J. Agric. Sci. Mansoura Univ., 34 (10): 10033 - 10041, 2009

EFFECT OF TILLAGE SYSTEMS AND CROP ROTATIONS ON MAIZE YIELD AND ITS COMPONENTS.

Toaima, S.E.A.; A.M. Abd El Galil and E.M. Ibrahim
Crop Intensification Research Dept. Field Crops Research Institute Agriculture Research Center, Egypt.

ABSTRACT

Two field experiments during 2005 and 2006 seasons were conducted at Malawi Agricultural Research Station, Eiminya Governorate. The aim of this investigation was to study the effect of soil tillage systems and crop rotation on maize (cv. T.W.C 310) yield and its components. Tillage systems were: no tillage (T_1), Chisel plowing (T_2) and mould board plowing (T_3). Crop rotations were: 2-year rotation; first year: Meskawi berseem (three cuts) followed by cotton, second year: faba bean followed by maize and 3- year rotation; first year, Meskawi berseem (three cuts) followed by cotton, second year; wheat followed by soybean and third year; Faba been, followed by maize. The experimental design was a split plot with four replicates. Data indicate that bulk density and soil porosity were improved when using tillage, compared with no tillage. Three-year rotation surpassed two-year rotation in reduced bulk density and increased soil porosity percentage. Tillage systems significantly affected growth, yield and yield components of maize under study, except number of rows/ ear. Grains yield/ fad increased (over that in no- till treatment) by 9.82 and 12.21% in the 1 st season and 8.96 and 13.64, % in the 2 nd season when using tillage systems of chisel plow and mould board plow, respectively. crop rotation had significant effect on plant height, ear height, ear length, number of grains/ row, ear and grain weight/ plant, weight of 100- grain and grain weight/ fad. Grains yield/ fad in 3- year rotation increased by 8.9 and 8.4 % in the first and second seasons, respectively, compared to 2- year rotation. Interaction effects between tillage systems X crop rotation, show that the maximum value was recorded when maize was grown in 3- year rotation, using tillage system with mould board plow. This study cleared that using tillage system of mould board plow before maize growing in 3- year rotation gav the maximum yield of maize.

Keywords: Crop rotation, Tillage systems, Maize Yield, soil properties.

INTRODUCTION

Soil tillage and crop rotation, plays an important and affecting role in soil productivity and increasing crop production. Maize is one of the most widely grown crop and is often responding to rotation and soil tillage effects which considered important factors influencing on maize yield.

With view to many investigators on soil tillage systems such as Selim and El- Sergany, (1995) and Mohamed (1999),) showed that tillage systems had no apparent influence on yield of maize, while Gomaa and El Douby (2002) indicated that 100 –kernel weight, ear weight and grain yield/ fad were affected by different systems of soil tillage. As well as, bulk density values of soil under no tillage tended to be higher than under concluded that grain yield of maize was increased with mould board plowing, compared to chisel plowing. On the other hand, Opoku *et al.* (1997) and Fadl Allah (1999 conventional tillage. On the other hand, porosity % values were the lowest

with no-tillage system followed by chisel plow, then mould board plow, while, combined of chisel + mould board plow recorded the highest values at the three different depth of soil (0-10,10-20 and 20-30 cm depth). Santos and Lhamby (2002) concluded that the yields of maize grown under no and minimum tillage were lower than the yield of maize obtained after conventional tillage using harrow or mould board plough. Silveira and Stone (2003) showed that maize grain yield significantly affected by mould board plowing, compared to no- tillage and disc harrow systems. Palle and Joseph (2003) stated that maize grain yield decreased by 5 % when the no- tillage system was used, compared with the conventional tillage system.

Numerous studies have been conducted to determine the effect of crop rotation on corn yield. Shafshak *et al.* (1982) found that growth traits, yield components and grain yield of maize were not significantly affected by rotation. While, Aly *et al.* (1993) showed that crop rotation had significant effects on ear diameter, ear weight, weight of grains/ ear and grain yield/ plant. However, insignificant effects were observed on plant height, number of rows/ ear, number of grains/ row, 100- grain weight and grain yield/ fad. Abou-Kreisha *et al.* (1998) revealed that crop rotation has pronounced effect on number of kernels/ rows, weight of kernels/ ear, 100- kernels weight and grain yield/ fad. Maize yields grown in 3- year rotation was 9.2 % higher than that in 2- year rotation. Palle and Joseph (2003) stated that corn rotated annually with soybean was lower in grain yield by 15 %, compared with that growing maize after maize for 5- year.

