component characters by which the breeder can design a successful program to improve the yield capacity of different crop plants.

The phenotypic correlation coefficients estimated among the ten studied characters including grain yield are presented in Table (1). It is worthy to note that grain yield per plant showed positive highly significant correlations with each of ear length, ear diameter, number of kernels per row, 100-kernel weight, plant height, ear height, stem diameter and days to silking. This result indicates that selection considered any of all these characters simultaneously may be effective in improving grain yield per plant, especially if those characters had high heritability estimates. However, no significant correlation coefficient was found between grain yield per plant and number of rows per ear. Similar results were found by **Mohamed (1993), Salama *et al* (1994), Soliman *et al* (1995 and 1999), Abdel-Sattar and Motawea (1999), Dora *et al* (1999), Hassan (2000) and El-Banna (2001)** concerning the relation with ear length, ear diameter, number of kernels per row, 100-kernel weight, plant height and ear height as well as by **El-Sherbieny *et al.* (1994)** for the relation with days to silking. Regarding ear length, it gave positive and significant correlations with each of number of kernels/row, 100-kernel weight, plant height,

Table 1. Phenotypic correlation coefficients among different attributes for 28 maize single crosses over 12 different environments

Characters		X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}
Grain yield/plant	(X_1)	0.571**	0.888**	-0.332	0.858**	0.936**	0.885**	0.853**	0.872**	0.859**
Ear length	(X_2)		0.233	-0.751**	0.810**	0.590**	0.746**	0.723**	0.722**	0.669**
Ear diameter	(X_3)			0.036**	0.607**	0.796**	0.699**	0.676**	0.654**	0.633**
Number of rows/ear	(X_4)				-0.673**	-0.417*	-0.592**	-0.539**	-0.494**	-0.524**
Number of kernels/row	(X_5)					0.776**	0.952**	0.878**	0.844**	0.864**
100-kernel weight	(X_6)						0.826**	0.807**	0.859**	0.827**
Plant height	(X_7)							0.942**	0.855**	0.884**
Ear height	(X_8)								0.917**	0.923**
Stem diameter	(X_9)									0.912**
Days to silking	(X_{10})									

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

ear height, stem diameter and days to silking. Meanwhile, it was correlated negatively and significantly with number of rows/ear. Similar results were obtained by **Mohamed (1993), El-Sherbieny *et al* (1994), Salama *et al* (1994), Nawar *et al* (1995 a and b), Hassib (1997), Abdel Sattar and Motawea (1999), Dora *et al* (1999), Soliman *et al* (1999), Hassan (2000) and El-Banna (2001).** Ear diameter exhibited positive significant correlations with each of number of kernels per row, 100-kernel weight, plant height, ear height, stem diameter and days to silking. These results are in agreement with those mentioned by **El-Sherbieny *et al* (1994), Salama *et al* (1994), Nawar *et al* (1995 a), Dora *et al* (1999) and El-Banna (2001).** Number of rows per ear showed negative significant correlations with each of number of kernels per row, 100-kernel weight, plant height, ear height, stem diameter and days to silking. These results indicate that the more early matured F_1 hybrids are expected to exhibit high number of rows per ear. Similar results were obtained by **El-Sherbieny *et al* (1994) and Salama *et al* (1994).** Concerning number of kernels per row, positive significant correlation coefficients were found between it and each of 100-kernel weight, plant height, ear height, stem diameter and days to silking. Previous results of **Sary *et al* (1990), El-Sherbieny *et al* (1994), Salama *et al* (1994), Abdel-Sattar and Motawea (1999), Dora *et al* (1999), Soliman *et al* (1999) and El-Banna (2001)** indicated also positive significant correlations between number of kernels per row and one or more of 100-kernel weight, plant height and ear height. 100-kernel weight gave positive significant correlations with each of plant height, ear height, stem diameter and days to silking. Similar findings were obtained by **Al-kaddoussi (1990) and Hassib (1997).** Plant height showed positive significant correlations with each of ear height, stem diameter and days to silking. Similar results were found by **Mohamed (1993), El-Sherbieny *et al* (1994), Nawar *et al* (1995 b) and Dora *et al* (1999).** Ear height exhibited positive significant correlations with each of stem diameter and days to silking. Similar results were obtained by **Soliman *et al* (1995), Hassib (1997) and Dora *et al* (1999).** Concerning stem diameter, positive significant correlation was found between it and days to silking. Such result is in accordance with the finding of **Hassib (1997).** In general, the existence of such positive significant phenotypic associations between grain yield per plant and some yield components such as ear length, ear diameter, number of kernels per row and 100-kernel weight suggests that an increment of grain production may be achieved upon improving one or more of these traits, especially 100-kernel weight as well as ear diameter and number of kernels per row, which had correlation coefficient values more than 0.85.

