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EFFECT OF SOWING METHOD, MICRONUTRIENTS AND NITROGEN FERTILIZER LEVELS ON WHEAT YIELD UNDER SANDY SOIL CONDITIONS

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ABSTRACT

Two field experiments were carried out at the experimental farm, Fac. of Agric., Zagazig Univ., Egypt, during the two successive seasons of 2007/2008 and 2008/2009 to study the effect of three sowing methods (Broadcasting, drilling and cross rows), five micronutrients treatments (control, Fe, Zn, Mn and Fe + Zn + Mn) and three nitrogen fertilizer levels (35, 70 and 105 kg N/fad) on yield and its attributes of wheat cv. Sakha 93. A split-split plot design with three replications was used. The most important results could be summarized as follows :

1. **Broadcasting method produced the highest values of number of grains/spike and straw yield ton/fad, whereas, cross rows method produced the highest values of number of spikes/m^2 and grain yield ardab/fad . In addition, 1000 grain weight of wheat was insignificantly affected by the different sowing methods.**
2. **Application of Zn led to a significant increase in 1000-grain weight, grain yield and biological yield. However, application of Fe + Zn + Mn in combination resulted in the highest values of straw yield ton/fad . Number of spikes/m^2 was insignificantly affected by micronutrients treatments.**
3. **All studied characters gradually increased by increasing nitrogen fertilizer levels from 35 up to 105 kg N/fad .**
4. **Drilling method interacted strongly with Zn or combination of Fe + Zn + Mn to increase grain, straw and biological yields ton/fad in wheat fields.**

Keywords: Wheat, sowing methods, micronutrients, nitrogen fertilizer levels.

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INTRODUCTION

Wheat (*Triticum aestivum*, L.) is the most strategic cereal crops in the world as well as in Egypt. The properties of its grain make it the main leading cereal crop for human food. The increasing demands of wheat is mainly due to the fast growth of human population, therefore maximizing wheat production should be achieved through cultivation of the high yielding wheat cultivars and appropriate agronomic practices such as sowing method, micronutrients and nitrogen fertilizer levels.

In Egypt, sowing wheat crop as broadcasting, drilling in rows (as a common practices) and also in hills on ridges of preceding crops i.e. cotton or maize, particularly when harvest of these crops in delayed. Considerable research has been conducted on the sowing methods. Prasad *et al.* (1991) reported that sown wheat in cross rows 22.5 cm a part gave the highest grain yield of 3.13 ton/ha compared with 2.81 and 1.84 ton/ha in rows 15 cm apart and broadcast sowing, respectively. Singh *et al.* (1994) found that grain yield of wheat were 2.59 ton/ha when broadcast, 3.57 ton/ha when cross sown (22.5 x 22.5 cm) and 3.43 and 3.31 ton/ha when line sown in 15 and 22.5 cm rows, respectively. Haikel *et al.* (1996) showed that the highest values of plant height, number of spikes/m^2, grain and straw yields/fad. resulted from drilling method as compared with broadcasting method. Dawelbeit and Babiker (1997) concluded that seed drilling as well as ridging resulted in significantly greater yields than broadcasting method. Keisling *et al.* (1997) revealed that yields of broadcasting incorporated and drill into prepared seedbed sowing methods of wheat were rather similar and were higher than those of the other two alternatives of drill no-till and broadcast unincorporated. Hassan *et al.* (2003) stated that the sowing methods were statistically significant for plant height, number of grains/spike, 1000-grain weight and biological yield. They also added that line sowing recorded the highest trait values followed by line + broadcast sowing then broadcast sowing. Muhammad (2003) found that sowing wheat in rows produced more productive tillers, heavier grains, maximum number of tillers/m^2, leaf area and biological yield as compared with broadcast sowing. Tanveer *et al.* (2003)

reported that number of spikes/m^2, spike length, number of grains/spike and grain yield were significantly higher in bed formation + drill sowing in comparison with broadcast sowing. Abd El-Hamid (2004) revealed that afir drilling and afir improved methods significantly surpassed afir broadcast as it increased number of tillers and produced the highest wheat grain yield.