This research was aimed to study the effect of tillage systems and crop rotations on maize yield and its components.

MATERIALS AND METHODS

Two field experiments during 2005 and 2006 seasons were conducted at Malawi Agricultural Research Station, Elminya Governorate to investigate; 1) the effect of tillage systems on soil properties; bulk density and soil porosity and hence, on maize (T.W. C. 310) yield and yield components. 2) the effect of crop rotation on maize (T.W. C. 310) yield and its components. The experimental design was a split plot with four replicates. The main plots was devoted to the tillage systems, while sub plots were devoted to crop rotations. Each sub plot consisted of 5 ridges, 70 cm apart and 3 m long occupying an area of 10.5 m^2 (i.e. 1/400 fad).

Each experiment included 6 treatments as follows:

A: Tillage systems

T_1 = No tillage

T_2 = Chisel plow

T_3 = Mould board plow

B: Crop rotation

1- Two-year rotation; first year: Meskawi berseem (var Helaly) followed cotton (v. Giza 80), second year: faba bean (var, Giza 843), followed by maize (var.T.W.C. 310).

2-Three-year rotation; first year: Meskawi berseem followed by cotton, second year: wheat (var. Sids 1), followed by soybean (var Clark), third year: Faba bean followed by Maize (var.TWC. 310).

Calcium superphosphate (15.5 % P_2O_5) was applied during soil preparation at rate of 150 kg/ fed. Potassium sulphate (48 % K_2O) at the rate of 50 kg/ fed was applied during soil preparation. Nitrogen fertilizer rate was added to maize in three equal doses at the rate of 110 kg N/ fad, in the form of urea (46 % N). The first dose was applied with planting maize. The second and the third were just before the first and the second irrigations. All the cultural practices of growing maize and other crops in the rotation were applied as recommended at the region.

- **Soil analysis:**

Samples of soil were taken from the soil depth of 0-30 cm from all sites of experiments. This was done before soil preparation to sowing maize in both seasons, as its clearing in the folloing table.

- **Mechanical and chemical analysis of the soil at experimental site (averages two seasons).**

Experiment site	2- year rotation	3- year rotation
Physical analysis		
Soil fractions:		
Sand%	14.60	16.40
Silt%	49.10	48.60
Clay%	36.30	35.00
Texture class	Clayey loam	Clayey loam
Chemical analysis		
Organic matter%	1.70	1.56
Available N ppm	24.40	23.85
Available P ppm	10.50	11.30
Available K ppm	317	309
pH	7.1	7.3
E.C.	3.8	3.9

*Classification of soil salinity according to United States " Salinity Laboratory staff (1954)":

1- EC = less than 1280 ppm (salinity free).
2- EC = 1280 – 2240 ppm (low salinity).
3- EC = 2240 – 4160 ppm (medium salinity).
4- EC = higher than 4160 ppm (high salinity).

Trait studies:

A: Soil properties were conducted according to the methods of ASTM (1980).

Soil samples were collected at 0- 10 , 10- 20 and 20-30 cm soil depth from all sites of experiments before planting, after planting (after planting maize and irrigation) and at harvest for soil properties measurements as follow:

1-Bulk density: It was calculated by dividing the soil weight in grams by soil volume in cubic centimeter.

2-Soil porosity: Soil porosity space percentage was estimated by the following formula:

$$\text{Soil porosity} = \frac{P_s - P_b}{P_s} \times 100$$

Where P_s = Real density (gm/ cm^3).

P_b = Bulk density (gm/ cm^3).

Bulk density and soil porosity traits were determined in the samples were taken from 2-year and 3-year rotations sites before tillage systems performance (before planting). Values obtained will considered as control for comparing with those obtained after planting and at harvest values.

B: Maize traits

Ten plants were selected at random from each sub plot to estimate plant height (cm), ear height (cm), ear length (cm), number of rows/ ear, number of grains/ row, ear and grain weight/ plant (gm), weight of 100 grains (gm), weight of yield/ fad (ardab). Grain yield/ fad was determined from the weight of grains adjusted to 14 % moisture of the three central rows of each sub plot and converted to ardab (140 kg) per faddan.Data were statistically analyzed according to (Gomez and Gomez 1984).

