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CORRELATION AND PATH COEFFICIENT ANALYSIS FOR GRAIN YIELD AND ITS COMPONENTS IN SOME MAIZE HYBRIDS (*Zea mays* L.)

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ABSTRACT

The present investigation was carried out at the Agricultural Experimental Farm of Faculty of Agriculture Kafr El-Sheikh, Tanta University, during 1998 and 1999 growing seasons. Twelve white and yellow maize hybrids, i.e., S.C. 10, S.C. 122, S.C. 123, S.C. 124, S.C. 125, T.W.C. 310, T.W.C. 320 and T.W.C. 321 (white maize) as well as S.C. 155, S.C. 159, T.W.C. 351 and T.W.C. 352 (yellow maize) were evaluated in a randomized complete blocks design (RCBD) with three replications, to study the phenotypic correlation coefficients between grain yield/plant and some yield components. Similar, the direct and indirect effects of these components on yield. The obtained results could be summarized as follows:

1. Significant positive phenotypic coefficients were observed between grain yield per plant and all yield attributes in two growing seasons.
2. Positive correlations were also recorded between some of the remaining traits.
3. The results indicated that the sources of grain yield per plant variation considered herein were responsible for 75.19% of the variation in the growing season of 1998, 85.78% in 1999 season, while the residual effect of other components were 24.81 and 14.22 for 1998 and 1999 growing seasons, respectively.
4. By using the path coefficients analysis, it was found that there was a high direct effect of number of ears/plant, number of rows/ear, ear length and number of kernels/row to increase grain yield/plant and played an important role in selection for high grain yield/plant in field maize.

INTRODUCTION

Maize is one of the most important cereal crops in Egypt. There is a critical need to increase its production to face the gab between the production and the consumption. In this respect, breeders and geneticists who are interested in corn improvement need conclusive information related to grain yield. However, till now the data obtained from studies of yield inheritance is relatively of little assistance in solving practical breeding problems.

Estimation of simple correlation among various agronomic characters may provide good informations necessary for maize breeders, when selection is based on two or more traits simultaneously. The association among traits may be measured by phenotypic coefficients of correlation depending on the types of materials studied. From the previous studies on the association between maize grain yield and other characters, it was apparent that positive and significant correlation was obtained between; yield and plant height (El-Demerdash, 1966; Shehata, 1975 and Abd El-Samie 2000), yield and number of ears per plant (El-Demerdash, 1966. Ibrahim, 1996), yield and number of kernels per ear (El-Demerdash, 1966), Salama *et al.,* 1994) yield and weight of 1000 kernels (El-Marakby, 1964, Gomaa and Shaheen, 1994; Ibrahim, 1996 and Abd El-Samie 2000): As well as yield and silking date (Salama *et al.,* 1994 and Ibrahim, 1996), grain yield/fed. (ton) and each of number of rows/ear and ear length (Abd El-Samie 2000). In addition path analysis was used to estimate the relative contribution of some yield attributes to grain yield variation, where it is known that the yield is quantitative characters, controlled by many genes and much affected by environmental fluctuations. Thus, selection for yield directly is misleading and time consuming. Therefore, vigorous determination of the characters which correlate directly or indirectly to yield becomes necessary. In this respect, path coefficient analysis procedure provides statistical analytical tool to determine the most effective characters accounting for the most part of the total variation in grain yield.

The objectives of the present study were:

1. To determine phenotypic correlations between grain yield and other related agronomic characters that might influence yield in maize populations.
2. To partition these correlations into direct and indirect effects.
3. To show to what extent yield is influenced by each of these characters.

MATERIALS AND METHODS

The materials used in this study were 12 maize hybrids of diverse genetic i.e. S.C. 10, S.C. 122, S.C. 123, S.C. 124, S.C. 125, T.W.C. 310, T.W.C. 320 and T.W.C. 321 (White maize) as well as S.C. 155, S.C. 159, T.W.C. 351 and T.W.C. 352 (Yellow maize). These hybrids were developed by national maize breeding program, field crops research institute, Agriculture Research Center.

