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USING SOME MULTIVARIATE PROCEDURES AND RESPONSE CURVE ANALYSIS IN MAIZE

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ABSTRACT

A two-year experiment was carried out at The Agricultural Research Station of Gemmeiza, Gharbia Governorate in the seasons of 2001 and 2002. The aims of the experiment were to study the effect of nitrogen levels (0, 40, 80, 120 and 160 Kg N/fed) on grain yield/fed of two maize hybrids namely: Single Cross 10 (S.C 10) and Three Way Cross 351 (T.W.C 351), a yellow hybrid, to determine the degree of response of grain yield to N fertilizer as well as to estimate the economic optimum N rate. Also to investigate the relationship between grain yield/plant and its components using some multivariate techniques namely: correlation, stepwise multiple linear regression and path-coefficient.

Grain yield/fed of S. C 10 surpassed that of T.W.C 351 in both seasons. The highest grain yield/fed of the two tested cultivars was produced by supplying 120 Kg N/fed in the two seasons. Quadratic model was the best of the tested models for describing the relationship between grain yield of the two maize hybrids to N fertilizer.

The economic optimum N rate ranged from 101 to 110 Kg N/fed. Grain yield produced by adding optimum N rate ranged from 3332.76 Kg/fed to 4509.89 Kg/fed and return raged from £.E 1953.34/fed to £.E 2687.23/fed.

The results of multivariate analysis techniques indicated that ear length, ear diameter, number of kernels/row and weight of 100 kernels were the most important contributing variables in the total variability of grain yield/plant. These variables have to be ranked the first in breeding program for improving grain yield of maize.

INTRODUCTION

Accurately quantifying the economic optimum fertilizer rate is essential to maximize profitability and minimize potential negative environmental impacts of fertilizer nitrogen use. Decisions regarding optimum rate of fertilizer require fitting some type of model to the data of yield collected when several fertilizer rates are applied. Cerrato and Blackmer (1990) fitted five response models namely: linear plus plateau, quadratic, quadratic plus plateau, exponential and square root to maize yield data in USA. They found that quadratic plus plateau model best described response of maize yield to nitrogen fertilizer. Economic optimum rate of N fertilizer was 184 Kg N ha^{-1}. Using quadratic response functions and a 1:10 fertilizer N : maize price ratio, Oberle and Keeney (1990) reported economic optimum N rates between 160 and 210 lb/acre on irrigated sandy soils and between 90 and 150 lb/acre on finer textured soils. Ashmawy (1994) reported that response of maize grain yield to N fertilizer was linear plus plateau, quadratic and quadratic plus plateau. He added that the economic optimum N rate was 110 and 150 Kg N/fed for the first and second seasons, respectively. In Wisconsin, USA, the fertilizer N rate required to maximize net return with maize was 160 to 170 lb/acre in both high –yielding and low–yielding years (Vanotti and Bundy, 1994). Schlegel *et al* (1996) in Kansas, USA, demonstrated that the economic optimum N rate for irrigated continuous maize was about 160 lb/acre. Response of maize grain yield to N fertilization under different plant densities was studied by El-Douby *et al* (2001). They found that the relation between grain yield and N fertilizer was described by the quadratic model.

Yield of maize is the integrated effect of many variables that affect plant growth during the season. Growth analysis and relative contribution studies may help in interpreting the results and perhaps lead the breeder to get better cultivars and good evaluation for the agricultural practices.

Correlation is an important statistical procedure used to facilitate breeding programs for high yield. It is also used to examine the direct and indirect contribution of the yield components. Stepwise multiple linear regression aims to construct a regression equation that includes the variables accounting for the majority of the total yield variation. Mohamed and Sedhom (1993), Ashmawy (1994) and Ashmawy and Mohamed (1998) determined the most important contributing variables in the variability of maize yield using stepwise approach. Path coefficient analysis divides correlation coefficients into direct and indirect effects through alternate path ways (Dewey and Lu, 1959). Several studies have been conducted using path coefficient to determine the direct and indirect effects as well as the relative contribution of maize characters contributing to grain yield/plant (Mohamed and Sedhom, 1993; Salama *et al*, 1994; Soliman *et al*, 1995; Ashmawy and Mohamed, 1998 and Soliman *et al*, 1999).

The objectives of this study were to (i) investigate effect of N fertilizer on grain yield/fed to determine the degree of response of grain yield to N fertilizer. (ii) Quantify the economic optimum N rate for maize yield. (iii) Determine the most important variables and their relative contribution to maize yield variability. The techniques utilized include fitting polynomial curves and performing economic analysis of the response curves as well as using multivariate procedures.

