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WHEAT RESPONSE TO SOWING METHODS AND NITROGEN FERTILIZER LEVELS

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ABSTRACT

Two field experiments were conducted at the Exp. Sta., Fac. of Agric., Mansoura Univ., during 2004/2005 and 2005/2006 seasons to determine the effect of three sowing methods (broadcasting, drilling in rows and hilling in ridges) and five nitrogen fertilizer levels (50, 65, 80, 95 and 110 kg N/fed) on growth, yield and its components and quality of wheat cv. Sakha 93. A split plot design with three replications was used. The most important results could be summarized as follows:

1- Sowing methods had a significant effect on most of the studied characters in the two seasons. Drilling in rows 15 cm apart produced the highest values of all studied characters in both seasons followed by sowing wheat grains on both sides of ridges in hills 15 cm apart. Whereas, the lowest values of all studied characters resulted from broadcasting method.
2- Nitrogen fertilizer levels significantly affected all studied characters in both seasons. All studied characters gradually increased by increasing nitrogen fertilizer levels from 50 up to 110 kg N/fed in both seasons. The highest values of studied characters resulted from fertilizing wheat plants by 110 kg N/fed in both seasons. But, the differences between 80 and 95 kg N/fed and 95 and 110 kg N/fed were not significant in most of the studied characters in both seasons.
3- The interaction between sowing methods and nitrogen fertilizer levels had a significant effect only on number of spikes/m^2 and grain yield in both seasons.
4- Generally, to maximize wheat productivity and reducing production costs as well as environmental pollution it is recommended sow wheat by drilling methods or hilling on both sides of ridges of former cotton or maize and fertilizing with 80 - 95 kg N/fed. Whereas, reducing nitrogen fertilizer levels from 110 to 80 kg N/fad did not associated with significant difference in grain yield, which was 0.27 ardab/fed only (as an average of both seasons) with monetary value about 40 L.E., whereas the price of nitrogen amount reduced (30 kg N/fed) reached to 70 L.E.

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 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 methods and nitrogen fertilizer levels.

In Egypt, sowing wheat crop as a broadcasting, drilling in rows (as a common practices) and also in hills on ridges of preceding crops *i.e.* cotton or maize in particular when harvest of these crops is delayed. Considerable research has been conducted on the sowing methods. Prasad et al. (1991) reported that sown wheat in cross rows 22.5 cm apart gave the highest grain yield of 3.13 t/ha compared with 2.81 and 1.84 t/ha in rows 15 cm apart and

broadcast sowing, respectively. Singh *et al.* (1994) found that grain yield of wheat were 2.59 t/ha when broadcast, 3.57 t/ha when cross sown (22.5 X 22.5 cm) and 3.43 and 3.31 t/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/fed 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 methods. Keisling *et al.* (1997) revealed that yields of broadcast 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.

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 level for wheat, vary widely in amounts ranged between 70 and 120 kg N/fed according to environmental conditions (Atta Allah and Mohmmed, 2003 ; Saleh, 2003 ; Tammam and Tawfils, 2004 ; Allam, 2005 ; Gab-Allah, 2005 and Salem, 2005). Yet, 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 key factor in determining bread-making quality, and the best strategy available to the farmer for optimizing wheat quality (Bellido *et al.*, 2001 and Abad *et al.*, 2004). With respect to soil nitrate pollution, Abad *et al.* (2004) found that soil nitrate residues after harvest increased with increasing nitrogen rates. Also, Zhao *et al.* (2006) reported that soil NO_3 movement out of the effective crop root zone is an important pathway of nitrogen losses and optimized nitrogen fertilization reducing nitrogen leaching losses.

Therefore, the main objective of this investigation was to determine the optimum sowing methods and nitrogen fertilizer levels to achieve maximum yields of wheat cv. Sakha 93 under environmental condition of Mansoura district, Dakhlia Governorate.

MATERIALS AND METHODS

Two field experiments were conducted at the Exp. Sta., Fac. of Agric., Mansoura Univ. during 2004/2005 and 2005/2006 seasons to determine the effect of sowing methods and nitrogen fertilizer levels on growth, yield and its components as well as crude protein percentage in grains of wheat cv. Sakha 93.

The experiments were carried out in a split-plot design with three replications. The main plots were occupied with the following three sowing methods:

S_1 – Broadcasting.

S_2 – Drilling in rows (15 cm apart of rows consists of 20 rows [3.5 m length] in each experimental unit).

S_3 – Hilling in ridges on the two sides with 15 cm between hills. Each experimental unit consists of 5 ridges, 60 cm apart and 3.5 m length.