The hybrids were grown in Faculty of Agriculture Farm at Kafr El-Sheikh during the growing seasons of 1998 and 1999. A randomized complete blocks design with four replications was used in both seasons. Each plot consisted of two rows 6.0 m. long and 70 cm a part with 25 cm between hills. Planting date were 25 May in the two seasons. Hills were thinned to one plant 21 days after planting to obtain 25,000 plants per feddan. Nitrogen fertilizer was applied at rate of 120 kg N/fed. in two equal doses before the first and the second irrigation and other cultural practices were carried out as recommended.

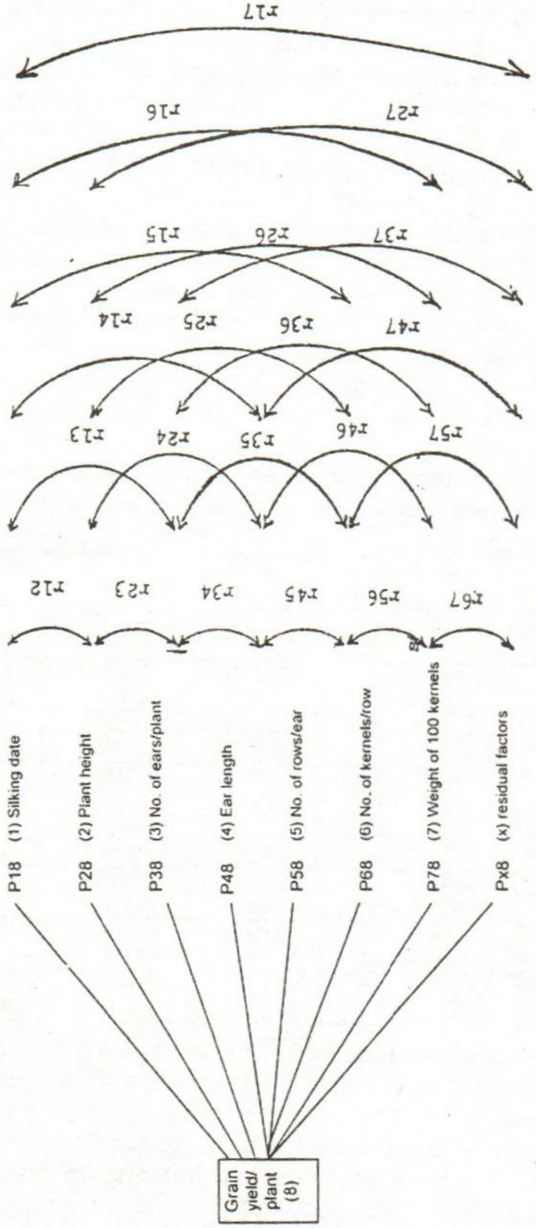
Readings on individual characters were taken on 10 guarded plants chosen at random from each plot. In every stock, the 40 plants were used for collecting data on the following characters.

1. Silking date (day).
2. Plant height (cm).
3. Ear length (cm).
4. Number of rows/ear.
5. Number ears/plant.
6. Number of kernels/row.
7. Weight of 100-kernels.
8. Grain yield/plant (g).

Statistical procedure:

The mean values of the eight characters, ranges and coefficients of variation during both seasons were calculated.

Simple correlation coefficients of all possible combinations of traits related to grain yield/plant were calculated according to Snedecor and Cochran (1967). Path coefficient analysis as suggested by Wright (1921, 1923, 1934 and 1960), and illustrated by Dewy and Lu (1959) was used to partition coefficient of correlation between grain yield/plant and each of the other traits into direct effects unidirectional (Pathways= P) and indirect effects through alternate pathways (Y x P). Grain yield was selected as the resultant (dependent) variable and the other seven traits under study as the causal (independent) variables. The nature of the causal system is represented diagrammatically.