MATERIALS AND METHODS

Two field experiments were conducted at the Agricultural Research Station of Gemmeiza in 2001 and 2002 seasons. The experiments were carried out to study the effect of five nitrogen fertilizer levels (0, 40, 80, 120, 160 kg N/fed) on the grain yield of two maize cultivars namely: Single Cross 10 (S.C 10) and Three Way Cross 351 (T.W.C 351), a yellow hybrid, to determine the degree of yield response to nitrogen fertilization as well as to estimate the economic optimum N rate. Also to investigate the relationship between yield and its components using some multivariate procedures *i. e* correlation, stepwise multiple linear regression analysis and path-coefficient.

The experimental treatments were arranged in three replicates in a split–plot design; Maize cultivars were planted in main plots while levels of nitrogen fertilizer were assigned in the sub–plots. Plot area was 3 X 3.5 m^2. Mechanical and chemical analysis of the soil of the experiment is presented in Table 1. Agricultural practices were done as recommended in maize fields.

Table 1: Mechanical and chemical analysis of the soil of the experiment.

Property	2001 season	2002 season
Sand %	19.42	17.36
Sillt %	27.93	28.21
Clay %	35.54	38.61
Available N (PPM)	36.23	39.41
Available P (PPM)	18.11	18.56
Available K (PPM)	349	489

At harvest, five plants were randomly selected from the three guarded rows in each plot to collect data on the following characters:

1- Ear diameter (cm).
2- Ear length (cm).
3- Number of rows/ear.
4- Number of kernels/row.
5- Weight of 100 kernels (gm).
6- Shelling percentage (%).
7- Grain yield/plant (gm).

Grain yield/fed in Kgs was estimated on the basis of plot area (10.5 M^2) and was adjusted to 15.5 % moisture content.

Statistical analysis:

Nitrogen response curve analysis:

Analysis of variance for split-plot design was done according to Gomez and Gomez (1984) to the data of grain yield/fed. Four response models were fitted to the data of grain yield/fed for the two tested cultivars during first and second seasons according to Neter *et al* (1990). The tested models were linear, quadratic, exponential and square root.

Linear model is estimated using the formula

$$Y = a + b x$$

Where :
Y: is the grain yield/fed in kg.
a: is the Y intercept.
b: is the linear coefficient of regression.
x: is the level of nitrogen fertilizer applied in kg/fed.

Quadratic polynomial model is computed using the formula

$$Y = a + bx + cx^2$$

Where :
Y: is the grain yield/fed in kg.
a : is the Y intercept.
b : is the linear coefficient of regression.
c : is the quadratic coefficient of regression.
x : is the level of nitrogen fertilizer applied in kg/fed.

The exponential model is defined by the following equation

$$Y = a + b^x$$

Where:
Y: is the yield of grains/fed in kg.
a: is the Y intercept.
b: is the regression coefficient.
x: is the level of nitrogen fertilizer applied in kg/fed.

The square root model is estimated by the following formula

$$Y = a + bx + cx^{1/2}$$

Where:
Y: is the grain yield/fed in kg.
a: is the Y intercept.
b: is the linear coefficient.
c: is the square root coefficient.
x: is the rate of N application in kg/fed.

Coefficient of determination (R^2), standard error of estimate (SE) and significance of the model were the bases that considered to compare among the above mentioned response models. The significant model that had highest (R^2) and lowest SE was the best model for describing the relationship between grain yield and N fertilization.

Economic analysis:

The economic techniques used to determine the optimum fertilizer rate depend heavily on the model used to fit the data. The economic optimum fertilizer rate also depends directly on the price of fertilizer and selling price of the grains.

For a single variable model being fitted to the data from a single site-year, the optimal rate will be obtained by optimizing the total profit equation (Engelstad, 1985). In this case since we are fixing the levels of all other factors throughout all the experiment plots, then the total profit equation represents returns for those fixed factors. Calculus techniques are used to maximize total profit. The total profit equation is

$$\pi = P_y \ f(x) - Px \ X$$

Where: π: is the amount of profit.

P_Y: is the price of product.

Px: is the price of input (in this case nitrogen).

X: is the level of input (nitrogen fertilizer).

$f(x)$: is the production function.

By taking the first derivative of the above profit equation with respect to X and equating that to zero

$$\delta / \delta x - P_y \ \delta \ f(x) \ / \ \delta \ x - P_x = 0$$

Which can be written as

$$P_y \ \delta \ f(x) \ \delta \ x = P_x$$

This gives the first order condition on profit maximization which says that the marginal value of the product should equal the fertilizer price at optimum. Solving this first order condition for the level of X (the only unknown) gives the optimum nitrogen level. In other words, the farmer would continue increasing nitrogen until the return from the last unit added is just equal to that unit's price. The price of ammounium nitrate, as a source of nitrogen used in the present study, and the price of maize grains considered for the economic analysis were those prevailing in Cairo, Egypt during 2002 *i.e* £. *E* 1.4/kg for ammounium nitrate and £.E 0.63/kg for maize grains.

