Zagazig J. Agric. Res., Vol. 37 No. (4) 2010 803-828

RESPONSE OF WHEAT CULTIVARS TO VARYING TIME OF N-APPLICATION, PLANTING DENSITIES AND SOWING DATE

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ABSTRACT

Four field experiments were conducted at El-Kassasein district, Ismailia Governorate, Egypt during the wheat growing seasons (2004/2005 and 2005/2006) to study the response of three wheat cultivars (Gemmeiza-9, Sakha-93 and Giza-168) to sowing dates, N-application time and planting densities. The two tested sowing dates were 15th and 30th, November in each experiment. Three N-application time (T_1, T_2, T_3) were placed the main plots. Three planting densities (400, 500 and 600 grains/m^2) were devoted to sub plots in a split plot design. The most important results can be summarised as follows:

The cultivars did not show significant variation in their height, Giza-168 cultivar gave the highest number of spikes/m^2, Gemmeiza-9 produced the heaviest grains/spike, Sakha-93 gave the heaviest grain in the first season and was replaced by Gemmeiza-9 in the second one and Sakha-93 outyielded Giza-168 only in the second one.

Ceasing N-application at 45 DAS (T_1) gave the tallest plants, highest number of spikes/m^2 and the highest grain weight/spike in one season only. T_2 (extended application to 75 DAS) produced the heaviest grains. Grain yield was favoured by T_1 in the first season and by T_3 in the second one.

Plant height was favoured by using 500 grains/m^2 in first season and by 400 grains/m^2 in the second season, number of spikes showed better results when dense planting was used (600 grains/m^2), grain weight/spike was better when 500 or 600 grains were used, 1000 grain weight gave the best values under 600 grains treatment and grain yield was the highest when 400 grains/m^2 was used in the first season only.

Delaying sowing to 30th, Nov. gave the tallest plants in the first season only, produced grater number of spikes/m^2 in the first season and vice-versa was observed in the second one, heavier grain/spike was favoured by early sowing. Delayed sowing produced heavier grains in the first season and the lighter grains in the second one and early sowing (15th, Nov.) was more optimum to produce the highest grain yield.

Keywords: Wheat cultivars, time of N application, planting density, sowing date.

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INTRODUCTION

Bread wheat (*Triticum aestivum* L) is one of the major cereal crops in the world as well as Egypt. Raising wheat production through increasing the productivity of unit area is the most important national target to minimize the gap between the Egyption production and annual local demand. Improving productivity could be achieved by cultivating high yield cultivars coupled with improved agronomic practices such as sowing date, time of nitrogen application and planting density.

Sowing date is one of the most important agronomic practices which limits environmental conditions (such as temperature, phato-period and humidity) suitable for wheat. Several studies showed that early sowing date at Nov., 15 led to high yield and its components.

Ramadan and Awaad (2008) stated that the varietal differences significantly affecting on plant height, No. of spikes/m^2, spike length, No. of grains/spike, grain weight/spike and straw and grain yields/fad. On the other hand, Gafar (2007) found that 1000 grain weight responsed for varietal differed while Mosalem (1993) and Saleh 2003 did not find effect of varietal differences on grain yield/fad.

Time of nitrogen application is a factor which play important and effective role on growth and productivity wheat crop. Gaballah (2005) reported that applying N in three equal doses, viz ⅓ at sowing, ⅓ at tillering and ⅓ at jointing gave a good values for plant height, No. of spikes/m^2, spike length, 1000 grain weight and grain and straw yields/fad. However, Madan and Munjal (2009) presented that applying N in three doses i.e., ⅓ dose at sowing, ⅓ at first node and ⅓ at post anthesis (95-100 DAS) achieved high grain yield/ha than the applying rate ½ dose at sowing and ½ dose at first irrigation.

Many workers studied the importance of seeding rate in increasing yield and its attributes. Ashmawy and Abo-Warda (2002) showed that high grain yield/fad was achieved by planting a number of 400 grain/m^2. On the other side, No. of spikes/m^2 and 1000 grain weight were not significantly affected by seeding rate. Also, Ali *et al.* (2004) decided that increasing seeding rate from 300 to 400 or 500 grain/m^2 significantly increased plant height, No. of spikes/m^2 and grain and straw

yields/fad. but significantly decreased grain weight/spike and 1000 grain weight. Madan and Munjal (2009) observed that the cultivated by seeding rate of 125 and 112.5 kg seeds/ha gave higher grain yield/ha compared with cultivated by 100 kg seeds/ha.

Therefore, the main objective of this study was to study the effect of sowing date, planting density and time of nitrogen application on growth and productivity of certain wheat cultivars in the new cultivated soils.

MATERIALS AND METHODS

This investigation was conducted in an private farm at El–Kassasin, Ismailia governorate, during two successive seasons (2004/2005 and 2005/2006) to study the effect of sowing date, planting density and time of nitrogen application on growth and productivity of certain wheat cultivars (*Triticum aestivum* L.) in the new cultivated soils.