Foliar fertilization with macro and micronutrients is considered as one of the most important factors which effect the productivity of wheat, expressly in the newly reclaimed sandy soils, where it allows to maximize the utilization of the nutrients. In this concern, El-Hawary (1999) detected that spraying wheat plants with Nervatin-vet formulation increased grain yield by 13.66% over control treatment (without foliar spraying). El-Kalla *et al.* (2002) concluded that using super grow fertilizer (20 + 20 + 20 NPK + trace element) as foliar application at tillering and elongation stages produced the highest values of plant height, flag leaf area, number of tillers and spikes/m^2 and grain yield/fad. Hussein (2005) stated that the highest values of grain and straw yields/fad. (10.72 ardab/fad and 3.038 ton/fad) and yield components were favoured when wheat plants were foliar sprayed with potassium and nervatin-vit.

It is quite known that nitrogen fertilization greatly affect wheat productivity. Hence, results of many researchers that achieved in Egypt revealed that nitrogen fertilizer levels significantly affected most of plant growth traits, yield and its components and the optimum nitrogen fertilizer levels significantly affected most of plant growth traits, yield and its components and the optimum nitrogen fertilizer level for wheat, vary widely in amounts and the optimum nitrogen fertilizer level for wheat, vary widely in amounts ranged between 70 and 120 kg N/fad according to environmental conditions (Tammam and Tawfils, 2004; Allam, 2005; Gab-Allah, 2005 and Salem, 2005). Seiling *et al.* (2005), in Germany, reported an increase in nitrogen fertilization compensated for the lower number of spikes/m^2 and increased grain yield. Moreover, nitrogen fertilizer proved to be a kay factor in determining bread-making quality, and the best strategy available to the farmer for optimizing wheat quality (Abad *et al.*, 2004).

Therefore, the main objective of this investigation was to determine the optimum sowing methods, micronutrients and nitrogen fertilizer levels to achieve maximum yields of wheat cv. Sakha 93 under environment condition of El Khattara project Faram, Fac. of Agric., Zagazig Univ., Sharkia Governorate.

MATERIALS AND METHODS

Two field experiments were carried out during two successive seasons (2007/2008 and 2008/2009) at the exp. Farm, Fac. of Agric., Zagazig Univ. at El-Khattara, to determine the effect of sowing method, micronutrients and nitrogen fertilizer levels on yield and its attributes of wheat cv. Sakha 93.

The experiments were carried out in a split split-plot design with three replications. The main plots were occupied with sowing method (broadcasting, drilling and cross rows), the sub-plots were occupied by micronutrients (control, Fe, Zn, Mn and Fe + Zn + Mn) and the sub-sub plots were devoted to N-fertilizer levels (35, 70 and 105 kg N/fad). The sub-sub plot area was 9 m^2 (3 x 3 m).

Sowing date taken place on 27th and 28th November in the 1st and 2nd seasons, respectively. Calcium super phosphate (15.5% P_2O_5) at a rate of 150 kg/fad and potassium sulphate (48% K_2O) at a rate of 50 kg/fad were added before sowing. The tried nitrogen fertilizer levels in the form of ammonium sulphate (20.5% N) were applied in five doses, one fifth of nitrogen was given as basal dressing. The remainder amounts were given in four equal splits from 15 day after sowing and in 15 days intervals. The common agricultural practices for growing wheat according to the recommendations of Ministry of Agriculture were followed except the factors under study.

The experiments were carried out in a sandy soil which their mechanical and chemical properties are shown in Table 1.

Studied Characters

At harvesting time, ten guarded plants of one square meter were randomly selected from each sub-sub plot to estimate the following characters :

1. Number of spikes/m^2.
2. Number of grains/spike.
3. 1000-grain weight (gm).

4. Grain yield (ardab/fad) : calculated by harvesting plants in one square meter taken from each sub-sub plot and were left to dry and the grains were weighted in kg consequently, the weight was converted to ardab per faddan (one ardab = 150 kg).
5. Straw yield (ton/fad) : the straw yield resulted from the previous sample was weighted in kg/plot, then it was converted to tons per faddan.
6. Biological yield (ton/fad) : was calculated according the following formula :

   = Grain yield (ton/fad) + straw yield (ton/fad)

Statistical Analysis

All data of this study were statistically analyzed according to the technique of analysis of variance (ANOVA) for the split-split plot design as published by Gomez and Gomez (1987). The treatments means were compared using least significant differences (L.S.D) according to the producer outlined by Waller and Duncan (1969).