Multivariate procedures:

1- Simple correlation was computed for various characters as outlined by Steel and Torrie (1980).

2- Stepwise multiple linear regression: This approach was used to determine the effective yield components, as independent variables, which significantly contribute to the total variability in grain yield as dependent variable. This technique develops a sequence of multiple regression equations in a stepwise manner. One variable is added to the regression model at each step. The added variable is the one that causes the greatest reduction in the error sum of squares. It is also the variable which has the highest partial correlation with the dependent variable for fixed values of those variables already added, and is the variable that has the highest F value in regression analysis of variance. Stepwise regression was carried out according to the method reported by Draper and Smith (1981).

3- Path coefficient analysis was done as applied by Dewy and Lu (1959). A path coefficient is simply a standardized partial regression coefficient as it measures the direct effect of one variable upon another and permits the separation of the correlation coefficient into components of direct and indirect effects.

RESULTS AND DISCUSSION

Effect of nitrogen fertilizer on grain yield/fed:

Results of the effect of nitrogen fertilizer rates on grain yield/fed for the maize cultivars S. C. 10 and T.W.C 351 are presented in Table 2. Grain yield/fed was significantly affected by N rates in both seasons of the study.

In the first season, the results clearly indicated that application of 40, 80, 120 and 160 kg N/fed increased grain yield by 37.43 %, 91.54 %, 135.27 % and 65.40 %, respectively compared to the check treatment. S. C 10 significantly surpassed T. W. C 351 under the studied levels of nitrogen fertilizer. Grain yield was significantly affected by the interaction between cultivars and nitrogen levels. The highest grain yield/fed being 4199.22 kg/fed was obtained by planting S. C 10 supplied with 120 kg N/fed. On the other hand, T. W. C 351 gave the lowest yield of grains (1648.76 kg /fed) without adding nitrogen fertilizer.

In the second season, grain yield/fed increased by 31.05 %, 86.54 %, 120.11 % and 64.49 % as a result of the application of 40, 80, 120 and 160 kg N/fed. S. C. 10 significantly surpassed T.W.C. 351 under the nitrogen fertilizer levels. Interaction of cultivars X nitrogen fertilizer levels significantly affected maize grain yield/fed. S. C. 10 supplied with 120 kg N/fed recorded the highest grain yield being 5016.38 kg/fed whereas the lowest yield of grains was 1908.29 kg/fed and produced by T. W. C 351 without supplying nitrogen fertilization.

Table 2: Effect of nitrogen fertilizer rates on grain yield/fed of maize cultivars in the seasons of 2001 and 2002.

Cultivars (c)	Nitrogen rates (kg N /fed)					Mean
	0	40	80	120	160	
2001 season						
S. C 10	1757.87	2436.49	3521.48	4199.22	2967.54	2976.52
T. W. C 351	1648.76	2245.37	3003.73	3815.53	2667.09	2676.10
Mean	1703.31	2340.93	3262.6	4007.38	2817.32	2826.31
L. S. D (0.05)	C = 80.97		N = 112.04		C x N = 158.45	
2002 season						
S. C 10	2353.30	2921.36	4268.50	5016.38	3839.85	3679.88
T. W. C. 351	1908.29	2663.36	3680.91	4363.90	3170.03	3170.03
Mean	2130.79	2792.36	3974.71	4690.14	3504.94	3418.59
L. S. D. (0.05)	C = 53.41		N = 77.04			C x N = 108.96

The increased yield findings are mainly due to the direct effect of nitrogen in increasing meristimatic activity and accumulation of photosynthesis assimilates in the reproductive organs of maize plants which led to the increase in ear length and diameter, weight of 100 kernels and grain yield/plant. These findings are similar to those obtained by Shams EL-Din and El–Habbak (1996), Soliman *et al* (1999) and El–Douby *et al* (2001).

Analysis of N response curve:

Linear, quadratic, exponential and square root models were fitted to the data of grain yield/fed for the tested maize cultivars in the first and second seasons, respectively. Three bases were considered to compare among the four models *i. e* coefficient of determination (R^2), standard error of estimate (SE) and the significance of the model. The significant model which had highest R^2 and lowest SE was the best model fitted to the yield data.