Factors Under Study

Sowing dates

(i) 15th of November

(ii) 30th of November

Wheat cultivars

(i) Sakha-93

(ii) Gemmeiza-9

(iii) Giza-168

Time of nitrogen application

The rate 100kg N/fad splited into four equal doses. The time of applications as follows:

(i) At 15, 25, 35 and 45 days after sowing (T_1).

(ii) At 15, 35, 55 and 75 days after sowing (T_2).

(iii) At 15, 45, 65 and 85 days after sowing (T_3).

Planting densities

(i) 400 grains/m^2.

(ii) 500 grains/m^2.

(iii) 600 grains/m^2.

Experimental Design

A split plot design with three replicates was used in each of sowing dates of the two seasons. Wheat cultivars and time of nitrogen application treatments were assigned to the main plots. The sub plots included planting densities.

Recorded Data

Yield and yield attributes

At harvest, ten guarded plants were randomly taken from the three or four inner rows of each

sub plot to determine the following yield characters:

1. Plant height (cm).
2. Number of spikes/m^2.
3. Spike length (cm).
4. Thousand grain weight (g).
5. Number of grains/spike.
6. Grain weight/spike (g).
7. Grain yield (kg/fad).
8. Straw yield (kg/fad).

Cultural Practices

In both seasons wheat preceded by summer follow. The sub plot area was $7m^2$ (2m x 3.5m), which included 10 rows, 20cm apart. Potassium sulphate (48%k_2O) by rate 50kg/fad were added before sowing. Sowing was carried out by hand drilled in rows. Surface irrigation ground water was used. Irrigation was given as normally practiced in both two seasons. N-fertilizer was in a form of ammonium nitrate (33.5%N). The dates of harvesting were 18^{th} of April to the first sowing date and 30^{th} of April to the second sowing date for 2004/2005 and 2005/2006 growing seasons, respectively.

The experimental field soil texture was sandy at depth from 0 to 30cm and loamy sand at depth from 30 to 60cm in the first season, but it was loamy sand at the two depths in the second season.

Statistical Analysis

The data obtained in each season were statistically analyzed, using procedure of Snedecor and Cochran (1967). Duncan's multiple range test, Duncan (1955) was used to compare the significant differences among means. Concerning the interaction tables, capital and Small letters were used for comparison among rows and columns means, respectively.

RESULTS AND DISCUSSION

Plant Height (cm)

Concerning wheat cultivars Table 1, the combined results revealed insignificant differences in both seasons. However, gave the longest plants in the first season while Sakha-93cv cultivar gave the longest plants in the second season. In this connection several investigators stated the varietal differences regarding plant height of wheat cultivars among them Gafar (2007) and El-Murshedy (2008). However, Mosalem (1993) reported that wheat cultivars were not differed in plant height.

Table 1. Plant height (cm), Number of spikes/m^2 and Spike length (cm) wheat cultivars as influenced by time of nitrogen application, planting density and sowing date

Main effects and interaction	Plant height (cm)		Number of spikes/m^2		Spike length (cm)	
	2004/2005 combined	2005/2006 combined	2004/2005 combined	2005/2006 combined	2004/2005 combined	2005/2006 combined
Cultivars(V)						
Gemmeiza 9	59.3	66.5	370.8 c	448.3 c	8.9 a	10.4a
Sakha 93	59.2	66.9	499.6 b	493.7 b	8.5 c	10.4a
Giza 168	59.8	66.6	566.2 a	520.9 a	8.8 b	10.3b
F- test	N.S	N.S	**	**	**	**
Time of N application(T)						
T_1	66.7 a	75.2 a	496.1 a	483.1 b	8.5 c	10.9a
T_2	55.1 c	61.2 c	474.9 b	481.3 b	8.7 b	9.7c
T_3	56.5 b	63.5 b	465.6 c	498.5 a	9.0 a	10.6b
F-test	**	**	**	**	**	**
Planting density (D)						
400grains/m^2	59.5 b	67.1 a	470.1 c	482.7	8.5 c	10.7 a
500 grains/m^2	60.3 a	66.5 b	479.3 b	488.9	9.1 a	10.3 b
600 grains/m^2	58.6 c	66.4 b	487.2 a	491.3	8.7 b	10.2 c
F-test	**	*	**	N.S	**	**
Sowing date						
Nov., 15	58.1 b	66.7	471.6 b	499.3 a	8.2b	10.0 b
Nov., 30	60.8 a	66.7	486.2 a	476.0 b	9.3a	10.8 a
	**	N.S	**	**	**	**
Interactions						
V X T	**	**	**	**	**	**
V X D	**	**	**	N.S	**	N.S
T X D	**	**	**	*	**	**
V XTX D	**	**	**	N.S	**	**

Table 1-a. Number of spikes/m^2 as affected by the interaction of cultivars and time of N application during the first season

Time of N application \ Cultivars	Gemmeiza-9	Sakha-93	Giza-168
T_1	C	B	A
	394.9 a	509.3 a	584.0 a
T_2	C	B	A
	384.6 a	494.8 a	545.4 b
T_3	C	B	A
	332.9 b	494.7 a	569.2 a

Table 1-b. Number of spikes/m^2 as affected by the interaction of cultivars and time of N application during the second season

Time of N application \ Cultivars	Gemmeiza-9	Sakha-93	Giza-168
T_1	B	B	A
	455.0 a	460.8 c	533.0 a
T_2	B	A	A
	457.7 a	498.5 b	487.7 b
T_3	C	B	A
	431.7 b	521.8 a	542.0 a

With respect to influence of time of N- application on plant height of wheat plants, the results in the same Table 1 revealed highly significant differences where T_1 application treatment achieved the longest plants followed by T_3 application in both seasons. These results are in a good connection with those reported by Mowafy (2002) and Gaballah (2005).