Table 1. Soil mechanical and chemical analysis of the experimental fields (30 cm depth) in the two seasons

Properties	2007/2008	2008/2009
Mechanical analysis :		
Coars sand%	56.1	57.2
Fine sand%	33	31.9
Silt%	4.9	4.8
Clay%	6	6.1
Texture	sandy	sandy
Organic matter%	0.30	0.31
Chemical analysis :		
Available (N) ppm	19	19.2
Available (P) ppm	3.5	3.7
Available (K) ppm	58.1	58.8
P.H.	7.6	8.0

RESULTS AND DISCUSSION

Effect of Sowing Method on Yield and Yield Attributes of Wheat

Number of spikes/m^2 was significantly affected by sowing methods Table 2. The largest number of spikes/m^2 was obtained by cross rows method. Similar results were obtained by Hussein (2002), Tomar (2002), and Sulieman (2009).

Number of grains/spike significantly increased due to sowing wheat with broadcasting method. This was true in the second season and combined analysis Table 2. 1000-grain weight of wheat was insignificantly affected by the different sowing methods on wheat plants and this was clearly shown in both seasons as well as the combined analysis Table 2. These results are in harmony with those obtained by Hassan *et al.* (2003) and Soomro *et al.* (2009).

Significant effect of sowing methods on grain yield/fad was observed (Table 3). The highest grain yield was obtained by sowing wheat with cross rows method. The positive response of grain yield of wheat to sowing methods was reported by several investigators, included Pandy and Kumar (2005) and El-Afandy (2006).

Straw yield was influenced significantly by sowing methods Table 3. Data of both seasons and the combined analysis revealed significant increase in straw yield. Results clear that either broadcasting or drilling methods gave higher straw yield. Soomro *et al.* (2009) found that the drilling method surpassed the other cultivation methods.

Biological yield (ton/fad) significantly increased due to the different sowing methods Table 3. This finding could be ascertained from first season and combined data. However, the differences in the second season failed to reach the level of significance. Results clear that either drilling or cross rows methods gave higher biological yield (combined data). These results are in harmony with El-Afandy (2006).

Effect of Micronutrients on Yield and Yield Attributes

Number of spikes/m^2 of wheat after spraying of different micronutrients showed that the differences could not reach the

Table 2. Number of spikes/m^2, number of grains/spike and 1000-grain weight (gm) of wheat as influenced by sowing methods, micronutrients and nitrogen fertilizer levels during the two growing seasons and their combined

		Number of spikes/m^2			Number of grains/spike			1000-grain weight (gm)		
		2007/2008	2008/2009	Comb.	2007/008	2008/2009	Comb.	2007/008	2008/2009	Comb.
Sowing method (S):										
Broadcasting	**S1**	286.42 c	276.80 b	281.61 b	41.95	43.99 a	42.97 a	40.46	39.12	39.79
Drilling	**S2**	321.14 b	318.57 a	319.86 a	41.87	39.06 b	40.47 b	42.37	38.99	40.68
Cross rows	**S3**	346.34 a	310.86 a	328.60 a	41.63	36.90 c	39.27 b	39.25	39.08	39.16
F-test		**	**	**	N.S	**	*	N.S	N.S	N.S
Micronutrients :										
Control	**M1**	316.47	303.77	310.12	41.84 ab	40.89 b	41.36	35.75 b	37.78 b	36.77 b
Fe	**M2**	314.90	301.85	308.37	44.03 a	37.95 c	40.99	40.64 ab	39.68 ab	40.16 a
Zn	**M3**	320.76	300.14	310.45	39.39 b	43.55 a	41.47	41.61 a	40.67 a	41.14 a
Mn	**M4**	317.00	300.74	308.87	41.45 ab	38.72 c	40.09	43.41 a	38.12b	40.76 a
Fe+Zn+Mn	**M5**	320.75	303.88	312.30	42.38 a	38.82 c	40.60	42.05 a	39.08 ab	40.56 a
F-test		N.S	N.S	N.S	*	**	N.S	*	*	**
Nitrogen levels (N) :										
35 kg N/fad	**N1**	301.88 c	276.64 c	289.26 c	41.40	37.55 b	39.48 b	40.35	40.79 a	40.57 a
70 kg N/fad	**N2**	316.83 b	304.53 b	310.68 b	42.32	40.66 a	41.49 a	40.96	39.77 a	40.37 a
105 kg N/fad	**N3**	335.20 a	325.06 a	330.13 a	41.74	41.74 a	41.74 a	40.77	36.64 b	38.70 b
F-test		**	**	**	N.S	**	**	N.S	**	*
Interactions :										
M × S		*	N.S	N.S	N.S	**	N.S	N.S	*	N.S
N × S		N.S	**	N.S	N.S	**	N.S	N.S	**	N.S
N × M		**	**	N.S	N.S	N.S	N.S	N.S	N.S	N.S
N × M × S		N.S	N.S	N.S	N.S	**	N.S	N.S	*	N.S