Wheat grains at the rate of 70 kg/fed were sown by using the previously mentioned methods. The sub plots were assigned to five nitrogen fertilizer levels (50, 65, 80, 95 and 110 kg N/fed). Nitrogen fertilizer was in the form of ammonium nitrate (33.5 % N) and applied in two equal doses prior to the first and the second irrigations and before heading.

The experimental unit was 3 X 3.5 m (10.5 m^2). The preceding summer crop was maize (*Zea mays*, L.) in both seasons. The experiments were carried out in clay loam soil with medium fertility. Soil samples were taken at random from the experimental field area at depth of 15 and 30 cm from soil surface before soil preparation to determine the physical and chemical soil properties as shown in Table 1.

Table 1: Physical and chemical soil characteristics at the experimental sites during the two seasons.

Parameter	2004/2005	2005/2006
Ca CO_3 , %	2.60	2.62
Sand, %	20.1	19.2
Silt, %	32.9	32.7
Clay, %	47	48.1
Soil texture	Clayey	Clayey
Organic mater, %	2.90	2.85
E.C, ds m^{-1}(25 ^{0}C)	1.65	1.71
pH	7.80	7.95
Available nitrogen, ppm	17	13
Available P, ppm	9	8
Available K, ppm	310	308

The experimental field was well prepared and calcium super phosphate (15.5 % P_2O_5) was applied during soil preparation at the rate of 150 kg/fed. The planting time was on November 15th and 17th in the first and second seasons, respectively. The first irrigation was applied after 25 days from sowing and then plants were irrigated every 30 days till the dough stage. Potassium sulphate (48 % K_2O) at the rate of 50 kg/fed was applied broadcasting in one dose before the first irrigation. The common agricultural

practices for growing wheat according to the recommendations of Ministry of Agriculture were followed, except the factors under study.

STUDIED CHARACTERS:

A- Growth characters:

After heading ten plants were randomly selected from each sub plots to estimate the following characters:

1- Plant height (cm).

2- Flag Leaf Area (cm^2) ; was calculated by the following formula;

$$a = L \times W \times 0.75 \text{ (Gardner } et\ al.\text{, 1985).}$$

Where; a = Flag Leaf Area, L = Maximum length of flag leaf and W = Maximum width of flag leaf.

B- Yield components: (At harvest time)

3- Number of spikes/m^2.

4- Spike length (cm); determined by taking the average length of the ten main spikes.

5- Number of spikelets/spike.

6- Grain weight/spike (g).

8- Number of grains/spike.

10- 1000 – grain weight (g).

C- Yield and quality characters:

7- Grain yield (ardab/fed); calculated by harvesting plants in three square meter from each sub-plot and left on air to dry, then they were threshed and the grains at 13 % moisture were weighted in kg then convert to ardab per fed (one ardab = 150 kg).

8- Straw yield (t/fed) ; the straw resulted from previous sample was weighted in kg/plot, then it was converted to tons per fed.

9- Crude protein percentage in grains ; was estimated by the improved Kjeldahl – method according to A.O.A.C. method (1980). Crude protein percentage was calculated by multiplying the total nitrogen values in wheat flour by 5.7.

Statistical analysis

All data of this study were statistically analyzed according to the technique of analysis of variance (ANOVA) for the split plot design as published by Gomez and Gomez (1984), using "MSTAT-C " Computer software package. The treatment means were compared using the Newly Least Significant Differences (N.L.S.D) according to the producer outlined by Waller and Duncan (1969).

RESULTS AND DISCUSSION

A- Effect of sowing methods:

Data presented in Tables 2 and 3 showed that sowing method had a significant effect on all studied characters in the two seasons, except number of spikelets/spike in both seasons and protein % in the second season. Drilling in rows 15 cm apart produced the highest values of growth characters (plant height and flag leaf area) and yield components (number of spikes/m^2, spike length, number of spikelets and grains/spike, grain weight/spike and 1000-grain weight) as well as yields and quality (protein %), the same trend method was obtained in both seasons. Furthermore, the differences between drilling method and other sowing methods *i.e.* hilling and broadcasting sowing were significant at 5 % level of significance for most of the studied characters in the first and second seasons.

Table 2: Plant height (cm), number of total tillers/plant, number of productive tillers/plant, flag leaf are (cm^2), number of spikes/m^2, spike length (cm) and no of spikelets/spike as affected by sowing methods and nitrogen fertilizer levels during 2004/2005 and 2005/2006 seasons.