Otherwise, Sadek, Eman (1990) showed that time of N- application had no significant effect on plant height of wheat.

Regarding the combined analysis, middle density planting of 500 grains/m^2 appeared to produce the tallest plants followed by light dense planting of 400 grains/m^2, while the dense planting of 600 grains/m^2 had the shortest plants in the first season. However, in the second season light dense planting of 400 grains/m^2 achieved the longest plants compared with either middle or dense plantings with no significant differences between the last two planting densities in this respect. Such increase in plant height of wheat may be indicative of vigourousity in growth since healthy vigour plants are usually produced when light planting density taken place resulting from saving enough moisture, light and nutrient elements in addition to reducing the competition among wheat plants. These results are in accordance with those reported by Hamada *et al.* (2001). Otherwise, the reverse directions were observed by several investigators included El-Ganayni and Gamalat (2008) and Soomro *et al.* (2009). In addition, Abdul-Khaliq *et al.* (1999), Sajjad-Hussain *et al.* (2001) and Abd-Alla (2002) reported that plant density had no significant effects on plant height of wheat.

Concerning the combined results of sowing dates during both growing seasons regarding plant height of wheat, highly significant difference was observed between the two sowing dates in the first season, whereas late sowing at Nov., 30 tended to produce taller plants than those produced at early sowing (Nov., 15). However, the difference was not significant between sowing dates in the second season respecting plant height of wheat. The superiority of late sowing regarding plant height at harvest was early observed during the most vegetative stages former noticed and discussed in Table 1. In this connection several investigators reported that early planting tended to produce taller

wheat plants as compared with later sowing among them Subhan *et al.* (2004) and Hardan (2008). While Qamar *et al.* (2004) reported that sowing dates did not significantly affected plant height of wheat.

Number of Spikes/m^2

Highly significant differences Table 1 were existed between wheat cultivars whereas Giza-168cv. achieved the highest number of spikes/m^2 followed by Sakha-93 cv., while Gemmeiza-9cv. gave the lowest numbers of spikes/m^2. Several investigators noticed the varietal difference regarding spikes number/m^2 from them Gafar (2007) and Ramadan and Awaad (2008).

Time of N-application results reveal highly significant difference throughout both seasons whereas regulating N-application each 10 days (T_1) appeared to produce higher spike numbers/m^2 in the first season. However, in the second season delaying N-application one month after first general adding (T_3) achieved greater number of spikes/m^2 compared with other N-application treatments.

It seems evident that influence of N-application time differed from season to another depend on edaphic and climatic conditions especially soil fertility where the physical properties of researchers field soil show higher silt and clay% in the second season than the first one. Several experimenters showed the positive response of spike numbers/m^2 due to splitting of nitrogen from them Mowafy (2002), Gaballah (2005) and Moursi and Abdel-Majeed (2005). Otherwise, Sadek, Eman (1990) indicate that splitting N-fertilizer with timing of its application had no significant effect on number of spikes/m^2 of wheat.

Generally, planting density results showed significant differences where increasing planting density from 400 to 500 then to 600 grains/ m^2 tended to be gradually increased number of spikes/m^2.

Although this general trend noticed annually, the differences could not reach the levels of significance in the second season. Such increase in number of spikes/m^2 which achieved by dense planting is mainly due to the increase in number of plants/m^2 at higher seeding rate. These results are in a good line with those reported by Subhan *et al.* (2004),

El-Afandy *et al.* (2007) and El-Ganayni and Gamalat (2008).

With respecting to the combined results of sowing dates, the results reveal highly significant differences in both seasons when late sowing (Nov., 30) gave higher number of spikes/m^2 and the early sowing (Nov., 15) was the superior one in the second season. Meanwhile, the rate of increasing in spikes/m^2 by late sowing in the first season amounted to around 3.1%, while that rate of increasing reached by early sowing in the second season amounted to around 4.9%. In this connection, Sharaan *et al.* (2000), Hardan (2008) and Zakria *et al.* (2008) reported that sowing date appeared significantly affecting number of spikes/m^2 of wheat.

Concerning the significant interaction among the studied factors on number of spikes/m^2, the results revealed that Giza-168cv. gave higher number of spikes/m^2 when T_1 or T_3 of N-application were used during the both seasons. On the other direction, the lowest number of spikes/m^2 was recorded by Gemmeiza-9cv. when T_3 application was applied (Tables 1-a and 1-b).