B- Path coefficient analysis studies

In order to study the direct and indirect effects of various yield components on grain yield/plant as well as the relative importance of these components as selection criteria, path coefficient analysis was estimated from the combined data. Values of the direct and indirect effects of ear diameter, number of rows per ear, number of kernels/row and 100-kernel weight on grain yield per plant variation (Table 2) showed that number of kernels

Table 2. Partitioning of the phenotypic correlation coefficient between grain yield per plant and its related attributes in maize crosses

	Source of variation	Effects
1	Ear diameter vs. grain yield/plant:	
	Direct effect	0.2180
	Indirect effect via number of rows/ear	0.0067
	Indirect effect via number of kernels/row	0.3029
	Indirect effect via 100 kernel weight	0.3606
	Total	0.8880
2	Number of rows/ear vs. grain yield/plant:	
	Direct effect	0.1850
	Indirect effect via ear diameter	0.0079
	Indirect effect via number of kernels/row	-0.3358
	Indirect effect via 100 kernel weight	-0.1889
	Total	-0.3320
3	Number of kernels/row vs. grain yield/plant:	
	Direct effect	0.4990
	Indirect effect via ear diameter	0.1323
	Indirect effect via number of rows/ear	-0.1225
	Indirect effect via 100 kernel weight	0.3515
	Total	0.8580
4	100-kernel weight vs. grain yield/plant:	
	Direct effect	0.4530
	Indirect effect via ear diameter	0.1735
	Indirect effect via number of rows/ear	-0.0772
	Indirect effect via number of kernels/row	0.3872
	Total	0.9360

per row had the highest positive direct effect (0.499) followed by 100-kernel weight (0.453). On the other hand, ear diameter and number of rows per ear appeared to have relatively low direct effects on grain yield per plant (0.218 and 0.185, respectively). However, the indirect effects of ear diameter through either number of kernels per row or 100-kernel weight were positive and high (0.3029 and 0.3606, respectively). Meantime, that for number of kernels per row through 100-kernel weight was positive and high (0.3515), while via number of rows per ear was negative and low (-0.1225). Also, 100-kernel weight gave, through number of kernels per row, high positive indirect effect (0.3872). On the other side, the indirect effects of number of rows per ear through either number of kernels per row (-0.3358) or 100-kernel weight (-0.1889) were negative. The indirect effects via

these two traits may explain the negative correlation (-0.332) between grain yield per plant and number of rows/ear. The remaining indirect effects of the yield related characters on grain yield variation were low in magnitudes.

The direct and joint effects for each of ear diameter, number of rows/ear, number of kernels/row and 100-kernel weight on plant yield variation are presented in Table (3). Data indicated that the main sources of grain yield variation in order of relative importance are the joint effect for number of kernels per row through 100-kernel weight (25.27%), followed by the direct effect for number of kernels per the row (17.93%) and the direct effect of 100- kernel weight (14.78%), followed by the joint effect of ear diameter through 100-kernel weight (11.32%), then the joint effect of ear diameter through number of kernels per row (9.52%), the joint effect for number of rows per ear through number of kernels per row (8.95%) and the joint effect of number of rows per ear through 100-kernel weight (5.04%). The total contribution of these mentioned traits directly and jointly reached 98.90%, while the residual effects were only 1.10% of the total phenotypic variation of grain yield per the plant. It is worthy to note that the direct effect of number of kernels/row as well as 100-kernel weight proved to be the major grain yield contributors. Results mentioned by other workers (**Alkaddoussi *et al* 1990; Sary *et al* 1990; Salama *et al* 1994; Gomaa and Shaheen, 1994; Nawar *et al* 1995 a and b; Abdel-Sattar and Motawea, 1999; Soliman *et al* 1999 and Hassan, 2000**) revealed that number of kernels/row as well as 100-kernel weight are considered as the main components of plant grain yield variation.

Table 3. The components of direct and indirect effects and their relative importance as contribution percentages in the variation of grain yield per plant

	Source of variance		CD*	RI %**
1	Ear diameter	(X_1)	0.0457	3.42
2	Number of rows/ear	(X_2)	0.0342	2.46
3	Number of kernels/row	(X_3)	0.2490	17.93
4	100-kernel weight	(X_4)	0.2052	14.78
5	(X_1) X (X_2)		0.0029	0.21
6	(X_1) X (X_3)		0.1321	9.52
7	(X_1) X (X_4)		0.1572	11.32
8	(X_2) X (X_3)		-0.1243	8.95
9	(X_2) X (X_4)		-0.0699	5.04
10	(X_3) X (X_4)		0.3508	25.27
11	Residual factors		0.0153	1.10
	Total		1.0000	100.00

* CD denote coefficient of determination

** RI % denote percentage contributed (Relative Importance)

It can be concluded from our results that number of kernels/row as well as 100-kernel weight seemed to be the most effective selection criteria in maize breeding programs aiming high grain yield capacity (since their direct, indirect and total effects represented first and second rank) followed by ear diameter via its indirect effects through these two traits.