RESULTS AND DISCUSSION

The data of the means, ranges and coefficients of variations for the eight studied traits are shown in Table (1). It may be suitable to divide these variations into the following classes; characters showing coefficients of variation below 10 percent will be considered of low variation and these included silking date, plant height, number of rows/ear, number of kernels/row, and weight of 100 kernels. Those ranged from 10 to 20 percent such as ear length, number of ears/plant and grain yield/plant, will be described as having high variations.

The diallel correlation coefficients between the eight studied traits are presented in Table (2). It was found that all characters were positively and significantly correlated with grain yield. With the except of grain yield traits, the diallel correlation among the other seven studied traits were mostly positive and significant in both seasons as shown in the Table. These results were in close agreement with these of Katta 1976, Nour El-Dein *et al.* (1984), Gomaa and Shaheen (1994), Salama *et al.* (1994); Ibrahim (1996) and Abd El-Samie (2000).

Table (1): The means, ranges and coefficients of variation of the studied characters during 1998 and 1999 growing seasons.

Traits	Year	No. of stocks	Trait mean	Range	C.V. %	C.V. mean
Grain yield/plant (gm)	1998 1999	40 40	183.75 171.70	138.40-236.80 116.03-261.17	15.40 14.1	14.75
Silking date (day)	1998 1999	40 40	63.61 64.40	60-68 61-70	3.02 2.70	2.86
Plant height (cm)	1998 1999	40 40	276.73 259.80	245.6-304.1 230.0-277	4.35 3.65	4.00
No. of ears/plant	1998 1999	40 40	1.02 1.03	1-1.10 1-1.25	12.39 10.69	11.54
No. of rows/ear	1998 1999	40 40	13.29 13.47	11.70-15.40 12.00-15.0	6.55 6.16	6.36
No. of kernels/row	1998 1999	40 40	40.45 44.40	38.0-43.60 39-54	3.44 9.50	6.47
Ear length (cm)	1998 1999	40 40	19.59 18.10	18-22.60 15-22.80	10.67 11.80	11.24
Weight of 100 kernels (gm)	1998 1999	40 40	40.27 39.38	37-45 35-48	3.92 8.20	6.06

The path coefficient method proposed by Wright (1921) was used to analyse the plant yield components within varieties. This method showed the relative importance of the characters contributing to plant yield. Therefore, simple correlation coefficients between plant yield and the chosen characters were individually partitioned into their components. In this case, direct and indirect path coefficient calculation of the seven characters on grain yield/plant in both seasons are presented in Table (3).

Days to silking date proved to have low to moderate direct effects on grain yield/plant and low indirect effects through the other traits in both seasons, except for number of rows/ear in the growing season of 1998 which showed moderate indirect effect.

Plant height proved to have low direct effects on grain yield/plant as well as negligible positive indirect effects through the other traits except, number of rows/ear in 1998, season and ear length in season 1999, which showed slightly higher indirect effects. The results suggest that plant height affect grain yield/plant directly or indirectly through ear length and number of rows/ear. These results were in agreement with those reported by Salama *et al.*, 1994 and Ibrahim, 1996.

Ear length showed moderate (in 1998) and high (in 1999) direct path effect on grain yield/plant. On the other side the indirect effect of this trait through the other traits on grain yield plant were low with the exception of number of rows/ear in 1998 and number of kernels/row as well as weight of 100 kernels in 1999 where they had moderate indirect values. Similar results obtained by Salama *et al.* (1994).

Table (2): Phenotypic simple correlation coefficients between yield and yield components during growing seasons of 1998 (above diagonal) and 1999 (below diagonal).