Table 3 shows coefficient of determination (R^2), standard error of estimate (SE) and calculated F value of the four models to study response of maize yield to N fertilizer during 2001 and 2002 seasons. Results clearly indicate that the highest value of coefficient of determination, R^2, was in favor of quadratic model for the two tested cultivars in the two seasons of the study. The values of R^2 of quadratic model were 83.90 % and 83.55 % for S. C 10 in the two seasons, respectively. Coefficient of determination value was 80.67 % and 86.36 % in the first and second seasons, respectively, for T. W. C 351. The square root model ranked second concerning R^2 value followed by exponential and linear models, respectively, for the two tested cultivars in both seasons. Exponential model had the lowest value of SE followed by quadratic, square root and linear models, respectively, The results in Table 3 clearly showed that the four tested models were significant where they had significant F values.

It could be concluded that quadratic model was the best of the response models tested for describing response of grain yield of maize cultivars S. C. 10 and T.W.C. 351 to nitrogen fertilizer in both seasons, (Table 3 and Fig 1 to 4). These results are similar to those obtained by Ashmawy (1994), Schlegel *et al* (1996) and El–Douby *et al* (2001) who reported that the relation between grain yield of maize and N fertilizer followed the quadratic model.

Table 3: Values of coefficient of determination (R^2), standard error of estimate (SE) and calculated F value for models describing relationship between N rate and grain yield of maize cultivars in 2001 and 2002 seasons.

Cultivars	Single Cross 10				Three Way Cross 351			
Models	R^2 %	SE	F(cal)	Prob	R^2 %	SE	F(cal)	Prob
2001 season								
Linear	48.50	654.69	12.24	0.0039	48.94	559.69	12.46	0.0037
Quadratic	83.90	380.99	31.27	0.0000	80.67	358.39	25.04	0.0001
Exponential	54.72	0.22	15.71	0.0016	55.88	0.20	16.47	0.0014
Square root	65.20	560.36	11.23	0.0020	63.40	492.95	10.41	0.0020
2002 season								
Linear	57.04	668.19	17.26	0.0011	50.29	637.93	13.15	0.0031
Quadratic	83.55	430.35	30.47	0.0000	86.36	347.83	37.99	0.0000
Exponential	62.84	0.18	21.99	0.0004	56.28	0.20	16.73	0.0013
Square root	67.50	605.30	12.44	0.0010	68.40	529.58	12.98	0.0010

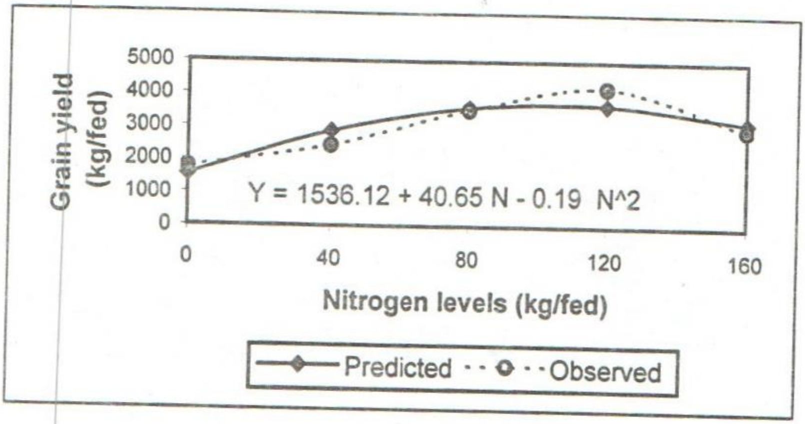

Fig 1: Rresponse of grain yield of maize cultivar Single Cross 10 to N fertilizer in 2001 season

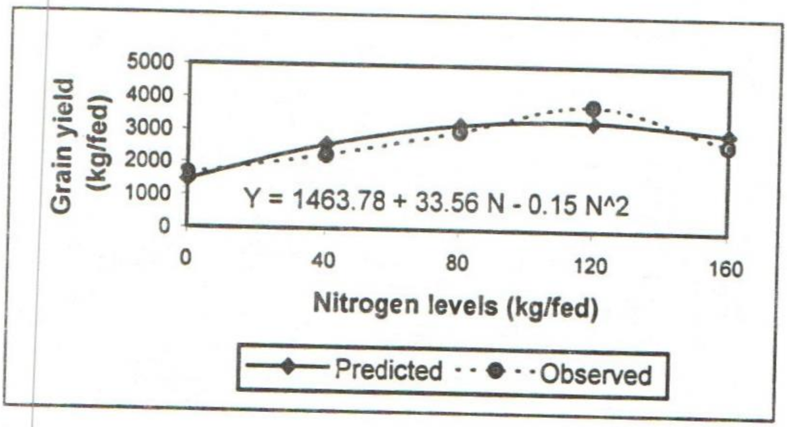

Fig 2: Rresponse of grain yield of maize cultivar Three Way Cross 351 to N fertilizer in 2001 season