Spike Length (cm)

Data in Table 1, expose spike length of wheat cultivars as influenced by time of N-application, planting density and sowing date, Meanwhile, wheat cultivars showed highly significant differences throughout the two seasons, whereas Gemmeiza-9cv. appeared to produce longer spikes in both seasons followed by Giza-168cv. However, in the second season spike length of Gemmeiza-9cv. did not differed significantly with Sakha-93cv. giving both longer spikes than Giza-168cv. Such differences in spike length almost due to the genetical variations and their interactions with environmental conditions. The results are in a good line with those reported by Gafar (2007) and Ramadan and Awaad (2008). However, Abdel-Aleem (1980) and Alam *et al.* (2007) reported that wheat cultivars did not differ significantly in spike length.

Thousand Grains Weight (g)

As seen in Table 2, wheat cultivars showed highly significant differences whereas the combined results indicate that Sakha-93cv. gave the heaviest 1000-grain (48.86 g) in the first season, while in the second season the heaviest

1000-grain of 49.97g was achieved by Gemmeiza-9cv. Several investigators reported that wheat cultivars differed significantly in 1000-grain weight included El-Sawi *et al.* (2006), Gafar (2007) and El-Murshedy (2008).

Regarding the influence of time of N-application on 1000-grain weight, the results revealed highly significant differences where regulating N-application each 20 day up to 75 DAS (T_2) appeared to produce the heaviest 1000-grain weight as compared with other two N-application treatments. These results are in accordance with those reported by Mowafy (2002) and Gaballah (2005). On the contrary, Saleh (2003) reported that time and dose of N- application had no significant effect on 1000-grain weight of wheat.

Concerning the influence of planting density on 1000-grain weight, the results revealed highly significant differences throughout the two seasons. Meanwhile, dense planting of 600 grains/m^2 appeared to produce heavier 1000-grain weight as compared with lighter and medium planting densities in the first season, which could be attributed to lower number of grains/spike recorded by dense planting (Table 2) resulted from the competition between plants, spikes and spikelets for available nutrient in the surrounding or closer media which in turn reflect such increase in grain weight of limited number of grains/spike.

Also, light planting density of 400 grains/spike tended to produce heaviest 1000-grain in the second season with no significant differences between lighter and dense planting densities. Such increase in 1000-grain weight achieved by light density may be attribute to reducing the competition between grains under wider spaces between wheat plants.

In this connection, El-Afandy *et al.* (2007) and Ramadan and Awaad (2008) reported that dense planting appeared to produce heaviest 1000-grain weight of wheat. Otherwise, the reverse effects were observed by Tabl *et al.* (2005), Gafar (2007) and Soomro *et al.* (2009) who reported that light or reducing density tended to produce heaviest 1000-grain weight of wheat. However, Ashmawy and Abo-Warda (2002) and Saleh (2000) reported that planting density had no significant effect on 1000-grain weight of wheat.

Sowing dates results Table 2 revealed highly significant effect during both seasons. Although late sowing at Nov., 30 gave heavier 1000-grain in the first season, the

reverse direction was found in the second season where early sowing at Nov., 15 achieved heavier 1000-grain weight. The results almost followed the same patterns of number of spikes/ m^2 and number of grains/spike (Tables 1 and 2) which indicate the effect of environmental conditions during both growing seasons especially soil fertility and degree of temperature. The results are in accordance with those reported by Akhtar *et al.* (2006). Hardan (2008) and Zakaria *et al.*, (2008).

Number of Grains/Spike

Data presented in Table 2 show number of grains/spike as affected by different factors of study, the three cultivars showed significant variation. Gemmeiza-9cv. gave the highest number of grains/spike. This was true in the two seasons. Sakha-93cv. produced similar number of grains/spike to Gemmeiza-9cv. in the second season and it occupied the third position in the first season. Several investigators stated the significant differences between wheat cultivars regarding number of grains/spike among them El-Hag (2006), Gafar (2007) and El-Murshedy (2008).

Likewise, ceasing N fertilizer application at 45 DAS (T_1) produced highest number of grains/spike in the second season but did not favour this character in the first season. These results are in accordance with those reported by Mowafy (2002), Pandey *et al.* (2003) and Gaballah (2005).

Light planting (400 grains/m^2) produced the highest number of grains/spike in the second season and 500 grains/m^2 was the best in the first one. In this connection, Tabl *et al.* (2005), El-Hag (2006) and Soomro *et al.* (2009) stated that number of grains/spike was significantly decreased as planting density or seeding rate was increased. However, Ashmawy and Abo-Warda (2002) and Hussain *et al.* (2003) reported that planting density had no significant effect on number of grains/spike.

Delaying sowing date up to 30th, Nov. produced higher number of grains/spike in the first season as compared with early sowing of 15th, Nov. The picture in the second season was the vice-versa. Several investigators reported that sowing date significantly affected number of grains/spike of wheat included Dokuyucu *et al.* (2004), Hardan (2008) and Zakaria *et al.* (2008).