Characters	Grain yield/ plant (gm)	Silking date	Plant height	No. of ears/ plant	Ear length (cm)	No. of rows/ ear	No. of kernels/ row	Weight of 100 kernels
Grain yield/plant (gm)	-	0.278**	0.303**	0.518**	0.480**	0.396**	0.283*	0.303**
Silking date	0.566**	-	0.490**	0.088	0.095	0.342**	0.099	0.069
Plant height	0.442**	0.251*	-	0.016	0.229	0.300*	0.160	0.057
No. ears/plant	0.486**	0.490**	0.029	-	0.106	0.038	0.054	0.021
Ear length	0.797**	0.260*	0.490**	0.246**	-	0.4212	0.299*	0.115
No. of rows/ear	0.403**	0.157	0.314**	-0.022	0.460**	-	0.269*	0.018
No. of kernels/row	0.762**	0.336**	0.244**	0.368**	0.660**	0.245*	-	-0.009
Weight of 100 kernels	0.747**	0.247**	0.435**	0.242*	0.783**	0.475**	0.598**	-

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

Number of rows/ear showed high (in 1998) and low (in 1999) direct path effect on grain yield/plant. On the other side the indirect effect of this trait through the other traits were positive or negative, low or negligible. This means that selection for number of rows/ear should be of little importance for maize improvement. Similar results obtained by Katta (1976) and Ibrahim (1996).

Number of ear/plant had high (1998) and low (1999) direct effects on grain yield/plant. However, in both seasons data mostly positive, low or negligible indirect effect values were obtained, suggesting that number of ears/plant affect directly the grain yield/plant. These results were in agreement with what obtained by Shehata (1975), Ulkkede (1980), Nour El-Din *et al.* (1984) and Ibrahim (1996).

Number of kernels/row showed low (1998) and moderate (1999) direct effect values on grain yield/plant. The indirect effects of this trait through the other characters were negligible with the exception of number of rows/ear in 1998 and ear length as well as weight of 100 kernels in season 1999 where they had low or moderate indirect values. These results were in close agreement with what obtained by Gomaa and Shaheen, 1994 and Ibrahim, 1996.

Table (3): Partition of correlation coefficients between grain yield/plant and other components during 1998 and 1999 season.

Sources	Seasons	
	1998	1999
1- Silking date vs. plant yield		
Direct effect (py_1)	0.028	0.257
Indirect effect via plant height	0.038	0.013
Indirect effect via ear length	0.012	0.082
Indirect effect via number of rows/ear	0.165	0.006
Indirect effect via number of ears/plant	0.044	0.065
Indirect effect via number of kernels/row	0.007	0.094
Indirect effect via weight of 100-kernels	-0.018	0.048
Total (ry_1)	0.278	0.566
2- Plant height vs. plant yield		
Direct effect (py_2)	0.079	0.053
Indirect effect via silking date	0.013	0.064
Indirect effect via ear length	0.029	0.155
Indirect effect via number of rows/ear	0.145	0.130
Indirect effect via number of ears/plant	0.008	0.003
Indirect effect via number of kernels/row	0.012	0.068
Indirect effect via weight of 100-kernels	0.015	0.083
Total (ry_2)	0.303	0.442
3- Ear length vs., plant yield		
Direct effect (py_2)	0.130	0.317
Indirect effect via silking date	0.003	0.067
Indirect effect via plant height	0.018	0.026
Indirect effect via number of rows/ear	0.204	0.020
Indirect effect via number of ears/plant	0.055	0.032
Indirect effect via number of kernels/row	0.039	0.184
Indirect effect via weight of 100-kernels	0.031	0.151
Total (ry_3)	0.480	0.797
4- Number of rows vs. plant yield		
Direct effect (py_4)	0.305	0.043
Indirect effect via silking date	0.009	0.40
Indirect effect via plant height	0.023	0.018
Indirect effect via ear length	0.054	0.146
Indirect effect via number of ears/plant	-0.019	-0.002
Indirect effect via number of kernels/row	0.020	0.068
Indirect effect via weight of 100-kernels	0.004	0.092
Total (ry_4)	0.396	0.403
5- Number of ears/plant		
Direct effect (py_5)	0.511	0.132
Indirect effect via silking date	0.002	0.125
Indirect effect via plant height	0.001	0.001
Indirect effect via ear length	0.013	0.077
Indirect effect via number of rows/ear	-0.018	-0.0009
Indirect effect via number of kernels/row	0.004	0.103
Indirect effect via weight of 100-kernels	0.005	0.047
Total (ry_5)	0.519	0.486
6- Number of kernels/row		
Direct effect (py_6)	0.075	0.279
Indirect effect via silking date	0.002	0.086
Indirect effect via plant height	0.012	0.012
Indirect effect via ear length	0.038	0.209
Indirect effect via number of rows/ear	0.130	0.010
Indirect effect via number of ears/plant	0.027	0.048
Indirect effect via weight of 100-kernels	-0.002	0.115
Total (ry_6)	0.253	0.762
7- Weight of 100-kernels vs. plant yield		
Direct effect (py_7)	0.268	0.193
Indirect effect via silking date	-0.001	0.063
Indirect effect via plant height	0.004	0.022
Indirect effect via ear length	0.014	0.248
Indirect effect via number of rows/ear	0.008	0.20
Indirect effect via number of ears/plant	0.010	0.032
Indirect effect via number of kernels/row	-0.001	0.167
Total (ry_7)	0.307	0.747