RESULTS AND DISCUSSION

Effect of tillage systems on soil properties:

1. Bulk density

The results in Table (1) Shows that tillage treatments significantly affected soil bulk density after planting and at harvest, compared with before planting values in average of both seasons. The lowest bulk density was recorded by using mould board plowing (T_3) this due to interment and decomposition for all residuals from weeds and previous crop and caused free clods of soil to particles, then chisel plowing (T_2) this due to the differences reaction between the system of moldboard and chisel plows in pulverizing soil particles and killing weeds produced the proper seedbed and consequently high yield is expected, whereas no tillage (T_1) recorded the highest value, this due to a compress of soil particles. Bulk density of 3- year rotation was lower than 2- year rotation. The present results were agreement with those obtained by Gomaa and El Douby (2002) who revealed that bulk density values of soil under no tillage tended to be higher than under conventional tillage.

2. Soil porosity

The results indicated that the porosity percentage had been significantly affected by tillage systems, compared with before planting values. The lowest values were associated with no-tillage systems (T_1) followed by chisel plow (T_2), while mould board plow (T_3) recorded the highest values in average of the first and second seasons. Also, 3-year rotation recorded higher values than 2-year rotation, Table (1). These results indicated that, tillage systems can influence soil physical condition since they reduce its compactness and also improved mechanical disturbance of soil compared with no tillage as the results are in agreement with Gomaa and El-Douby (2002).

Table 1: Effect of tillage systems on physical properties of soil (average of 2005 and 2006 seasons).

Treatment	2- year rotation			3- year rotation		
	Before planting	After planting	At harvest	Before planting	After planting	At harvest
Bulk density						
T_1 (No tillage)	1.161	1.180	1.187	1.157	1.175	1.180
T_2 (Chisel plow)	1.123	1.157	1.166	1.120	1.152	1.160
T_3 (Mould board)	1.115	1.157	1.152	1.113	1.150	1.148
L.S.D at 0.05	0.028	0.019	0.018	0.025	0.017	0.014
Porosity %						
T_1 (No tillage)	47.81	48.22	47.22	48.20	48.60	47.60
T_2 (Chisel plow)	49.82	50.10	48.78	50.10	50.70	49.10
T_3 (Mould board)	50.87	50.90	49.33	50.95	51.20	49.75
L.S.D at 0.05	1.22	1.32	1.12	1.21	1.33	1.140

A- Effect of tillage systems on maize yield and yield components.

As shown in Table (2), results indicated that tillage systems significantly affected the studied traits of maize, except number of rows/ ear in both seasons. Tillage system of mould board (T_3) recorded the highest value, followed by chisel plow (T_2), whereas no till plow gave the lowest value (T_1). Data showed that grains yield/ fad increased over no- till treatment by 12.21 and 9.82 % in the first season and 13.64 and 8.96 % in the second season, compared with T_3 and T_2, respectively, the superiority in grain yield/fad by using mold board plow could be attributed to improving soil physical condition where allow greater rooting depth and better plant growth environmental, that has a positive effect on grain yield. Similar results were obtained by Selim and El- Sergany (1995) and Mohamed (1999), who found that grain yield of maize was increased with tillage system, compared with no till. On the other hand, Opoku *et al.* (1997) and Fadl-Allah (1999) found that tillage systems had no apparent influence on yield of maize.

B. Effect of crop rotation on yield and yield components of maize.

Results in Table (2) indicated that plant height and ear height were significantly affected by crop rotation. Three- year rotation gave higher values than those in 2- year rotation. These results are in accordance with those obtained by Aly *et al.* (1993), but in a contrast with those obtained by Shafshak *et al.* (1982).

Yield components and grain yield of maize are shown in Table (2). Results revealed that crop rotation had nosignificant effect on number of rows/ ear in both season. On the other hand, ear length, number of grains/ row, ear and grain weight/ plant, and weight of 100- grain were significantly affected by crop rotation in the 1 st and 2 nd seasons. The values of these traits in 3- year rotation were significantly higher than those in the 2- year rotation. These results were due to that rotation improved crop yields by increasing of organic materials, availability of soil moisture to plant and good airing of the soil more than that grown continuously.