Grain Weight/Spike (g)

As seen in Table 2 regarding wheat cultivars, the results indicate

that Gemmeiza-9cv. cultivar gave heavier grains/spike as compared with other two varieties. These differences were confirmed significantly during the first season while they could not reach the level of significance in the second season. The superiority of Gemmeiza-9cv. in grain weight/spike was expected, since it had longer spikes and higher grain number/spike (Tables 1 and 2). these results are in a good line with those reported by El-Sawi *et al.* (2006) and El-Murshedy (2008) However, Abd El-Aleem (1980) indicate that wheat cultivars had no significant effect on grain weight/spike.

Concerning the influence of N-application time on grain weight/spike, the results revealed highly significant differences when late N-application up to 85 DAS (T_3) appeared to produce heavier grains/spike during the first season. Otherwise, early N-application up to 45 DAS (T_1) obtained heaviest grains/spike in the second season. Such fluctuated results could be attributed to environmental effects specially soil fertility. The results are in general agreement with those reported by Abdul-Galil *et al.* (2000), Mowafy (2002) and Pandey *et al.* (2003).

Planting density results revealed significant differences. Therefore, combined data showed that middle density of 500 grains/m^2 gave heavier grains/spike in the first season, while in the second season dense planting of 600 grains/ m^2 appeared to produce heavier grains/spike. However, the reverse effect was observed by Ghanem and El-Khawaga (1991), Salem (1999) and El-Hosary *et al.* (2000).

The combined results of sowing dates during both seasons in the same Table 2 indicate significant differences whereas early sowing of Nov., 15 heavier grains/spike were obtained compared with late sowing of Nov., 30. This straight trend was confirmed significantly during both growing seasons and followed the same patterns of number of grains/spike in the second season. Furthermore, the obtained results are in agreement with those reported by Subhan *et al.* (2004) and Qamar *et al.* (2004) who reported that early-sown wheat had higher grains/spike than late planted wheat.

Table 2. Thousand grains weight Number of grains/spike and grains weight / spike wheat cultivars as influenced by time of nitrogen application, planting density and sowing date

Main effects and interaction	1000-grain weight (g)		Number of grain/spike		grain weight / spike(g)	
	2004/2005 combined	2005/2006 combined	2004/2005 combined	2005/2006 combined	2004/2005 combined	2005/2006 combined
Cultivars(V)						
Gemmeiza 9	47.63 b	49.97 a	34.8 a	45.1 a	1.72 a	2.14
Sakha 93	48.86 a	49.06 b	31.2 c	44.3 a	1.52 c	2.10
Giza 168	47.20 b	48.86 b	33.2 b	42.7 b	1.59 b	2.09
F- test	**	**	**	**	**	N.S
Time of N application(T)						
T_1	46.54 c	49.67 b	31.7 c	47.7 a	1.56 c	2.20 a
T_2	49.59 a	52.25 a	34.2 a	40.7 c	1.60 b	2.11 b
T_3	47.56 b	45.98 c	33.3 b	43.6 b	1.67 a	2.02 c
F-test	**	**	**	**	**	**
Planting density (D)						
400grains/m^2	46.95 b	49.97 a	32.2 b	45.5 a	1.57 b	2.10 b
500 grains/m^2	47.44 b	84.18 b	35.2 a	43.5 b	1.67 a	2.10 b
600 grains/m^2	49.31 a	49.74 a	31.8 b	43.1 b	1.58 b	2.14 a
F-test	**	**	**	**	**	*
Sowing date						
Nov., 15	46.87 b	51.45 a	32.7 b	47.9 a	1.64 a	2.13 a
Nov., 30	48.92 a	47.15 b	33.4 a	40.2 b	1.57 b	2.09 b
	**	**	**	**	**	*
Interactions						
V X T	**	**	**	**	**	**
V X D	**	**	**	**	**	**
T X D	**	**	**	**	**	**
V XTX D	**	**	**	**	**	**

Grain Yield (kg/fad)

Data presented in Table 3 show varietal differences of wheat and the influence of N-application time, planting density and sowing date on grain yield during the two seasons.

Concerning the varietal differences, the results revealed highly significant differences whereas Sakha-93cv. gave the highest grain yield during both seasons. The results followed the same patterns of 1000-grain weight during the first season. The varietal differences were reported by several investigators included Tabl (2005), El-Sawi *et al.* (2006) and El-Murshedy (2008). However, El-Far and El-Nagar (1995) and Saleh (2003) noticed that wheat cultivars did not differed significantly in grain yield/fad.

Regarding the effect of time of N-application on grain yield/fad, the results revealed highly significant differences throughout both seasons where early N-application up to 45 DAS (T_1) appeared to produce the highest grain yield/fad during the first season. However, in the second season the reverse direction was observed, whereas late N-application up to 85 DAS achieved the highest grain yield/fad. Such fluctuate results during both seasons might be attributed to weather conditions prevailing as well as soil fertility during both growing seasons. Nitrogen application in the late stages of wheat development increased the photosynthetic ability of the plant leaves in the later stages, and also lengthened the peak of grain filling stage, thus enhancing the grain weight and yield of wheat significantly. The significant effects due to time of N-application and splitting were also observed by Moursi and Abdel-Majeed (2005) and Madan and Munjal (2009). However, Sadek, Eman (1990) reported that time of N-application had no significant effect on grain yield of wheat.