Table 3. Grain yield (Ardab/fad), straw yield (ton/fad) and biological yield (ton/fad) of wheat as influenced by sowing methods, micronutrients and nitrogen fertilizer levels during the two growing seasons and their combined

		Grain yield (ardab/fad)			Straw yield (ton/fad)			Biological yield (ton/fad)		
		2007/2008	2008/2009	Comb.	2007/008	2008/2009	Comb.	2007/008	2008/2009	Comb.
Sowing method (S):										
Broadcasting	**S1**	9.69 b	11.58 b	10.64 c	1.71 a	2.21 a	1.96 a	3.53 a	3.94	3.55 b
Drilling	**S2**	11.90 a	11.75 b	11.83 b	1.75 a	2.14 a	1.94 a	3.53 a	3.90	3.72 a
Cross rows	**S3**	12.59 a	12.38 a	12.48 a	1.64 b	1.97 b	1.81 b	3.16 b	3.83	3.68 a
F-test		**	*	**	*	**	**	**	N.S	*
Micronutrients :										
Control	**M1**	10.28 c	11.58 b	10.93 b	1.79 a	2.04 c	1.92 ab	3.33 bc	3.78	3.55 b
Fe	**M2**	12.05 ab	11.26 b	11.65 b	1.57 c	2.19 ab	1.8 b	3.38 bc	3.87	3.63 b
Zn	**M3**	12.95 a	13.38 a	13.16 a	1.79 a	1.92 d	1.86 b	3.74 a	3.93	3.83 a
Mn	**M4**	10.15 c	11.84 b	10.99 b	1.66 bc	2.12 bc	1.89 b	3.18 c	3.90	3.54 b
Fe+Zn+Mn	**M5**	11.55 b	11.46 b	11.50 b	1.68 b	2.26 a	1.97 a	3.41 b	3.98	3.70 ab
F-test		**	*	**	**	**	*	**	N.S	**
Nitrogen levels (N) :										
35 kg N/fad	**N1**	10.01 c	9.25 c	9.63 c	1.57 c	1.65 c	1.61 b	3.07 c	3.04 c	3.05 c
70 kg N/fad	**N2**	11.66 b	12.85 b	12.25 b	1.73 b	2.27 b	2.00 a	3.47 b	4.19 b	3.83 b
105 kg N/fad	**N3**	12.51 a	13.61 a	13.06 a	1.80 a	2.40 a	2.10 a	3.68 a	4.45 a	4.06 a
F-test		**	**	**	**	**	**	**	**	**
Interactions :										
M × S		**	N.S	*	**	**	**	**	**	**
N × S		N.S	**	N.S	N.S	N.S	N.S	**	**	*
N × M		**	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S
N × M × S		N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S

significance level in the two seasons and their combined Table 2.

Number of grains/spike was affected significantly by micronutrients (Table 2). The results of the first season showed that the combination (Fe + Zn + Mn) was more effective in this concern, but in the second season a gradual increase in number of grains/spike was obtained due to spraying wheat plants by Zn application. The obtained results are in agreement with Salem and El-Beshbeshy (1995) and Abd El-Hammed (2006).