Further, Varvel and Peterson (1990) demonstrated that rotation can reduce the needs of inorganic nitrogen fertilizer and the amount of available for leaching at the same time which are important for increasing crop yields. Grain yield/ fad was significantly affected by crop rotation in both seasons. Data were higher in 3- year rotation than with 2- year rotation. The increase in grain yield amounted to 1.95 and 2.05 ardab/ fad with 3- year rotation, compared to 2- year rotation in first and second seasons, respectively. These results are in agreement with those obtained by Abou Kreisha *et al.* (1998), Santos and Lhamby (2002) and Silveira and Stone (2003).

Table 2: Effect of tillage systems and crop rotation on maize yield and yield Components during 2005 and 2006 seasons.

Traits / Treatments	Plant height (cm)	Ear height (cm)	Ear length (cm)	No of rows/ ear	No of grains/ rows	Ear weight / plant (gm)	Grains yield/ plant (gm)	Weight of 100-grain (gm)	Grains yield/ fad (ardab)
2005 season									
Tillage system									
T_1 (No till)	249.71	135.30	24.05	12.41	30.63	201.54	162.93	38.93	20.49
T_2 (Chisel plow)	255.29	138.73	25.15	12.70	32.22	217.65	176.04	40.04	22.72
T_3 (Mould board plow)	259.67	143.64	26.31	13.19	34.28	223.14	180.95	41.89	23.34
L.S.D at 0.05	1.20	1.22	1.66	N.S	1.38	0.68	2.80	1.12	0.89
Crop rotation									
2-year rotation	244.77	123.42	24.09	12.53	31.28	205.90	166.59	38.17	21.21
3-year rotation	265.01	155.03	26.25	13.01	33.48	222.33	180.03	42.41	23.16
F. Test	*	*	*	N.S	*	*	*	*	*
2006 season									
Tillage system									
T_1 (No till)	255.65	150.39	22.92	12.20	30.13	186.93	150.32	37.34	20.33
T_2 (Chisel plow)	261.49	155.30	24.25	12.30	31.68	205.17	165.33	39.54	22.33
T_3 (Mould board plow)	265.84	159.53	25.26	12.44	33.18	215.06	173.39	40.79	23.54
L.S.D at 0.05	1.35	3.45	1.40	N.S	1.15	1.45	2.13	1.15	1.47
Crop rotation									
2-year rotation	254.04	135.86	23.10	12.25	30.59	192.14	154.44	38.10	21.04
3-year rotation	267.96	174.29	25.19	12.38	32.75	212.64	171.59	40.36	23.09
F. Test	*	*	*	N.S	*	*	*	*	*

C. Interaction effects of crop rotation X tillage system:

Ear length showed insignificant difference between T_2 and T_3 treatments in 2-year rotation the first season, but it was significant in the second season. As well as, data cleared that significant and insignificant when maize was grown in 3- year rotation for T_2 and T_3 in the first and second seasons, respectively.

Number of rows/ ear was not reached to the 5 % significant level in both seasons. Number of grains/ row indicated that insignificant differences were observed between T_1 and T_2 treatments for 2 and 3- year rotations in

both season, while there is no significant between 2 and 3- year rotation with no-till treatment in both seasons.

Concerning ear weight/ plant, significant differences between all treatments were observed in the second season. Grain yield/ plant showed significant difference was observed between all treatments through 2- and 3- year rotations. Weight of 100- grain indicated that significant difference was observed through 3- year rotation and between T_1, T_2 in both seasons.

Regarding grains yield/ fad, the results indicated that significant difference between T_1 and T_2 and between T_2 and T_3 when maize was grown in 2 or 3- year rotation in both seasons. Results of 3-year rotation and using treatment T_3 gave the highest value. The increments were expected since most of maize traits were increased such ear weight/ plant, grain yield/ plant and weight of 100- grain. These results are in agreement with those obtained by Gomaa and El Douby (2002) they revealed that maize grown in 3- year rotation resulted higher yield, than with maize grown in 2- year rotation (Table 3).

It could be concluded that improve the soil physical condition and the mechanical disturbance soil. Using 3- year rotation with mould board tillage (T_3) gave the maximum yield of maize.

Table 3: Interaction effects of tillage systems X crop rotation on maize yield and yield components.