Concerning the weight of 100 kernels, proved to have moderate (1998) and low (1999) direct effect values. The indirect effects of this trait through the other characters were positive or negative negligible values esceptically in season 1998 except what of ear length and number of kernels/row in 1999 where they had low indirect effect on grain yield/plant. So such characters must be considered effective in direct selection programe for improving grain yield/plant. These results were in agreement with those of Nawar *et al.* (1995a-1995b) and Ibrahim (1996).

The relative importance of each character to grain yield/plant was presented in Table (4). It included that the percentage of variation determined by each character and its interaction with other characters.

Table (4): Direct and joint effects of some yield components as percentages of grain yield variation in twelve maize hybrids during 1998 and 1999 seasons.

Plant yield Variation	Year			
	1998		1999	
	C.D	%	C.D	%
1. Silking date	0.0007	0.07	0.066	6.63
2. Plant height	0.0062	0.60	0.002	0.20
3. Ear length	0.0169	1.64	0.100	10.05
4. No. of rows/ear	0.2342	22.70	0.001	0.10
5. No. of ears/plant	0.2611	25.31	0.017	1.71
6. No. of kernels/row	0.0056	0.54	0.078	7.84
7. Weight of 100-kernels	0.0718	6.96	0.037	3.72
Silking date x plant height	0.0021	0.20	0.006	0.60
Silking date x ear length	0.006	0.06	0.042	4.22
Silking date x No. of rows/ear	0.0092	0.89	0.003	0.30
Silking date x No. of ears/plant	0.0025	0.24	0.033	3.32
Silking date x No. of kernels/row	0.0004	0.04	0.48	4.82
Silking date x weight of 100-kernels	-0.0010	0.09	0.0245	2.46
Plant height x ear length	0.0047	0.46	0.0160	1.61
Plant height x No. of rows/ear	0.022	2.13	0.0011	0.11
Plant height x No. of ears/plant	0.0013	0.13	0.0004	0.04
Plant height x No. of kernels/row	0.0018	0.17	0.0072	0.72
Plant height x weight of 100-kernels	0.0024	0.23	0.0088	0.88
Ear length x No. of rows/ear	0.053	5.14	0.0127	1.28
Ear length x No. of ears/plant	0.14	1.36	0.021	2.11
Ear length x No. of kernels/row	0.0058	0.56	0.116	11.66
Ear length x weight of 100-kernels	0.0110	1.07	0.095	9.64
No. of rows/ear x No. of ears/plants	-0.018	1.74	-0.0002	0.02
No. of rows/ear x No of kernels/row	0.019	1.84	0.0059	0.59
No. of rows/ear x weight of 100 kernels	0.004	0.39	0.008	0.80
No. of rows/ear x No. of kernels/row	0.0004	0.04	0.027	2.71
No. of rows/ear x weight of 100-kernels	0.0057	0.55	0.012	1.21
No. of kernels/row x weight of 100 kernels	-0.0003	0.03	0.064	6.43
Residual factors	0.256	24.81	0.1415	14.22
Total	1	100	1	100

Cd Coefficient of determination
% Percentage contributed

The main sources (direct effects) of grain yield/plant variation in 1998 according to their importance were number of ears/plant (25.31%), number of rows/ear (22.70%) and weight of 100 kernels/row (6.96%). On the other hand, the joint effects proved to have 5.14% for ear length with number of rows/ear and 2.13% for plant height with number of row/ear. The residual effect of other component on grain yield/plant was 24.81%.