The effect of micronutrients treatments was significant on 1000-grain weight (Table 2). The results of the second season and combined analysis showed that, Zn application was more effective in this concern. Whereas, in the first season Mn application was more effective and there was no significant difference between adding either (Fe + Zn + Mn) combination or Zn and Mn as single treatments.

The grain yield ardab/fad was significantly affected by micronutrients treatments (Table 3). A gradual increase in grain yield was obtained due to spraying wheat plants by Zn treatment compared to control plants. These results are align with Seadh *et al.* (2009).

Also, straw yield/fad was affected significantly by micronutrients treatments (Table 3). Data clear that fertilizating wheat plants by different micronutrients was more effective in raising straw yield/fad. especially with adding the three micronutrients as tri-combination treatment. This is true in the second season and combined analysis. The results of the first season showed that Zn application was more effective in this concern. These results are in harmony with those reported by Seadh *et al.* (2009).

Micronutrients treatments significantly affected the biological yield/fad (Table 3). This results were true in the 1st season and combined analysis. While, the difference did not reach to the level of significance at 2nd season. The highest biological yield of wheat was obtained by adding Zn application.

Effect of Nitrogen Fertilizer Levels on Yield and Yield Attributes

Number of spikes/m^2 was significantly affected by nitrogen fertilizer levels (Table 2).

Application of 105 kg N/fad gave the highest values of spikes/m^2. These results are in harmony with Allam (2005).

In addition, fertilizer levels had a significant effect on number of grains/spike (Table 2). These results were true in the second season and combined analysis. While, the difference did not reach to the level of significances at first season. Application of 105 kg N/fad. gave the best effect on number of grains/spike. These results are in harmony with those reported by Gab-Allah (2005).

Nitrogen fertilizer had a significant effect on 1000-grain weight Table 2. 35 or 70 kg N/fad caused the heaviest grains. These results are in harmony with Allam (2005).

Significant effect of nitrogen fertilizer levels on grain yield/fad was observed Table 3. The highest grain yield was obtained by application of 105 kg N/fad. These results in accordance with Seiling *et al.* (2005).

Nitrogen fertilizer levels had a significant effect on straw yield Table 3. 105 kg N/fad produced highest straw yield. These results are in harmony with Seiling *et al.* (2005).

Also, significant effects of nitrogen fertilizer levels on biological yield/fad were given in Table 3. Application 105 kg N/fad significantly out yielded all other nitrogen treatments. These results are in a good harmony with Abad *et al.* (2004).

Interaction Effect

Grain yield was significantly affected by the interaction as found in Table 3-a. It is clear that the highest grain yield was recorded by treating drilling method with Zn treatment. On the other hand, the lowest mean value of grain yield was given when wheat plants exposed to broadcasting under Mn application. Other grain yield values due to the different treatments laid in between.

Also, straw yield was markedly affected by the interaction between the different sowing methods and micronutrients as found in Table 3-b indicating that the greatest mean record of such trait was given when the untreated wheat plants were exposed to broadcasting method.

Biological yield was significantly affected by the interaction between sowing methods and micronutrients treatments as found in Table 3-c.

Table 3-a. Grain yield (ardab/fad) as influenced by the interaction between sowing method and micronutrients (combined data)

Sowing method	Micronutrients				
	Control	Fe	Zn	Mn	(Fe+Zn+Mn)
Broadcasting	AB 10.04 a	A 11.33 a	A 12.30 b	AB 9.12 b	AB 10.39 b
Drilling	B 10.88 a	B 11.40 a	A 14.34 a	B 11.39 a	B 11.13 b
Cross rows	A 11.87 a	A 12.22 a	A 12.68 ab	A 12.48 a	A 12.98 a

Table 3-b. Straw yield (ton/fad) as influenced by the interaction between sowing method and micronutrients (combined data)

Sowing method	Micronutrients				
	Control	Fe	Zn	Mn	(Fe+Zn+Mn)
Broadcasting	A 2.26 a	A 1.97 b	A 1.90 b	C 1.64 c	A 2.02 a
Drilling	C 1.68 c	A 1.98 a	A 1.99 a	B 1.94 b	A 2.13 a
Cross rows	B 1.81 b	B 1.69 c	B 1.68 c	A 2.09 a	B 1.77 b