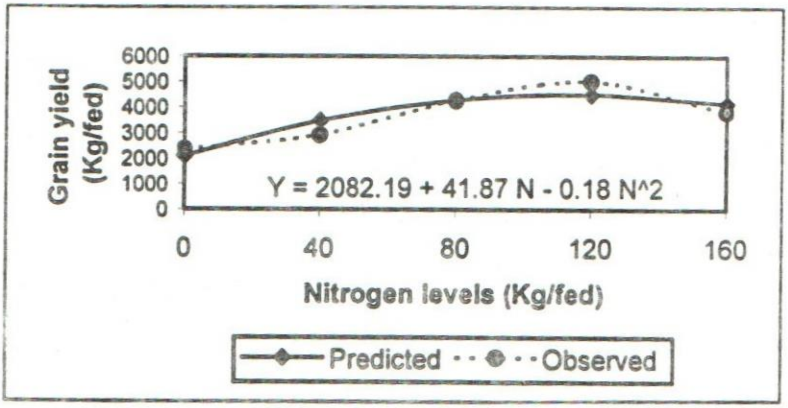

Fig 3: Rresponse of grain yield of maize cultivar Single Cross 10 to N fertilizer in 2002 season

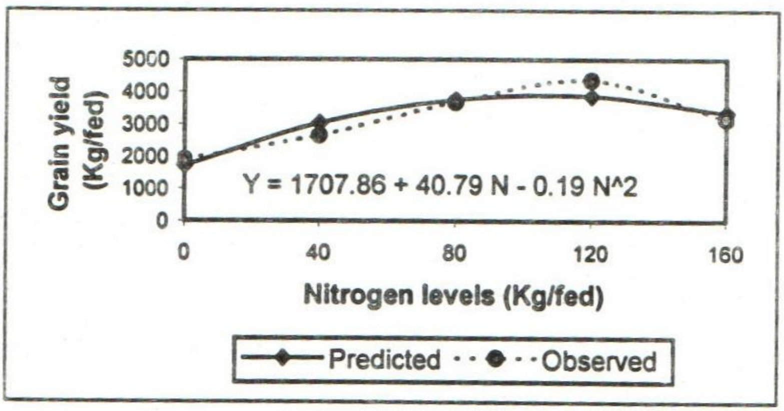

Fig 4:Response of grain yield of maize cultivar Three Way Cross 351 to N fertilizer in 2002 season

The results in Table 3 showed that the computed values of R^2 indicate that 83.90 % and 80.67 % of the total variability in the mean yield of cultivars S. C.10 and T.W.C 310, respectively, in the first season were explained by the estimated quadratic regression equation. In the second season, second degree equation explained 83.55 % and 86.36 % of the total variation of grain yield of the two tested cultivars in the two seasons.

Table 4: Quadratic regression equations, maximum nitrogen rate and grain yield at maximum nitrogen rate for maize cultivars in the 2001 and 2002 seasons.

Cultivars	Regression equations	Maximum N rate (kg/fed)	Yield at maximum N rate (kg/fed)
2001 season			
Single Cross 10	$Y = 1536.12 + 40.65 N - 0.19 N^2$	107	3710.36
Three way Cross 351	$Y = 1463.78 + 33.56 N - 0.15 N^2$	112	3340.90
2002 season			
Single Cross 10	$Y = 2082.19 + 41.87 N - 0.18 N^2$	116	4517.03
Three way Cross 351	$Y = 1707.86 + 40.79 N - 0.19 N^2$	107	3897.08

Maximum nitrogen rate estimated by the quadratic equation was 107 and 112 kg N/fed for S.C 10 and T. W. C 351, respectively, in the first season. It ranged from 107 Kg N/fed for T. W. C 351 to 116 kg N/fed for S. C 10 in the second season, (Table 4). The results showed that S. C 10 outyielded T. W. C 351 in the two seasons at the maximum level of fertilizer nitrogen recording 3710.36 and 4517.03 kg/fed in the first and second season, respectively. T.W. C 351 gave 3340.90 and 3897.08 kg/fed at the maximum level of N fertilization.

Economic analysis:

Data in Table 5 show the economic analysis of nitrogen fertilizer depending on quadratic response function. In the season of 2001, optimum nitrogen rate was 101 kg N/fed for S. C 10 and 104.5 kg N/fed for T. W. C 351. Grain yield produced by supplying the optimum N dose was 3703.58 Kg/fed giving return equal to £ E 2191.86/fed for S. C 10, whereas grain yield of T.W.C 351 was 3332.76 kg/fed recording return of £ E 1953.34/fed.

