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ECONOMIC STUDY TO EVALUATE THE NITROGEN RESPONSE CURVE IN MAIZE

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ABSTRACT

Two field experiments were carried out at Sids Agricultural Research Station, Beni-Swef Governorate in the seasons of 2003 and 2004. The aims of this investigation were to study the effect of nitrogen levels (0, 80, 120 and 160 Kg N/fed) on grain yield (ard/fed)of Single Cross 10 (S.C 10) and to determine the response degree of grain yield to N fertilizer as well as to estimate the economic optimum N rate. Also to investigate the relationship between grain yield and its components using some statistical techniques namely: correlation, stepwise multiple linear regression and path-coefficient.

The highest grain yield (ard/fed) of the tested cultivar was produced by supplying 160 Kg N/fed in the two seasons. Quadratic model was the best of the tested models for describing the relationship between grain yield of maize hybrid to N fertilizer.

The economic optimum N rate (121.3 and 120.8 Kg N/fed), respectively, for the two seasons (2003 and 2004). Grain yield produced by adding optimum N rate (26.8 and 28 ard/fed) respectively and net return £.E 1106.8/fed in the first season (2003) and £.E1250.8/fed in the second season (2004).

The results of statistical analysis techniques indicated that ear height, plant height, and ear length were the most important contributing variables in the total variability of maize grain yield. These variables have to be ranked the first in breeding program for improving maize grain yield.

INTRODUCTION

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) that 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. 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 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

The objectives of this study were to (i) investigate effect of N fertilizer on grain yield ard/fed to determine the response degree of grain yield to N fertilizer. (ii) calculated economic optimum N rates 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 some multivariate procedures.

MATERIALS AND METHODS

Two field experiments were conducted at the Agricultural Research Station of Sids in 2003 and 2004 seasons. The experiments were carried out to study the effect of four nitrogen fertilizer levels (0, 80, 120 and 160 kg N/fed) on the maize grain yield of cultivar Single Cross 10 (S.C 10), 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 statistical procedures (correlation, stepwise multiple linear regression analysis and path-coefficient).

The experimental treatments were arranged in four replicates in a randomized complete blocks design. Plots consisted of five ridges, 3 m long and 70 cm apart. Planting was done in hills spaced 25 cm along the ridge. Plot area was 3 X 3.5 (10.5 m^2). In both seasons, ammonium nitrate (33.5%N) was applied in two equal doses before the first and second irrigations (21 and 33 days after sowing), date of sowing (10 and 15 May) respectively 2003 and 2004. Calcium super phosphate (15.5% P_2O_5) and potassium sulphate (48.5% K_2O) at rates of 30 and 24 kg/fed, respectively, were applied before sowing in all treatments. At harvest time, ten guarded plants were randomly selected from each plot and screened for the plant characteristics, which designated as (X_1) Plant height, (X_2) Ear height, (X_3) Stem diameter in cm., (X_4) Ear length in cm, (X_5) Ear diameter in cm, (X_6) No.of rows/ear, (X_7) No .of kernels/row, (X_8) No. of plants at harvested and (Y) Grain yield in Ard/Fed was estimated on the basis of plot area (10.5 m^2)

and was adjusted to 15.5 % moisture content. Mechanical and chemical analysis of the soil of the experiment is presented in Table 1. All cultural practices were applied as recommended.

Table 1: Mechanical and chemical analysis of the soil at the experimental sites during the two seasons.

Property	2003 season	2004 season
Sand %	21.15	14.42
Silt %	34.60	28.58
Clay %	44.25	57.00
Texture	Clay	Clay
p^H1:2.5	8.45	8.20
O.M %	2.02	2.04
CEC m.e./100 g soil	36.20	36.00
Total N %	0.157	0.180
NH_4 ppm	15.20	5.90
NO_2 ppm	0.11	0.32
NO_3 ppm	20.20	15.13
Available (p) ppm	9.25	15.50
Available (k) m.e./100 g soil	0.90	0.91

Statistical analysis:

Analysis of variance for a randomized complete blocks design wa done according to Gomez and Gomez (1984) to the data of grain yield. Three response models were fitted to the grain yield data for the tested cultivar during first and second seasons according to Neter, *et al.* (1990).