Traits		Plant height (cm)	Ear height (cm)	Ear length (cm)	No. of rows (cm)	No of grains / Row	Ear weight/ plant (gm)	Grains yield/ plant (gm)	Weight of 100- grain (gm)	Grains yield/ fad (ardab)
Tillage systems	Crop rotation									
2005 season										
T_1	2-year	239.68	120.31	23.05	12.00	29.91	192.16	155.27	37.02	19.20
	3-year	259.74	150.29	25.05	12.82	31.35	210.92	170.59	40.85	21.79
T_2	2-year	245.37	121.84	24.23	12.50	31.10	210.37	170.00	37.62	21.94
	3-year	265.21	155.62	26.07	12.91	33.35	224.94	182.09	42.47	23.50
T_3	2-year	249.27	128.11	25.00	13.09	32.82	215.16	174.50	39.87	22.50
	3-year	270.07	159.17	27.62	13.29	35.75	231.12	187.41	43.92	24.18
L.S.D at 0.05		2.12	1.60	1.06	N.S	2.15	5.85	4.18	1.08	0.27
2006 season										
T_1	2-year	248.91	131.12	21.88	12.13	29.10	175.10	140.65	37.15	19.14
	3- year	262.40	169.67	23.97	12.27	31.17	198.76	160.00	37.53	21.52
T_2	2-year	254.53	136.00	23.10	12.23	30.46	193.10	155.56	37.85	21.17
	3- year	268.45	174.60	25.40	12.37	32.91	217.24	175.10	41.24	23.49
T_3	2- year	258.67	140.47	24.33	12.38	32.20	208.21	167.12	39.29	22.82
	3-year	273.02	178.60	26.20	12.50	34.17	221.91	179.67	42.30	24.27
L.S.D at 0.05		5.18	3.40	1.12	N.S	2.1	1.70	2.12	2.09	0.36

REFERENCES

Abou Kreisha, M.A.; A.A. Zohry and M.A. Haikel (1998): Maize and soybean yield as affected by preceding crops and crop rotation. J. Agric. Sci. Mansoura Univ., 23 (11): 4721-4728.

Aly, A.M.; S.K. Badr and M.N. Sherif (1993): Effect of crop rotation and preceding winter crops on growth, yield and yield components of maize. Egypt, J. Appl Sci., 8 (12): 1165-1178.

ASTM (1980): Specific test method of specific gravity of soils: (ASTMD 854-58) in Annual Book of standers. ASTM; 1916 Race st., Philadelphia PA.

Crookston, R.R. and J.E. Kurle (1989). Corn residue effect on the yield of corn and soybean grown in rotation. Agr. J. 81: 229-232.

Fadl-Allah, A.M. (1999): Effect of soil tillage and weed control on maize productivity.M. Sc. Thesis. Fac. Agric. Moshtohor, Zagazig Univ., Egypt. Yield in short rotation with legume. Exp. Agric., (25): 367-374.

Gomez, K.A. and A.A. Gomez (1984): Statistical procedures for agricultural research 2 nd (ed.) Jon Wiley, USA.

Gomaa, M.R. and K.A. El Douby (2002): Maize grain yield as influenced by nitrogen levels with and without organic manure under different tillage systems. Annals Agric Sci., Moshtohor, Zagazig Univ., 40 (2): 723-739.

Mohamed, A.H. (1999): Effect of some seedbed preparation practices and fertilization on growth and yield of maize. Ph. D. Thesis, Fac. Agric., Moshtohor, Zagazig Univ., Egypt.

Opoku, G.; T.J. Vyn and C.J. Swanton (1997): Modified no- till systems for corn following wheat on clay soils. Agron. J. 89: 549-556.

Palle, P. and G.L. Joseph (2003): Corn and soybean response to rotation sequence, row spacing and tillage system. Agron. J. 95 (1): 965-971.

Santos, H.P.-dos and J.E.P. Lhamby (2002): Effect of soil tillage systems and crop rotation on corn yield. Pesquisa- Agropecuaria- Gaucha 8 (1/2)93-10.

Selim, M.S.M. and D.Z., El- Sergany (1995): Response of till and no till maize to nitrogen fertilizer after different winter crops. Zagazig J. Agric. Res. 22 (2): 287- 299.

Shafshak, S.E.; A.S. El-Debaby; M.S. Salem and G.Y. Galilah (1982): Crop rotation studies in Egypt. 111: Growth and yield of maize as affected by crop rotation and fertilization residues. Res. Bull. 2090 Fac. Agric. Ain Shams Univ.