In the season of 2002, adding the optimum N rate (110 and 101.5 kg N/fed) gave grain yield of 4509.89 and 3890.62 kg/fed for the two tested cultivars, respectively. Return was £ E 2687.23 and 2308.99/fed for the corresponding cultivars, respectively. Similar results were obtained by Cerrato and Blackmar (1990), Oberle and Keeney (1990), Ashmawy (1994), Vanotti and Bundy (1994) and Schlegel *et al* (1996).

The fact that the estimates of profitability from response functions to nitrogen fertilization is not quite sufficient to allow for the precisian of comparisons between the studied cultivars. For example, information on the interaction between nitrogen fertilizer and other variables is not taken into account when calculating these optima. Therefore, the results of the current study should be interpreted cautionly. However, at least they give some indication about relative economic performance of the two tested maize cultivars. An economic analysis with more details would be required to verify these results.

Table 5: Economic analysis of nitrogen fertilization for maize cultivars in the seasons of 2001 and 2002.

Cultivars	Optimum N rate (kg /fed)	Yield at optimum N rate (kg/fed)	Return (£ E /fed)
2001 season			
Single cross 10	101.00	3703.58	2191.86
Three way Cross 351	104.50	3332.76	1953.34
2002 season			
Single Cross 10	110.00	4509.89	2687.23
Three Way Cross 351	101.50	3890.62	2308.99

Price of nitrogen = £ E 1.4/kg.
Price of maize grain = £ E 0.63/kg

Multivariate procedures:

Correlation analysis:

Simple correlation coefficients among grain yield/plant and its components in maize are presented in Table 6. The obtained results showed that the relationship between all possible pairs of the studied traits were highly significant (0.01) in most cases. Grain yield/plant showed highly significant and positive correlation with each of ear diameter (0.709**), ear length (0.920**), number of kernels/row (0.877**), weight of 100 kernels (0.882**) and shelling percentage (0.614**). Results clearly indicated that ear diameter, ear length, number of kernels/row and 100–kernel weight had the greatest influence on the grain yield. Another highly significant and positive correlation worthy of some attention are that between ear length and each of number of kernels/row (0.976**), weight of 100 kernels (0.896**) and shelling percentage (0.707**). Also, there was positive and highly significant association between number of kernels/row and each of weight of 100 kernels (0.875**) and shelling percentage (0.752**). Weight of 100 kernels revealed highly significant and positive correlation with shelling percentage (0.704**). These findings are in agreement with those reported by Soliman *et al* (1999).

Table 6: Simple correlation coefficients among grain yield/plant and its components in maize. (Combined over seasons of 2001 and 2002).

Characters		X_1	X_2	X_3	X_4	X_5	X_6
Ear diameter	X_1	1.000					
Ear length	X_2	0.476**	1.000				
Number of rows/ear	X_3	0.225	-0.254	1.000			
Number of kernels/row	X_4	0.394**	0.976**	-0.288*	1.000		
Weight of 100 kernels	X_5	0.424**	0.896**	-0.326*	0.875**	1.000	
Shelling percentage	X_6	0.205	0.707**	-0.248	0.752**	0.704**	1.000
Grain yield/plant	Y	0.709**	0.920**	-0.139	0.877**	0.882**	0.614**

* Significant at 0.05 level of significance.
** Significant at 0.01 level of significance.

Stepwise multiple linear regression analysis:

Data were subjected to stepwise analysis to determine the significant variables contributing to the variation of grain yield and their relative contributions. Accepted variables and their relative contributions are shown in Table 7. The results revealed that the most contributing variables in grain yield of maize were ear length, ear diameter and weight of 100 kernels. Those variables were responsible for 95.9 % in grain yield variation. It is observed from the results that ear length was the most important variable followed by ear diameter and weight of 100 kernels. The relative contribution in the total variability of grain yield of maize were 84.6 %, 9.5 % and 1.8 % for the above mentioned variables, respectively (Fig 5). The best prediction equation was

$$\hat{y} = -348.543 + 9.982\ X_2 + 61.206\ X_1 + 2.750\ X_5$$

Number of rows/ear, number of kernels/row and shelling percentage were eliminated due to their low relative contribution (0.10 %).

Table 7: Characters explaining grain yield of maize using stepwise multiple regression analysis over seasons of 2001and 2002.