Characters / Treatments	Plant height (cm)		Flag leaf area (cm^2)		No. of spikes/m^2		Spike length (cm)		No. of spikelets/spike	
	2004/2005	2005/2006	2004/2005	2005/2006	2004/2005	2005/2006	2004/2005	2005/2006	2004/2005	2005/2006
A- Planting methods effects										
Broadcasting	91.9	91.3	60.1	54.7	369.1	348.0	14.2	14.0	17.0	16.80
Drilling	102.4	101.1	68.5	65.5	417.5	398.5	15.8	15.4	19.6	19.60
Hilling	95.1	94.8	64.0	61.8	399.0	375.3	15.1	14.2	19.6	19.46
F. test	*	*	*	*	*	*	*	*	NS	NS
N-LSD 5 %	1.5	0.8	4.6	3.8	4.4	3.7	0.3	0.5	-	-
B- Nitrogen fertilizer levels effects										
50 kg N/fed	88.1	85.4	42.6	40.2	324.4	314.0	12.8	12.5	16.0	15.5
65 kg N/fed	93.8	93.2	61.3	58.1	371.0	352.2	14.3	13.7	17.5	17.3
80 kg N/fed	99.7	99.5	71.1	67.5	422.8	398.2	15.7	15.3	19.7	19.7
95 kg N/fed	100.3	100.1	72.6	68.6	427.5	401.2	16.0	15.3	20.2	20.0
110 kg N/fed	100.5	100.4	73.4	69.1	430.2	404.1	16.4	15.8	20.2	20.4
F. test	*	*	*	*	*	*	*	*	*	*
N-LSD 5 %	0.6	0.7	2.9	1.0	3.8	2.3	0.2	0.3	0.5	0.6
C- Interaction effect:										
	NS	NS	NS	NS	*	*	NS	NS	NS	NS

Table 2: Plant height (cm), number of total tillers/plant, number of productive tillers/plant, flag leaf are (cm^2), number of spikes/m^2, spike length (cm) and no of spikelets/spike as affected by sowing methods and nitrogen fertilizer levels during 2004/2005 and 2005/2006 seasons.

Characters / Treatments	Plant height (cm)		Flag leaf area (cm^2)		No. of spikes/m^2		Spike length (cm)		No. of spikelets/spike	
	2004/2005	2005/2006	2004/2005	2005/2006	2004/2005	2005/2006	2004/2005	2005/2006	2004/2005	2005/2006
A- Planting methods effects										
Broadcasting	91.9	91.3	60.1	54.7	369.1	348.0	14.2	14.0	17.0	16.80
Drilling	102.4	101.1	68.5	65.5	417.5	398.5	15.8	15.4	19.6	19.60
Hilling	95.1	94.8	64.0	61.8	399.0	375.3	15.1	14.2	19.6	19.46
F. test	*	*	*	*	*	*	*	*	NS	NS
N-LSD 5 %	1.5	0.8	4.6	3.8	4.4	3.7	0.3	0.5	-	-
B- Nitrogen fertilizer levels effects										
50 kg N/fed	88.1	85.4	42.6	40.2	324.4	314.0	12.8	12.5	16.0	15.5
65 kg N/fed	93.8	93.2	61.3	58.1	371.0	352.2	14.3	13.7	17.5	17.3
80 kg N/fed	99.7	99.5	71.1	67.5	422.8	398.2	15.7	15.3	19.7	19.7
95 kg N/fed	100.3	100.1	72.6	68.6	427.5	401.2	16.0	15.3	20.2	20.0
110 kg N/fed	100.5	100.4	73.4	69.1	430.2	404.1	16.4	15.8	20.2	20.4
F. test	*	*	*	*	*	*	*	*	*	*
N-LSD 5 %	0.6	0.7	2.9	1.0	3.8	2.3	0.2	0.3	0.5	0.6
C- Interaction effect:										
	NS	NS	NS	NS	*	*	NS	NS	NS	NS

From the same tables, it could be noticed that sowing wheat grains on both sides of ridges in hills 15 cm apart came the second after drilling for all studied characters in both seasons. Whereas, the lowest values of all studied characters resulted from broadcasting method in both seasons.

Generally, from obtained results of this study, it can be concluded that drilling method is recommend, which improved wheat productivity.

However, in case of delaying harvest of cotton or maize preceding crops it is preferable to sow wheat in ridges in order to maximize wheat productivity compared with broadcasting method. The superiority of drilling method may be attributed to that grain drills offer more seeding precision and allows uniform depth of planting and resulted in more uniform stand than other sowing methods, consequently increased wheat productivity. These results are partially in accordance with those reported by Singh *et al.* (1994), Haikel *et al.* (1996), Dawelbeit and Babiker (1997), Muhammad (2003) and Tanveer *et al.* (2003).