Planting density results showed that light planting of 400 grains/m^2 produced the highest grain yield/fad as compared with either middle or dense planting densities during the first season. In the second season the results had no significant effects in this respect. The superiority of light planting density was noticed through specific growth attributes included plant hight, number of grains/spike and grain weight/spike. Such increase in grain yield/fad

achieved by light planting density might be attributed to reducing competition between wheat plants for available nutrients in surrounding or closer media which in turn reflect the increase in vegetative growth resulted in synthesize more metabolites, then supplying and producing more grain yield/fad under wider spaces between wheat plants. The obtained results are in accordance with those reported by Hussain *et al.* (2003), However, El-Hag (2006), Gafar (2007) and Madan and Munjal (2009) stated that dense planting or increasing seeding rate tended to produce higher grain yield per unit area of wheat compared with lighter planting densities. Otherwise, Ramadan and Awaad (2008) reported that planting density had no significant effect on grain yield/fad of wheat.

Likely, sowing date results showed high significant differences during both growing seasons when early sowing at 15 of Nov. appeared to produce higher grain yield/fed than the late one. The superiority of grain yield/fed achieved by early sowing amounted to 13.52 and 4.17% during both growing seasons, respectively compared with late sowing. This indicates that the climatic conditions were less suitable for growth duration with the delay in sowing date. So, weather conditions prevailing during wheat growth may be reason for the detected variations. In this connection, Subhan *et al.* (2004) reported that wheat sown in mid-November gave significantly the highest grain yield/fad to significant increase in grains/spike and 1000-grain weight while delayed sowing in mid-December depressed the grain yield. Also, the obtained results are in a good line with those reported by Akhtar *et al.* (2006), Hardan (2008) and Zakaria *et al.* (2008).

Generally, second growing season appeared to produce higher yield attributes, thus it was obtained higher grain yield/fad than the first season, which could be attributed to the seasonal environmental condition effects especially soil fertility.

With respecting to the interaction effects between the studied factors, the significant interaction effect between wheat cultivars and time of N-application (Tables 3-a and 3-d) indicate that Sakha-93 and Gemmeiza-9 cultivars tended to produce higher grain yield/fad when early N-application (T_1) was applied in the first season. However, in the second season

Table 3. Grain yield (kg/fad) and straw yield (kg/fad) wheat cultivars as influenced by time of nitrogen application, planting density and sowing date

Main effects and interaction	Grain yield (kg/fad)		Straw yield (kg/fad)	
	2004/2005 combined	2005/2006 combined	2004/2005 combined	2005/2006 combined
Cultivars(V)				
Gemmeiza 9	2252.4 b	3153.2 a	3430.9 c	4415.9 b
Sakha 93	2331.7 a	3166.2 a	3628.1 b	4593.8 a
Giza 168	2283.5 b	3106.5 b	3770.8 a	4495.4 ab
F- test	**	**	**	**
Time of N application(T)				
T_1	2347.4 a	3013.0 c	4507.9 a	5310.3 a
T_2	2292.5 b	3101.8 b	3356.3 b	4278.8 b
T_3	2227.6 c	3311.0 a	2965.6 c	3916.0 c
F-test	**	**	**	**
Planting density (D)				
400grains/m^2	2344.9 a	3133.4	3853.2 a	4776.4 a
500 grains/m^2	2243.8 b	3137.1	3548.2 b	4374.9 b
600 grains/m^2	2278.9 b	3155.3	3428.4 c	4353.8 b
F-test	**	N.S	**	**
Sowing date				
Nov., 15	2434.1 a	3206.1 a	2913.1 b	4824.6 a
Nov., 30	2144.2 b	3077.8 b	4306.8 a	4178.8 b
	**	**	**	**
Interactions				
V X T	**	**	**	**
V X D	**	**	**	**
T X D	**	**	**	**
V XTX D	**	**	**	**

Table 3-a. Grain yield (kg/fad) as affected by the interaction of cultivars and time of N application during the first season

Time of N application \ Cultivars	Gemmeiza-9	Sakha-93	Giza-168
T_1	A 2405.4 a	A 2454.5 a	B 2182.2 b
T2	B 2177.8 b	A 2338.4 b	A 2361.3 a
T3	B 2173.8 b	AB 2202.3 c	A 2306.8 a

Table 3-b. Grain yield (kg/fad) as affected by the interaction of cultivars and seeding rate during the first season

Seeding rate \ Cultivars	Gemmeiza-9	Sakha-93	Giza-168
400 grain/m^2	A 2321.2 a	A 2336.3 a	A 2377.1 a
500 grain/m^2	C 2062.8 b	B 2281.2 a	A 2387.4 a
600 grain/m^2	A 2373.1 a	A 2377.7 a	B 2085.9 b

Table 3-c. Grain yield (kg/fad) as affected by the interaction of time of N application and seeding rate during the first season