Nitrogen response curve Models:

To describe maize grain yield response to N fertilizer, four statistical models (linear, quadratic, exponential, and square root) were fitted to the data using the regression curve procedure of the SPSS software. Economically optimum N rates (EONR) for the four models were computed for grain yields. The EONR (kg N fed) is defined as the rate of N application where £ E 1 of additional N fertilizer returned £ E 1 of maize, and it describes the minimum rate of N application required to maximize economic return. This analysis assumes that fertilizer N costs are the only variable costs and that all other costs are fixed. The EONR was calculated by setting the first derivative of the N response curve equal to the ratio between the cost of fertilizer and the price of maize for the four tested models(Dustin, *et al.*, 2004).

For the four statistical models, *Y* is the grain yield in ard/fed, *N* is the N fertilization rate in kg N fed, and *a*, *b*, and *c* are parameter estimates using the regression curve procedure (Gilles Bélanger, *et al.*, 2000).

The liner model is $Y = a + bN$

The quadratic model is $Y = a + bN + cN^2$

The square root model is $Y = a + bN + cN^{1/2}$

The exponential model is $Y = a + b\exp(N)$

The coefficients 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.

Economically Optimum Nitrogen Rate and Yield at Economically Optimum Nitrogen Rate:

The EONR was calculated for N rate, the yield response to N was calculated for all treatments. If the yield did not significantly increase with N application, the EONR was set at zero. If the yield curve function fitted a simple linear model, the EONR was the maximum N rate used (in this case kg N fed). If the yield curve function fitted a quadratic model, the EONR was calculated by setting the derivative of the gross return function in following equation:

$$\text{Gross return} = (b_0 + b_1 * \text{N rate} + b_2 * \text{N rate}^2) * P_c - P_n * \text{N rate}$$

equal to zero. The gross return was calculated using this equation , where b_0, b_1, and b_2 are intercept, linear, and quadratic parameters, respectively; p_c is the price of maize; and p_n is the cost of N. The price of maize was £ E 120/ard, and the price of N fertilizer per kilogram was £ E 1.76/kg at the time of the experiment. Gross return comparison was made between EONR and a uniform N rate recommendation that would be made by the University of Minnesota (Mamo *et al.*, 2003).

Statistical 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 effect of 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 Dewey 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 nitrogen fertilizer rates effect on grain yield ard/fed in maize single cross hybrid G12A-10(S.C.10) are presented in Table 2. Grain yield ard/fed was significantly affected by N rates in both seasons of the study.

In the first season, the results clearly indicated that application of 80, 120 and 160 kg N/fed increased grain yield by 56.17 %, 72.2 % and 75.9 % in the first season 2003, 52.5%, 80.2% and 84.6% in the second season 2004 respectively compared to the check treatment.Nitrogen fertilizer levels significantly affected maize grain yield ard/fed, the highest grain yield (28.5, 29.9 ard/fed) respectively in the two seasons with the rate 160 kg N/fed relative to the lowest grain yield of 16.2 ard/fed in both seasons under check treatment (zero nitrogen fertilizer).

Table 2: Effect of nitrogen fertilizer rates on grain yield(ard/fed) of maize cultivar(S.C.10) in the seasons of 2003 and 2004.

Characters	Nitrogen rates (N kg /fed) 2003					Nitrogen rates (N kg /fed) 2004				
	0	80	120	160	Mean	0	80	120	160	Mean
Yield (ard/fed)	16.2 C	25.3 B	27.9 AB	28.5 A	24.5 2.8*	16.2 C	24.7 B	29.2 A	29.9 A	25.0 3.1*
Return	1944	3036	3345	3416	2935	1940	2964	3509	3585	3000
Profit	46	998.5	1236	1236	879.3	42	927.9	1400	1405	943.9
Total cost	1898	2038	2109	2179	2056	1898	2038	2109	2179	2056

*LSD value at 5%.