B- Effect of nitrogen fertilizer levels:

Concerning the effect of nitrogen fertilizer levels, data in Tables 2 and 3 revealed that nitrogen fertilizer levels significantly affected all studied characters in both seasons. Growth characters *i.e.* plant height and flag leaf area gradually increased by increasing nitrogen fertilizer levels from 50 up to 110 kg N/fed in both seasons. The highest values of these characters resulted from fertilizing wheat plants by 110 kg N/fed in both seasons. Nevertheless, it must be noticed that the differences between application of 80 and 95 kg N/fed and 95 and 110 kg N/fed were not significant in most studied growth characters in both seasons. However, using 80 kg N/fed caused a significant increases in all growth traits compared with 50 or 65 kg N/fed in both seasons. The increase in growth characters due to nitrogen fertilization may be attributed to the role of nitrogen in increasing division and elongation of cells as well as activation metabolic and photosynthesis processes. These results are in accordance with those reported by Saleh (2003), Allam (2005) and Gab-Allah (2005).

Yield components under this study such as number of spikes/m^2, spike length, number of spikelets/spike, number of grains/spike, grains weight/spike and 1000-grain weight followed the same trend of plant growth characters in the two seasons. Besides, nitrogen levels up to 80 kg N/fed markedly increased some yield attributes such as number of tillers, number of spikes/m^2 and number of grains/spike which in turn increased grain yield. Grain and straw yields/fed as well as protein % significantly responded to increasing nitrogen fertilizer level up to 80 kg N/fed in both seasons. Whereas, further increases of nitrogen fertilizer levels up to 95 or 110 kg N/fed did not significantly increase these traits in both seasons. It could be stated that addition of 80-95 kg N/fed should be recommended for maximizing wheat productivity. The increase in yield and its components as well as quality due to nitrogen fertilization may be due to its role in activation of cells division, metabolic and photosynthesis process and nutritive status of wheat plant. Similar results were reported by Atta Allah and Mohmmed (2003), Saleh (2003), Tammam and Tawfils (2004) and Seiling *et al.* (2005).

C- Effect of the interaction:

The interaction between sowing methods and nitrogen fertilizer levels had only significant effect on number of spikes/m^2 and grain yield/fed in the two growing seasons as shown in Tables 2 and 3 and graphically illustrated in Figs 1 and 2. The significant highest values of these characters resulted from sowing wheat by drilling in rows 15 cm apart together with application of 80 kg N/fed. On the other hand, the lowest means of these traits associated with broadcasting method and using 50 kg N/fed in the two growing seasons.

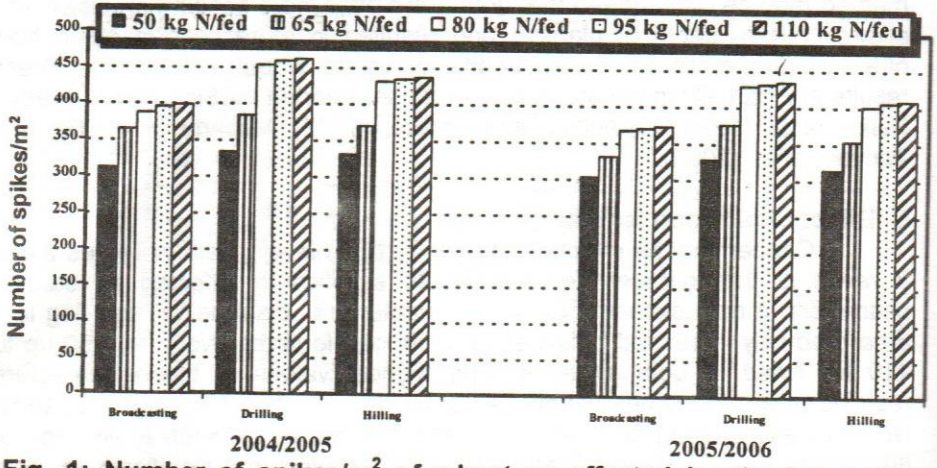

Fig. 1: Number of spikes/m^2 of wheat as affected by the interaction between sowing methods and nitrogen fertilizer levels during 2004/2005 and 2005/2006 seasons.