Seeding rate \ Time of N application	T_1	T_2	T_3
400 grain/m^2	B 2100.0 b	A 2295.2 a	A 2292.7 a
500 grain/m^2	B 1924.7 c	B 1984.9 c	A 2273.1 a
600 grain/m^2	A 2383.3 a	B 2004.0 b	B 2040.1 b

Table 3-d. Grain yield (kg/fad) as affected by the interaction of cultivars and time of N application during the second season

Time of N application \ Cultivars	Gemmeiza-9	Sakha-93	Giza-168
T_1	**A** 3121.5 b	**B** 2977.2 c	**B** 2940.4 c
T_2	**B** 3067.1 b	**A** 3196.5 b	**B** 3041.9 b
T_3	**A** 3271.0 a	**A** 3324.9 a	**A** 3337.1 a

Table 3-e. Grain yield (kg/fad) as affected by the interaction of cultivars and seeding rate during the second season

Seeding rate \ Cultivars	Gemmeiza-9	Sakha-93	Giza-168
400 grain/m^2	**A** 3206.4 a	**A** 3133.1 b	**B** 3060.7 a
500 grain/m^2	**A** 3172.5 ab	**A** 3134.4 b	**A** 3104.4 a
600 grain/m^2	**B** 3080.7 b	**A** 3231.1 a	**AB** 3154.2 a

Table 3-f. Grain yield (kg/fad) as affected by the interaction of time of N application and seeding rate during the second season

Seeding rate \ Time of N application	T_1	T_2	T_3
400 grain/m^2	**C** 2956.9 b	**B** 3054.3 a	**A** 3389.0 a
500 grain/m^2	**C** 2913.3 b	**B** 3137.1 a	**A** 3361.0 a
600 grain/m^2	**A** 3168.9 a	**A** 3114.1 a	**A** 3182.9 b

Giza-168cv. and Sakha-93cv. appeared to produce higher grain yield/fad when late N-application (T_3) was applied.

Furthermore, the significant interaction effects between wheat cultivars and planting density (Tables 3-b and 3-e) showed varying responses whereas Sakha-93 gave highest grain yield/fad with dense planting in both seasons, while Giza-168cv. tended to produce higher grain yield/fad when either light or middle planting densities were used in the first season. In addition Gemmeiza-9cv. achieved higher grain yield/fad when light planting density was used in the second season.

Regarding the significant interaction effect between time of N-application and planting density (Tables 3-c and 3-f), the results indicate that highest grain yield/fad (2383.3 kg) in the first seasone was obtained by dense planting when early N-application (T_1) was applied. However, in the second season the highest grain yield/fad (3389.0 kg) was achieved by light planting density when late N-application up to 85 DAS was applied.

Straw Yield (kg/fad)

Data presented in Table 3 show varietal differences results indicate highly significant differences among wheat cultivars where Giza-168cv. almost outyielded other wheat cultivars. Also, varietal differences in straw yield of wheat were reported by Gafar (2007) and Ramadan and Awaad (2008). Otherwise, El-Shami *et al.* (1995) stated that wheat cultivers had no significant effect on straw yield.

Concerning the influence of time of N-application on straw yield, the results revealed highly significant differences where early N-application up to 45 DAS (T_1) appeared to produce the highest straw yield of wheat throughout the two seasons followed by middle N-application up to 75 DAS (T_2). Then the late N-application up to 85 DAS (T_3) gave the lowest straw yield of wheat/fad. These results almost followed number of spikes/m^2 and grain yield/fad (first season).

The results are in a good line with those reported by Gaballah (2005), and Madan and Munjal (2009). However, Sadek, Eman (1990) reported that time of N-application had no significant effect on straw yield of wheat.

Likely, planting density results showed highly significant differences where increasing

planting density from 400 to 500 or 600 grains/m^2 tended to be gradually decrease straw yield/fad throughout the two seasons.

It is quite interesting to note that decreasing planting density was followed by a significant decrease in plant competitions which in turn reflects on plant growth and development, then producing more straw yield/fad than dense planting. On the contrary, other investigators reported that dense or higher seeding rates tended to produce higher straw yield, from them El-Hag (2006), El-Afandy *et al.* (2007) and El-Ganayni and Gamalat (2008).

Regarding the combined results of both sowing dates during the two growing seasons, the statistical analysis indicated highly significant differences when the late sowing at 30th Nov. appeared to produce higher straw yield than the early one during the first season. However, the reverse direction was attained in the second season, whereas early sowing at 15th Nov. gave higher straw yield/fad than the late one. Such seasonal exchange effects were former observed with plant height, number of spikes/m^2, number of grains/spike and 1000-grain weight which might be due to the effect of environmental conditions especially soil fertility during both growing seasons.

These results are in a partial agreement with those reported by Salem (1999), Akdamar *et al.* (2002) and Rakesh Kumar and Sharma (2003).