Analysis of N response curve:

Linear, quadratic, exponential and square root models were fitted to the grain yield data for the tested maize cultivar in the first and second seasons, respectively. Three bases were considered to compare among the four models *i. e* coefficient of determination (R^2), estimate standard error (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 grain yield to N fertilizer during 2003 and 2004 seasons. Results clearly indicate that the highest value of coefficient of determination, R^2, was in favor of quadratic model for the tested cultivar in the two seasons of the study. The values of R^2 of quadratic model were 75.2 % and 75.6 % in the two seasons, respectively. The second degree model had standard error of estimate less than those of linear, exponential and square root models. Moreover, quadratic model had significant calculated F value for the tested cultivar in the two seasons. Therefore, the quadratic model was the best of the response models tested for describing response of grain yield of maize cultivar S. C. 10 to nitrogen fertilizer, (Table 3 and Fig 1,2). These results are similar to those obtained by 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.

Maximum nitrogen rate estimated by the quadratic equation was 121.3 and 120 kg N/fed respectively in the two seasons, (Table 4). The results showed that cultivar S.C.10 outyielded in the two seasons at the maximum level of fertilizer nitrogen recording 26.8 and 28 ard/fed in the first and second seasons, respectively.

Economic analysis:

Data in Table 5 show the economic analysis of nitrogen fertilizer. In the season of 2003, optimum nitrogen rate was 121.3 kg N/fed. Grain yield produced by supplying the optimum N dose was 26.8 ard/fed giving return equal to £ E 3216/fed. In the season of 2004, adding the optimum N rate 120.8 kg N/fed gave grain yield of 28 ard/fed and return was £ E 3360.

Similar results were obtained by Cerrato and Blackmar (1990), Oberle and Keeney (1990), Vanotti and Bundy (1994), Schlegel, *et al.*, (1996) and William, *et al.*, (2004)

Table 3: Coefficient values 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 2003 and 2004 seasons.

Cultivars Models	2003				2004			
	R^2%	S.E.	F(cal)	P	R^2%	S.E.	F(cal)	P
Linear	69.5	3.22	77.4	0.0	73.1	3.34	92.3	0.0
Quadratic	75.2	2.95	50.1	0.0	75.6	3.23	51.2	0.0
square root	74.9	2.96	49.3	0.0	75.1	3.26	49.7	0.0
Exponential	73.5	0.13	94.3	0.0	77.2	0.13	114	0.0

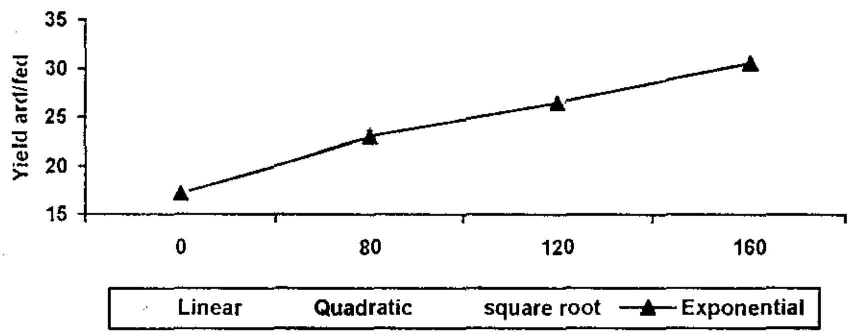
Table 4: Quadratic regression equations, maximum nitrogen rate and grain yield at maximum nitrogen rate for maize cultivars in the 2003 and 2004 seasons.