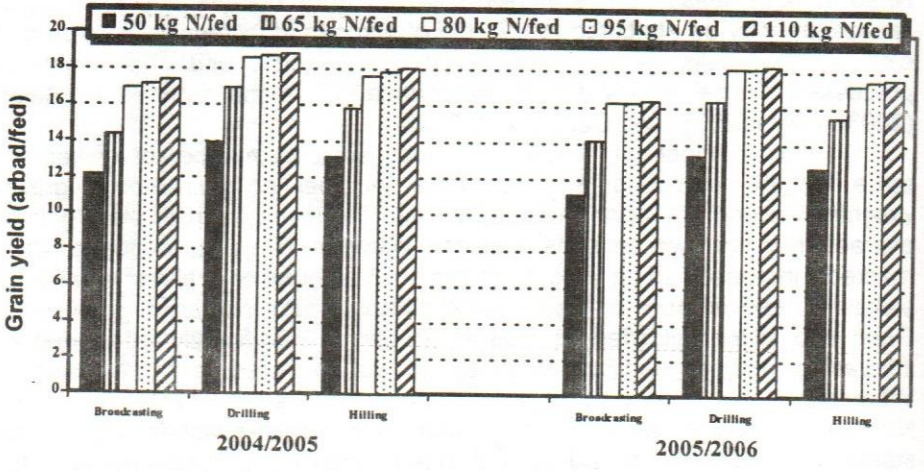

Fig. 2: Grain yield (ardab/fed) of wheat as affected by the interaction between sowing methods and nitrogen fertilizer levels during 2004/2005 and 2005/2006 seasons.

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إستجابة القمح لطرق الزراعة ومستويات التسميد النيتروجينى

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أجريت تجربتان حقليتان بمحطة التجارب والبحوث الزراعية بكلية الزراعة – جامعة المنصورة خلال موسمى ٢٠٠٤/٢٠٠٥ و٢٠٠٥/٢٠٠٦ لدراسة تأثير ثلاث طرق للزراعة (بدار ، تسطير فى صفوف ، جور على خطوط) وخمسة مستويات من التسميد النيتروجينى (٥٠ ، ٦٥ ، ٨٠ ، ٩٥ و ١١٠ كجم نيتروجين/فدان) على صفات النمو ومكونات المحصول والمحصول والجودة للقمح صنف سخا ٩٣. وقد أستخدم تصميم القطع المنشقة فى أربع مكررات. ويمكن تلخيص أهم النتائج المتحصل عليها فيما يلى:

١- كان لطرق الزراعة تأثيرا معنويا على معظم الصفات تحت الدراسة فى كلا الموسمين. أدت زراعة القمح تسطير فى صفوف المسافة بينها ١٥ سم للحصول على أعلى القيم المعنوية لجميع الصفات تحت الدراسة تلاها زراعة القمح فى جور على خطوط خلال موسمى الدراسة. فى حين أدت الزراعة البدار للحصول على أقل القيم لتلك الصفات فى كلا الموسمين.

٢- أدت مستويات التسميد النيتروجينى إلى زيادة معنوية فى جميع الصفات تحت الدراسة فى كلا الموسمين. كما أدت زيادة مستويات التسميد النيتروجينى من ٥٠ إلى ١١٠ كجم نيتروجين للفدان إلى زيادة تدريجية لجميع الصفات تحت الدراسة. أما إستخدام ٨٠ كجم نيتروجين للفدان مصحوبا بزيادة معنوية فى جميع الصفات المدروسة خلال موسمى الدراسة مقارنة بالمستويات الأخرى (٥٠ و٦٥ كجم نيتروجين للفدان).

٣- كان للتفاعل بين طرق الزراعة ومستويات التسميد النيتروجينى تأثيرا معنويا على صفتى عدد السنابل للمتر المربع ومحصول الحبوب للفدان فقط خلال موسمى الدراسة.

٤- عموما يمكن التوصية بزراعة القمح تسطير فى صفوف على مسافة ١٥ سم أو فى جور على جانبى خطوط القطن أو الذرة الشامية فى حالة تأخير حصادهم مع التسميد النيتروجينى بمعدل ٨٠ – ٩٥ كجم للفدان وذلك للحصول على أعلى إنتاجية لوحدة المساحة مع توفير تكاليف الإنتاج وتقليل التلوث البيئى. حيث أن تقليل مستويات التسميد النيتروجينى من ١١٠ إلى ٨٠ كجم نيتروجين للفدان لم يكن مصحوبا بفرق معنوى فى محصول الحبوب والذى بلغ ٠,٢٧ أردب/فدان (كمتوسط خلال موسمى الدراسة) والذى يقدر بحوالى ٤٠ جنيه مصرى. فى حين أن ثمن السماد النيتروجينى الذى تم توفيره (٣٠ وحدة نيتروجين) يقدر بحوالى ٦٥ جنيه مصرى.