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استجابة أصناف القمح لمواعيد إضافة السماد الأزوتى والكثافات النباتية وميعاد الزراعة

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أجريت أربع تجارب حقليـــة خـــلال موســـمي ٢٠٠٤/٢٠٠٥، ٢٠٠٥/٢٠٠٦ بأحـــد المزارع الخاصة بمنطقة القصاصين– محافظة الإسماعيلية وذلك لدراســـة تـــأثير مواعيـــد الزراعة (١٥، ٣٠ نوفمبر) وثلاثة مواعيد لإضافة السماد الأزوتى بمعدل ١٠٠كجـــم ن/ف (الإضافة حتى ٤٥، ٧٥، ٨٥ يوم من الزراعة) والكثافات النباتية المختلفـــة (٤٠٠، ٥٠٠، ٦٠٠ حبة/ م^{٢}) على نمو وإنتاجية بعض أصناف القمح (سخا ٩٣، جميزة ٩، جيزة ١٦٨).

ويمكن تلخيص أهم النتائج على النحو التالي:

لوحظت اختلافات صنفية فى كل الصفات المدروسة حيث حقق الصنف سخا ٩٣ أعلى وزن ١٠٠٠ حبة فى موسم الزراعة الأول فقط، أعلى عدد حبوب/ سنبلة وكـــذا محصـــول حبوب وقش/ فدان فى موسم الزراعة الثانى بينما حقق الصنف جميزة ٩ أعلى طول سنبلة وعدد ووزن حبوب/ سنبلة كما حقق أعلى وزن ١٠٠٠ حبة فى موسم الزراعة الثانى فقط فى حين حقق الصنف جيزة ١٦٨ أعلى عدد سنابل/ م^{٢} وكذا أعلى محصول قـــش/ ف فـــى الموسم الأول فقط بينما لم يكن هناك اختلافات معنوية بين الأصناف فى صفة طول النبات.

إضافة السماد الأزوتى حتى ٤٥ يوم من الزراعة أعطى تفوقـــاً فـــى طـــول النبـــات ومحصول القش بينما كان تفوقه فى عدد السنابل/ م^{٢}، محصول الحبوب/ ف فـــى الموســـم الأول فقط كما تفوق فى طول السنبلة وعدد ووزن حبوبها فى الموسم الثانى فقط.

أعطى التسميد الأزوتى حتى ٧٥ يوم من الزراعة تفوقا فى وزن ١٠٠٠ حبة فى نفس الوقت أعطى تفوقا فى عدد حبوب السنبلة للموسم الأول فقط.

التسميد الأزوتى حتى ٨٥ يوم من الزراعة أعطى أعلى عدد سنابل/ م^2 وأعلى محصول حبوب للفدان للموسم الثانى فقط بينما أعلى طول ووزن سنبلة تحقق فى الموسم الأول فقط.

الزراعة بمعدل ٤٠٠ حبة/ م^2 أعطت تفوقا فى صفات كل من طول النبات، وزن ١٠٠٠حبة، عدد حبوب/ سنبلة وذلك فى الموسم الثانى فقط بينما أعطت تفوقا فى محصول الحبوب/ ف فى الموسم الأول فقط كما أعطى هذا المعدل أعلى وزن لمحصول القش/ ف.

الزراعة بمعدل ٥٠٠ حبة/م^2 أعطى أطول النباتات للموسم الثانى فقط بينما حقق هذا المعدل أطول سنابل وأكبر عدد ووزن حبوب/ سنبلة فى الموسم الأول فقط.

الزراعة بمعدل ٦٠٠ حبة/ م^2 أعطت أكبر عدد سنابل/ م^2 للموسم الأول فقط كما أعطت أثقل وزن حبوب/ سنبلة للموسم الثانى فقط وبشكل عام أعطت أثقل وزن ١٠٠٠ حبة.

حققت الزراعة فى منتصف نوفمبر تفوقا فى كل من عدد السنابل/ م^2، وزن ١٠٠٠ حبة وعدد حبوب السنبلة، وزن القش/ ف للموسم الثانى فقط كما حققت الزراعة فى ذلك المعياد أعلى وزن حبوب/ سنبلة، أعلى محصول حبوب/ ف.

أما الزراعة فى أخر نوفمبر فقد حققت تفوقا فى صفات كل من طول النبات، عدد السنابل/ م^2، وزن ١٠٠٠حبة، عدد حبوب السنبلة، وزن القش/ ف وذلك فى الموسم الأول فقط بينما حققت أطول السنابل.

وبشكل عام حقق الصنف جميزة ٩ أعلى محصول عندما تم تسميده حتى ٤٥ يوم من الزراعة مع استعمال كثافة زراعة ٤٠٠حبة/ م^2 كذلك يمكن له أن يعطى أعلى محصول إذا تم تسميده حتى ٨٥ يوم من الزراعة.

أما الصنف سخا ٩٣ فقد أعطى أعلى محصول عندما تم تسميده حتى ٤٥ يوم من الزراعة مع الزراعة بمعدل ٤٠٠ حبة/ م^2 كما يمكن أن يعطى أعلى محصول عند التسميد حتى ٨٥ يوم من الزراعة مع الزراعة بمعدل ٦٠٠ حبة/ م^2 .

بينما الصنف جيزة ١٦٨ أعطى أعلى محصول عندما استمر تسميده حتى ٧٥ أو ٨٥ يوم من الزراعة مع الزراعة بمعدل ٥٠٠ حبة/ م^2.