Seasons	Regression equations	Maximum N rate (kg/fed)	Yield at maximum N rate (kg/fed)
2003	$Y = 16.18 + 0.1538 N - 0.0012 N^2$	121.3	26.8
2004	$Y = 16.06 + 0.1448 N - 0.0010 N^2$	120.8	28.0

Table 5: Economic analysis of nitrogen fertilization for maize cultivars in the seasons of 2003 and 2004.

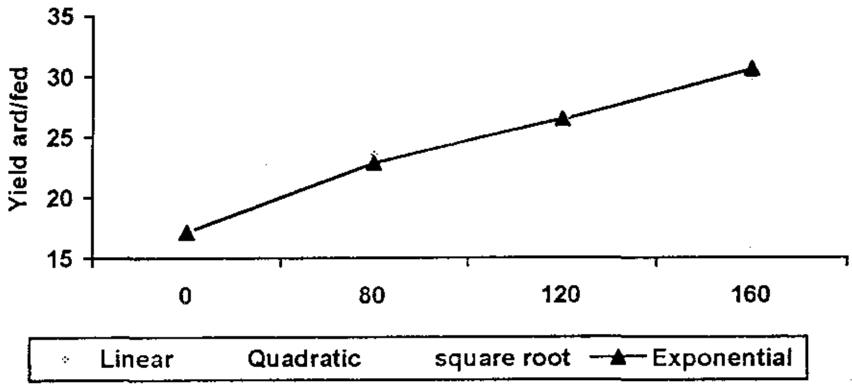
Seasons	Optimum N rate (kg /fed)	Yield at optimum N rate (ard/fed)	Net return (£ E /fed)
2003	121.3	26.8	1106.8
2004	120.8	28.0	1250.8

Price of nitrogen = £ E 1.76/kg.
Price of maize grain = £ E 120/ard



Applied N kg/fed

Fig(1): Nitrogen response curves 2003



Applied N kg/fed
Fig(1): Nitrogen response curves 2004

Correlation analysis:

Simple correlation coefficients among grain yield ard/fed and its components in maize are presented in Table 6. The obtained results showed that the relationship among all possible pairs of the studied traits were highly significant (0.01) in most cases. In the first season (2003), grain yield ard/fed showed highly significant and positive correlation with each of plant height (0.77^{**}), ear height (0.90^{**}), stem diameter (0.47^{**}), ear length (0.61^{**}), ear diameter (0.66^{**}), number of kernels/row (0.77^{**}) and number of plant at harvested (0.66^{**}) while number of rows/ear was not significant. In the second season, also showed highly significant and positive correlation with each of plant height (0.81^{**}), ear height (0.87^{**}), stem diameter (0.59^{**}), ear length (0.64^{**}), ear diameter (0.78^{**}), number of row/ears (0.28^{*}), number of kernels/row (0.79^{**}), and number of plant at harvested (0.65^{**}). Results clearly indicated that ear height, plant height, ear length and ear diameter had the greatest influence on the grain yield.

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 maize grain yield were ear height, and plant height in the first season 2003 while the second season 2004,ear height and ear length. Those variables were responsible for (83.7 % and 80.4%) respectively in the two seasons in grain yield variation. It is observed from the results that ear height was the most important variable followed by plant height and ear length. The relative contribution in the total variability of maize grain yield were (81.3 %, 2.3 %) for the first season and (76.1 %, 4.3 %)in the second season for the above mentioned variables, respectively. The best prediction equations for the two seasons as follow:

$$\hat{y}_1 = -32.555 + 0.287 X_2 + 0.0436 X_1 \quad (2003)$$

$$\hat{y}_2 = -10.162 + 0.335 X_2 - 0.646 X_4 \quad (2004)$$

Table 6: Simple correlation coefficients among maize grain yield (Y) and its components (X's) in seasons of 2003 and 2004.