Characters	Regression Coefficient	Standard Error	Prob.	Commul-Ative R^2 %	Partial R^2 %
1- Ear length (X2)	9.982	1.299	0.000	84.6	84.6
2- Ear diameter (X1)	61.206	5.379	0.000	94.1	9.5
3-Weight of 100 kernels (X5)	2.750	0.560	0.000	95.9	1.8

Intercept = -348.543
R^2 for accepted characters = 95.90 %
R^2 for eliminated characters = 0.10 %
R^2 for studied characters = 96.00 %
Standard error of estimate = 9.65

Path–coefficient analysis:

Simple correlation coefficients among maize grain yield/plant and its components were individually partitioned into their components of direct and indirect effects. The results of direct and indirect effects of yield components and their relative importance to the variability of grain yield are presented in Table 8 and diagrammatically illustrated in Figure 6.

The results indicated that ear length, ear diameter and weight of 100 kernels possessed the highest direct effects towards grain yield/plant. The relative importance to the total variability of grain yield was 11.75 %, 11.32 % and 8.88 % for the three corresponding variables, respectively. Number of kernels/row accounted for 1.81 % contributing to the grain yield variation.

Ear length indirectly contributed by 18.30 % to the grain yield variation through weight of 100 kernels while it accounted for 8.99 % through number of kernels /row. Ear diameter had indirect effect being 10.98 % in the total variance of grain yield through ear length, 8.50 % through weight of 100 kernels and 3.56 % through number of kernels/row which accounted for 7.01 % through weight of 100 kernels.

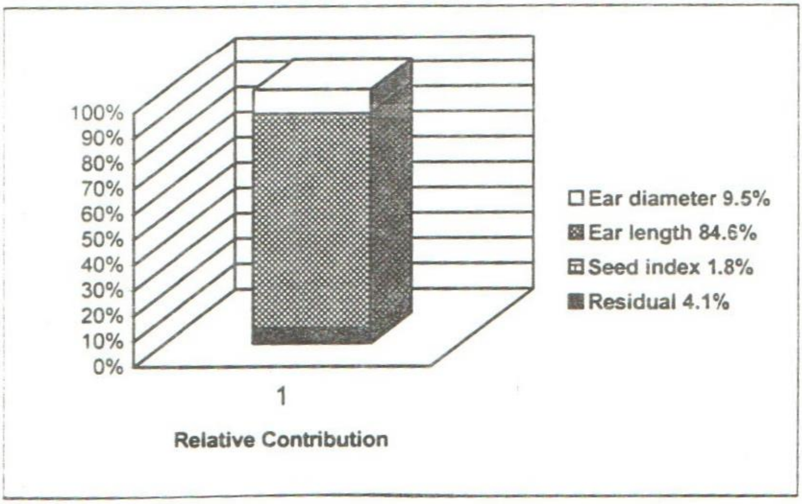

Fig 5: Accepted variables due to stepwise regression and their relative contributions in the total variation in grain yield of maize

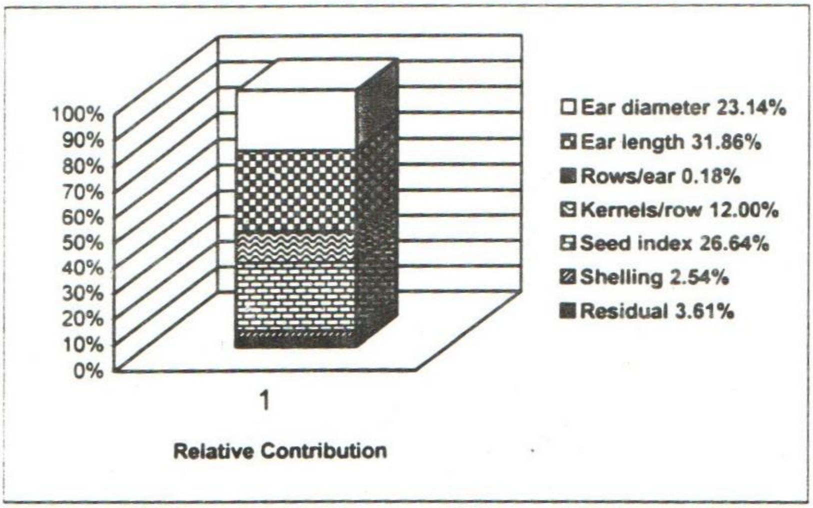

Fig 6: Direct and indirect effects of yield components in the total variation of maize grain yield

The results clearly indicated that the total relative contribution of the studied characters to the variability of grain yield was 96.40 and the residual effect of the other yield components was 3.61%. It is evident that the residual effect has slight magnitude and showed very small contribution to the variability of the grain yield and also to the other characters that were probably not included into this model.

Although number of kernels/row showed highly significant and positive correlation with grain yield/plant ($r = 0.877^{**}$) and it had relative importance being 12.00 % to the total variability of the grain yield (Table 8 and Fig 6), this character was not included into stepwise equation, (Table 7). This may be due to presence of multicolinearity with each of ear diameter, ear length and weight of 100 kernels, (Table 6).