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مجلة اتحاد الجامعات العربية للدراسات والبحوث الزراعية ، جامعة عين شمس ، القاهرة ، ١١(١) ، ١٨١ - ١٩٠ ، ٢٠٠٣

دراسة الارتباط والأهمية النسبية لبعض صفات النبات ومحصول الحبوب فى الهجن الفرديه للذرة الشامية

[١٤]

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تم إجراء هذا البحث على ٢٨ هجين فردى من الذرة الشامية ناتجة من إجراء التهجين بين ثمانى سلالات نقية منها خمس محلية وثلاث أجنبية لدراسة محصول الحبوب بالنبات وعلاقته ببعض الصفات الأخرى. تمت زراعة هذه الهجن الفردية خلال الموسمين الزراعيين الصيفيين فى عام ١٩٩٨ ، ٢٠٠٠ تحت كثافتين نباتيتين هما ٢٤ ، ٣٠ الف نبات / فدان و ٣ معدلات للتسميد الأزوتى بمعدل ٥٠ ، ١٠٠ ، ١٥٠ كجم ازوت / فدان حيث أخذت البيانات على صفات محصول النبات الفردى من الحبوب - طول الكوز - قطر الكوز - عدد السطور بالكوز- عدد الحبوب بالسطر- وزن المائة حبة- طول النبات -ارتفاع الكوز- قطر الساق - عدد الأيام حتى ظهور الحريرة - وذلك فى ٣ تجارب مستقلة تمثل كل منها مستوى من التسميد الأزوتى - فى تصميم قطع منشقة مرة واحدة احتلت فيها مسافات الزراعة (الكثافات) القطع الرئيسية - ووضعت التراكيب الوراثية المختلفة فى القطع الفرعية.

وتشير النتائج المتحصل عليها إلى ما يلى

١-كان هناك ارتباطا موجبا ومعنويا بين محصول النبات من الحبوب وكل من طول الكوز وقطر الكوز وعدد الحبوب بالسطر ووزن المائة حبة و طول النبات وارتفاع الكوز و قطر الساق وعدد الأيام حتى ظهور الحريرة.

٢- أظهرت صفة طول الكوز تلازما موجبا ومعنويا مع كل من عدد الحبوب بالسطر ووزن المائة حبة و طول النبات وارتفاع الكوز و قطر الساق وعدد الأيام حتى ظهور الحريرة بينما كان ارتباطها سالبا ومعنويا مع عدد السطور بالكوز.

٣- ارتبطت صفة قطر الكوز ارتباطا موجبا ومعنويا مع كل من عدد الحبوب بالسطر ووزن المائة حبة و طول النبات وارتفاع الكوز وقطر الساق وعدد الأيام حتى ظهور الحريرة.

٤- فيما يخص صفة عدد السطور بالكوز فقد أظهرت ارتباطا سالبا ومعنويا مع كل من عدد الحبوب بالسطر ووزن المائة حبة و طول النبات وارتفاع الكوز و قطر الساق وعدد الأيام حتى ظهور الحريرة.

٥- كان هناك ارتباطا موجبا ومعنويا بين عدد الحبوب بالسطر وكل من وزن المائة حبة و طول النبات وارتفاع الكوز و قطر الساق وعدد الايام حتى ظهور الحريرة.

٦- أظهرت صفة وزن المائة حبة ارتباطا موجبا ومعنويا مع كل من طول النبات وارتفاع الكوز و قطر الساق وعدد الايام حتى ظهور الحريرة.

٧- أظهرت صفة طول النبات ارتباطا موجبا ومعنويا مع كل من ارتفاع الكوز و قطر الساق وعدد الأيام حتى ظهور الحريرة.

٨- أظهرت صفة ارتفاع الكوز ارتباطا موجبا ومعنويا مع كل من قطر الساق وعدد الأيام حتى ظهور الحريرة ، على حين كان هناك ارتباطا موجبا ومعنويا بين كل من قطر الساق وعدد الأيام حتى ظهور الحريرة.

٩- تشير نتائج تحليل معامل المرور الى أن صفة عدد الحبوب بالسطر كانت أكثر الصفات مساهمة فى تباين محصول النبات حيث كان تأثيرها المباشر ١٧,٩٣ % وتأثيرها غير المباشر عبر صفة وزن المائة حبة ٢٥,٢٧ % على حين كانت صفة وزن المائة حبة تمثل المرتبة الثانية من حيث مساهمتها فى تباين المحصول النبات حيث كان تأثيرها المباشر ١٤,٧٨% تليها فى الأهمية صفة قطر الكوز حيث ساهمت بمقدار ٣,٤٢% كتأثير مباشر علاوة على تأثيرها من خلال وزن المائة حبة بمقدار ١١,٣٢% ، كما كان تأثيرها من خلال عدد الحبوب بالسطر ٩,٥٢%. ومن ذلك يمكن استنتاج أن صفتى عدد الحبوب بالسطر ووزن المائة حبة تمثلان أهم مكونات المحصول للنبات تليهما صفة قطر الكوز من خلال تأثيرها غير المباشر لكل منهما.

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