	Characters	X_1	X_2	X_3	X_4	X_5	X_6	X_7	Y
Season 2003	Plant height X_1	1.00							0.77**
	Ear height X_2	0.74**	1.00						0.90**
	Stem diam. X_3	0.33**	0.57**	1.00					0.47**
	Ear length X_4	0.54**	0.70**	0.92**	1.00				0.61**
	Ear diam. X_5	0.57**	0.75**	0.89**	0.96**	1.00			0.66**
	No.of rows/earX_6	0.26*	0.23*	0.14	0.17	0.21	1.00		0.18
	No.of kernels/rowX_7	0.68**	0.84**	0.80**	0.91**	0.91**	0.09	1.00	0.77**
	No.of plant/harv.X_8	0.47**	0.72**	0.87**	0.90**	0.93**	0.05	0.91**	0.66**
Season 2004	Plant height X_1	1.00							0.81**
	Ear height X_2	0.85**	1.00						0.87**
	Stem diam. X_3	0.54**	0.79**	1.00					0.59**
	Ear length X_4	0.57**	0.86**	0.90**	1.00				0.64**
	Ear diam. X_5	0.71**	0.93**	0.91**	0.95**	1.00			0.78**
	No.of rows/earX_6	0.15	0.35**	0.38**	0.47**	0.40**	1.00		0.28*
	No.of kernels/rowX_7	0.72**	0.95**	0.87**	0.95**	0.98**	0.40**	1.00	0.79**
	No.of plant/harv.X_8	0.53**	0.80**	0.79**	0.92**	0.90**	0.38**	0.89**	0.65**

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

Table 7: Characters explaining grain yield of maize using stepwise multiple regression analysis in seasons of 2003and 2004.

	Characters	Regression Coefficient	Standard Error	Prob.	Commul-ative R^2 %	Partial R^2 %
Y_1	Ear height X_2	0.278	0.041	0.000	81.3	81.3
	Plant height X_1	0.0436	0.020	0.038	83.6	2.3
Y_2	Ear height X_2	0.335	0.041	0.000	76.1	76.1
	Ear length X_4	-.646	0.242	0.012	80.4	4.3

Path–coefficient analysis:

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. The results indicated that ear height, plant height, ear length and number of plant at harvested possessed the highest direct and indirect effects towards grain yield ard/fed. The relative importance to the total variability of grain yield was 49.3%, 24%, 8,43% and 5.39% the four corresponding variables, respectively in the first season 2003. In the second season, ear height, ear length, ear diameter and stem diameter realized the total variability of grain yield was 45.7%, 31.9%, 9.26% and 5.78% respectively.

The results clearly indicated that the total relative contribution of the studied characters to the variability of grain yield was 94% and 97.9% respectively, in the first and second seasons and the residual effect of the other yield components was 6% and 2.1% respectively (2003 and 2004). 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.

Table 8: Direct and indirect effects of yield components and their relative importance in grain yield of maize for seasons of 2003 and 2004.

	Characters	Direct effect X_i			Indirect effect X_i / X's			Total effect		
		Effects	CD*	RI %	Effects	CD*	RI %	Effects	CD*	RI %
Season 2003	Plant height X_1	0.284	.081	3.34	0.489	.278	20.7	0.774	.359	24.0
	Ear height X_2	0.691	.478	19.7	-.001	-.00	29.6	0.690	.476	49.3
	Stem diam. X_3	-.047	.002	0.09	0.026	-.00	2.35	-.021	-.00	2.44
	Ear length X_4	-.187	.035	1.44	0.199	-.07	6.99	0.012	-.04	8.43
	Ear diam. X_5	-.115	.013	0.55	0.321	-.07	3.38	0.205	-.06	3.93
	No.of rows/earX_6	-.008	.000	.003	0.016	-.00	.013	0.008	-.00	.015
	No.of kernels/rowX_7	-.016	.000	.011	0.330	-.01	.447	0.313	-.01	.458
	No.of plant/harv.X_8	0.361	.131	5.39	0.000	.000	.000	0.361	.13	5.39
	Total D+I							2.343	.855	94.0
	Residual								.145	6.0
	Total								1.00	100
Season 2004	Plant height X_1	0.053	.003	.036	0.760	.081	2.62	0.813	.083	2.66
	Ear height X_2	0.822	.676	8.64	0.004	.007	37.1	0.827	.683	45.7
	Stem diam. X_3	-.130	.017	.217	0.043	-.01	5.56	-.087	.006	5.78
	Ear length X_4	-.904	.818	10.4	0.929	1.68	21.5	0.024	-.86	31.9
	Ear diam. X_5	0.527	.278	3.55	0.423	.446	5.71	0.951	.724	9.26
	No.of rows/earX_6	0.099	.009	.124	0.159	.031	.402	0.258	.041	.525
	No.of kernels/rowX_7	0.213	.045	.580	0.174	.074	0.946	0.387	.119	1.52
	No.of plant/harv.X_8	0.196	.038	.490	0.000	0.00	0.00	0.196	.038	.489
	Total D+I							3.368	.834	97.9
	Residual								.166	2.1
	Total								1.00	100