Table 3-c. Biological yield (ton/fad) as influenced by the interaction between sowing method and micronutrients (combined data)

Sowing method	Micronutrients				
	Control	Fe	Zn	Mn	(Fe+Zn+Mn)
Broadcasting	A 3.76 a	A 3.67 a	B 3.75 a	B 3.00 b	A 3.58 a
Drilling	B 3.32 c	A 3.69 b	A 4.14 a	A 3.65 b	A 3.80 b
Cross rows	AB 3.59 ab	A 3.52 ab	B 3.61 ab	A 3.96 a	A 3.71 a

Table 3-d. Biological yield (ton/fad) as influenced by the interaction between sowing method and nitrogen fertilizer levels (combined data)

Sowing method	Nitrogen fertilizer levels		
	35	70	105
Broadcasting	B 2.95 a	A 3.82 a	A 3.89 a
Drilling	A 3.21 a	A 3.98 a	A 3.97 a
Cross rows	C 3.00 ab	B 3.70 a	A 3.34 a

The highest biological yield was recorded by treating drilling method with Zn application. At the mean time, treating wheat plants by Mn under broadcasting produced significantly the lowest value of such character.

Biological yield was significantly affected by the interaction between sowing methods and nitrogen fertilizer levels as found in Table 3-d. The highest biological yield was recorded by cross rows method under 105 kg N/fad. The lowest mean value of biological yield was given when the wheat plants exposed to broadcasting under 35 kg N/fad.

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تأثير طريقة الزراعة والعناصر الصغرى ومستويات السماد النيتروجينى على محصول القمح تحت ظروف الأرض الرملية

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أقيمت تجربتان حقليتان بمزرعة كلية الزراعة – جامعة الزقازيق – مصر خلال الموسمين الزراعيين ٢٠٠٧/٢٠٠٨ ، ٢٠٠٨/٢٠٠٩ لدراسة تأثير ثلاث طرق زراعة (بدار – تسطير – تسطير متعامد) وخمسة معاملات للتسميد بالعناصر الصغرى (كنترول ، حديد ، زنك ، منجنيز ، خليط الحديد والزنك والمنجنيز) وثلاث مستويات من السماد النيتروجينى (٣٥ ، ٧٠ ، ١٠٥ كجم ن/ف) على المحصول ومساهماته لحبوب القمح (صنف سخا ٩٣) وقد استخدم تصميم القطع المنشقة مرتين فى ثلاث مكررات. ويمكن تلخيص أهم النتائج المتحصل عليها فيما يلى :

١ – كان لطرق الزراعة تأثيراً معنوياً على معظم الصفات تحت الدراسة. أدت زراعة القمح بدار إلى الحصول على أعلى القيم المعنوية لصفات عدد الحبوب/ سنبلة ، محصول القش (طن/فدان). بينما زراعة القمح بالتسطير المتعامد أعطت أعلى القيم لصفات عدد السنابل/م^2 ومحصول الحبوب (أردب/فدان) بينما لم يكن لطريقة الزراعة تأثير معنوى على وزن الألف حبة (جم).

٢ – أدى رش نباتات القمح بالزنك إلى الحصول على أعلى القيم لصفات وزن الألف حبه ، محصول الحبوب والمحصول البيولوجى كما أدى الرش بمخلوط الحديد والزنك والمنجنيز للحصول على أعلى محصول للقش بينما لم يتأثر عدد السنابل/م^2 بمعاملة العناصر الصغرى.

٣ – أدى زيادة مستويات السماد النيتروجينى إلى زيادة معنوية فى جميع الصفات تحت الدراسة. حيث أدى زيادة مستويات السماد النيتروجينى من ٣٥ – ١٠٥ كجم نيتروجين/فدان إلى زيادة فى صفات عدد السنابل/م^2 – عدد حبوب السنبلة – محصول الحبوب ، القش والبيولوجى.

٤ – أظهرت نتائج التفاعل بين طرق الزراعة ومعاملات الرش بالعناصر الصغرى فروقاً معنوية، حيث أدى استعمال الزنك أو مخلوط العناصر إلى زيادة محصول الحبوب والقش والمحصول البيولوجى معنوياً عند استخدام طريقة الزراعة تسطير.