Table 8: Direct and indirect effects of yield components and their relative importance in grain yield of maize over seasons of 2001 and 2002.

Characters		Effects	CD*	RI %**
Direct				
Ear diameter	X_1	0.355	0.126	11.315
Ear length	X_2	0.361	0.131	11.745
Number of rows/ear	X_3	0.006	0.000	0.003
Number of kernels/row	X_4	0.142	0.020	1.807
Weight of 100 kernels	X_5	0.314	0.099	8.878
Shelling percentage	X_6	-0.041	0.002	0.148
Indirect				
X_1 vs X_2		0.172	0.122	10.975
X_1 vs X_3		0.001	0.001	0.089
X_1 vs X_4		0.056	0.040	3.563
X_1 vs X_5		0.133	0.095	8.499
X_1 vs X_6		-0.008	-0.006	0.531
X_2 vs X_3		-0.002	-0.001	0.102
X_2 vs X_4		0.138	0.100	8.993
X_2 vs X_5		0.282	0.204	18.299
X_2 vs X_6		-0.029	-0.021	1.865
X_3 vs X_4		-0.041	-0.001	0.046
X_3 vs X_5		-0.102	-0.001	0.114
X_3 vs X_6		0.010	0.000	0.011
X_4 vs X_5		0.275	0.078	7.009
X_4 vs X_6		-0.031	-0.009	0.778
X_5 vs X_6		-0.029	-0.018	1.615
Residual			0.0402	3.6138

Multiple coefficient of determination = 96.3862 %
***C D = Coefficient of determination.**
****R I = Relative importance.**

From previous results of multivariate analysis, it could be concluded that the most important contributing characters to the total variability of maize grain yield were ear length, ear diameter, number of kernels/row and weight of 100 kernels. Therefore, these four variables have to be ranked the first in breeding program for improving grain yield of maize.

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استخدام تحليل العوامل المتعددة و منحنيات الاستجابة فى الذرة الشامية

فتحى عشماوى
المعمل المركزى لبحوث التصميم و التحليل الاحصائى-مركز البحوث الزراعية

اقيمت تجربة حقلية فى محطة البحوث الزراعية بالجميزة – محافظة الغربية فى موسمى ٢٠٠١و ٢٠٠٢ بهدف دراسة تأثير معدلات السماد الأزوتى (صفر– ٤٠– ٨٠– ١٢٠– ١٦٠ كم أزوت/فدان) على محصول الحبوب لهجينين من الذرة الشامية هما هجين فردى ١٠ و هجين ثلاثى أصفر ٣٥١ و درست درجة العلاقة بين محصول الحبوب و السماد الأزوتى كما تم تقدير المعدل الاقتصادى الأمثل للسماد الأزوتى و ايضا تم تحديد أهم العوامل المساهمة فى تباين محصول الذرة الشامية باستخدام بعض اساليب تحليل العوامل المتعددة .

أوضحت النتائج أن الصنف هجين فردى ١٠ تفوق معنويا على الصنف هجين ثلاثى ٣٥١ بالنسبة لمحصول حبوب الفدان كما تحقق أعلى محصول حبوب للفدان نتيجة التسميد بمعدل ١٢٠ كجم أزوت/ف. و أظهرت النتائج أن العلاقة بين التسميد الأزوتى و محصول حبوب الذرة الشامية تتبع الدرجة الثانية حيث كان منحنى الدرجة الثانية أفضل المنحنيات لوصف هذه العلاقة.

و تراوح المعدل الاقتصادى الأمثل للسماد الأزوتى بين ١٠١ الى ١١٠ كم أزوت/فدان كما تراوح محصول الحبوب على أساس المعدل الاقتصادى الأمثل للسماد الأزوتى من ٣٣٣٢،٧٦ كجم/فدان الى ٤٥٠٩،٨٩ كجم/فدان و تراوح العائد الناتج من ١٩٥٣،٣٤ جنيها/فدان الى ٢٦٨٧،٢٣ جنيها/فدان.

وأظهرت نتائج تحليل العوامل المتعددة أن طول و قطر الكوز و عدد حبوب الصف و وزن ١٠٠ حبة أهم العوامل المساهمة فى تباين محصول النبات حيث سجلت هذه العوامل أعلى مساهمة نسبية فى التباين الكلى للمحصول، مما يجدر بمربى الذرة الشامية أن يأخذ هذه العوامل فى الاعتبار عند تصميم برامج التربية لتحسين و رفع انتاجية محصول الذرة الشامية.