*C D = Coefficient of determination.
**R I = Relative importance.

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دراسة اقتصادية لتقييم منحنيات استجابة الذرة الشامية للتسميد الآزوتي

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١- المعمل المركزي للتصميم والتحليل الإحصائي ، مركز لبحوث الزراعية – الجيزة
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أقيمت تجربة حقلية في محطة البحوث الزراعية بسدس – محافظة بني سويف في موسمى ٢٠٠٣ و ٢٠٠٤ بهدف دراسة اقتصادية لتقييم منحنيات استجابة الذرة الشامية لمعدلات السماد الآزوتي (صفر– ٨٠– ١٢٠– ١٦٠ كم أزوت/فدان) على محصول حبوب الذرة الشامية للصنف هجين فردى ١٠ و درست درجة العلاقة بين محصول الحبوب و السماد الآزوتي كما تم تقدير المعدل الاقتصادي الأمثل للسماد الآزوتي و أيضا تم تحديد أهم العوامل المساهمة في تباين محصول الذرة الشامية باستخدام بعض أساليب الإحصائية.

أوضحت النتائج بالنسبة لمحصول حبوب الفدان تحقق أعلى محصول حبوب للفدان نتيجة التسميد بمعدل ١٦٠ كجم أزوت/ف. و أظهرت النتائج أن العلاقة بين التسميد الآزوتي و محصول حبوب الذرة الشامية تتبع الدرجة الثانية حيث كان منحنى الدرجة الثانية أفضل المنحنيات لوصف هذه العلاقة.

والمعدل الاقتصادي الأمثل للسماد الآزوتي ١٢٠,٨ و ١٢١,٣ كم أزوت/فدان على التوالي لموسمي ٢٠٠٣ و ٢٠٠٤ . كما بلغ محصول الحبوب على أساس المعدل الاقتصادي الأمثل للسماد الآزوتي من ٢٦,٨ إردب/فدان عام ٢٠٠٣ و ٢٨ إردب/فدان عام ٢٠٠٤ و وصل الدخل ٣٢١٦ جنيها/فدان و صافي الدخل ١١٠٦,٨ جنيها/فدان لموسم ٢٠٠٣ و ٣٣٦٠ جنيها/فدان و صافي الدخل ١٢٥٠,٨ جنيها/فدان لموسم ٢٠٠٤.

وأظهرت نتائج تحليل الأساليب الإحصائية أن ارتفاع الكوز وطول النبات و قطر الكوز من أهم العوامل المساهمة فى تباين محصول النبات حيث سجلت هذه العوامل أعلى مساهمة نسبية فى التباين الكلي للمحصول، مما يجدر بمربى الذرة الشامية أن يأخذ هذه العوامل في الاعتبار عند تصميم برامج التربية لتحسين و رفع إنتاجية محصول الذرة الشامية.