Silveria, P.M.; and D.A. Stone (2003): Tillage systems and crop rotation on yield of corn, soybean and wheat. Revista- Brasileira-da Engenharia-Agricola-e- Ambiental 7 (2): 240-244.

United States Salinty Laboratory Staff (1954). Diagnosis and improvement of saline and alkaline soils. U.S.Dept. Agric. Hand Book, 60.

Varvel, G.E. and T.A. Peterson (1990): Residual soil nitrogen as affected by continuous, two year and four- year crop rotation systems. Agron. J. 82: 958-962.

J. Agric. Sci. Mansoura Univ., 34 (10), October, 2009

تأثير نظم الخدمة والدورات الزراعية على محصول الذرة الشامية ومكوناته

صلاح السيد عطية طعيمة وعبد الجليل محمد عبد الجليل والغريب محمد ابراهيم
قسم بحوث التكثيف المحصولي - معهد بحوث المحاصيل الحقليةمركز البحوث الزراعية-مصر

أجريت هذه التجربة بمحطة البحوث الزراعية بملوي محافظة المنيا موسمي ٢٠٠٥ و ٢٠٠٦ بهدف دراسة تأثير الخدمة والدورات الزراعية على حاصل الذرة الشامية (هجين ثلاثي ٣١٠) ومكوناته. اشتملت كل تجربة على ٦ معاملات عبارة عن التوافق بين ثلاث نظم حرث مختلفة وهى بدون حرث (T_1) والحرث بالمحراث الحفار (T_2) و الحرث بالمحراث القلاب (T_3) ود ورتين زراعيتين ١- زراعة الذرة في دورة ثنائية: السنة الأولى: برسيم تحريش ثم قطن و السنة الثانية: فول بلدي ثم ذرة ٢- زراعة الذرة في دورة ثلاثية: السنة الأولى: برسيم تحريش ثم قطن والسنة الثانية:قمح ثم فول صويا والسنة الثالثة: برسيم مسقاوى ثم ذرة أستخدم تصميم القطع المنشقة مرة واحدة حيث وزعت معاملات الحرث في القطع الرئيسية ومعاملات الدورة في القطع الشقية في أربع مكررات.

وتتلخص أهم النتائج المتحصل عليها فيما يلي:

- أدت عمليات الخدمة الى تحسين الخواص الطبيعية للتربة بالمقارنة بعدم الخدمة حيث أثرت نظم الخدمة معنويا على ارتفاع النبات ارتفاع الكوز- طول الكوز وزن الكوز للنبات وحاصل النبات والفدان من الذرة مقارنة بمعاملة عدم الخدمة.
- زاد حاصل الذرة المنزرع بمقدار ٩,٨٢ و ١٢,٢١ % في السنة الأولى٨,٩٦ و١٣,٦٤ % في السنة الثانية لمعاملات الخدمة بالمحراث الحفار ثم الحرث بالمحراث القلاب مقارنة بمعاملة عدم الخدمة على الترتيب.
- اتباع الدورة الثلاثية خفض قيمة الكثافة الظاهرية ورفع قيمة المسامية مقارنة بالدورة الثنائية.
- كان للدورات الزراعية تأثير معنوي على ارتفاع النبات ارتفاع الكوز- طول الكوز- عدد الحبوب بالصف- وزن الكوز للنبات وحاصل النبات والفدان من الذرة حيث كانت أعلى قيم تحصل عليها عند زراعة الذرة في دورة ثلاثية.
- زاد حاصل الذرة المنزرع بنظام الدورة الزراعية الثلاثية بمقدار ٨,٤١ و ٨،٨٧ % في الموسم الأول و الثاني على التوالي مقارنة بزراعة الذرة في الدورة الثنائية.
- أدى التفاعل بين الدورات الزراعية و عمليات الخدمة إلى الحصول أعلى إنتاجية من الفدان عند زراعة الذرة في دورة ثلاثية و الحرث بالمحراث القلاب .
- أظهرت الدراسة أن الخدمة بالمحراث القلاب وزراعة الذرة(هجين فردى ٣١٠) فى دورة ثلاثية أعطى أعلى انتاجية من المحصول تحت ظروف التجربة.

قام بتحكيم البحث

أ. د/ أحمد أبو النجا قنديل — كلية الزراعة – جامعة المنصورة
أ. د/ نبيل عوض الهواري — خارجى