In the growing season of 1999, the main sources (direct effects) of variation of grain yield/plant were ear length (10.05%), number of kernels/row (7.8%) and silking date (6.63%), the joint effects of ear length with number of kernels/row, ear length with weight 100 kernels (9.54), number of kernels/row (11.66) with weight of 100 kernels (6.43%), silking date with number of kernels/row (4.82%) and silking date with ear length (4.22%), while the residual effect of other component was 14.22%. These results were in close agreement with those of Katta (1976), Mahmoud (1989) and Ibrahim (1996).

Consequently, those results proved that in selecting for high-yielding genotypes it will be preferable to focus on number of ears/plant, number of rows/ear, ear length and number of kernels/row. However, care should be taken when an early selection for improving grain yield/plant is going to be done.

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تحليل معامل الارتباط ومعامل المرور لمحصول الحبوب وبعض مكوناته فى بعض هجن الذرة الشامية

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قسم المحاصيل ـ كلية الزراعة بكفرالشيخ ـ جامعة طنطا

أجريت هذه الدراسة فى المزرعة البحثية لكلية الزراعة بكفرالشيخ ـ جامعة طنطا خلال موسمى ١٩٩٨ ، ١٩٩٩. حيث تم تقييم اثنى عشر من هجن الذرة الشامية البيضاء والصفراء وهى الهجن البيضاء فردى ١٠ ـ ١٢٢ ، ١٢٣ ، ١٢٤ ، ١٢٥ و الهجن الثلاثية ٣١٠ ، ٣٢٠ ، ٣٢١. بالاضافة الى الهجن الصفراء فردى ١٥٥ ، ١٥٩ والهجن الثلاثية ٣٥١ ، ٣٥٢. وذلك بهدف دراسة معامل الارتباط ومعامل المرور لبعض الصفات لمعرفة مقدار ما تساهم به كل من هذه الصفات فى محصول الحبوب ويمكن تلخيص النتائج فيما يلى:

١- كان معامل الارتباط المظهرى بين المحصول ومكوناته المختلفة موجبا ومعنويا لجميع الصفات المدروسة وهى: عدد الايام حتى ظهور ٥٠% من الحراير ، إرتفاع النبات ، عدد الكيزان/نبات ، طول الكوز ، عدد الصفوف لكل كوز ، عدد الحبوب لكل صف ووزن المائة حبه مع محصول النبات الفردى.

٢- وجود معاملات ارتباط موجبه ومعنوية بين عديد من الصفات المدروسة الاخرى.

٣- بينت النتائج أن مصادر الاختلاف فى محصول الحبوب للنبات والتى نتجت عن تأثير الصفات المدروسة فى هذه الدراسة كانت ٧٥,١٩% بالنسبة لموسم ١٩٩٨ ، ٨٥,٧٨% بالنسبة للموسم ١٩٩٩ بينما كان الجزء المتبقى الراجع لعوامل أخرى هو ٢٤,٨١% بالنسبة للموسم ١٩٩٨ ، ١٤,٢٢% بالنسبة للموسم ١٩٩٩.

٤- من خلال دراسة معامل المرور كان ترتيب الصفات المؤثرة على محصول النبات (بصفة مباشرة أو غير مباشرة) وذلك حسب الأهمية هى عدد الكيزان للنبات ، عدد الصفوف للكوز ، طول الكوز وعدد الحبوب للصف ـ حيث ساهمت هذه الصفات بنسبة كبيرة فى صفة المحصول ويمكن أن تساهم بنصيب كبير فى صفة المحصول فى برامج الانتخاب بغرض تحسين محصول هجن الذرة المختلفة.