

EFFECT OF DISTANCE FROM DRAIN LINE ON WHEAT CROP UNDER DIFFERENT RATES OF NITROGEN FERTILIZATION IN CLAY SOIL

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ABSTRACT

This study was carried out to evaluate the influence of distance from drain line on response of wheat (Giza 168 variety) to different levels of N-fertilizer. Two field experiments were conducted during 2003/2004 and 2004/2005 successive seasons. The experimental field provided with pipe drain network spaced at 20 m. with 1.2 m depth. N-fertilizer in the form of urea was added in three levels (50, 75 and 100 kg N/fed.) at L/4 and L/2 distance from drain line in two equal doses after the first and second irrigation, respectively.

Results showed that 1000 grain weight (gm), grain yield (ardab/fed.) and straw yield (Heml/fed.) significantly increased as the distance from drain line decreased from L/2 to L/4 in both studied seasons. These increases were equivalent to 1.37 and 1.16 (gm), 1.43 and 1.89 (ardab/fed.) and 1.69 and 1.3 (Heml/fed.) in the first and second season, respectively. Nitrogen uptake (%) by wheat at booting stage increased by decreasing distance from drain line from L/2 to L/4 and the increase was significant in the second season with high wheat yield.

Data also indicated that wheat grain and straw yield significantly increased with increasing applied nitrogen rate up to 100 kg N/fed. in both studied seasons. Weight of 1000 grain (gm) and nitrogen uptake % at booting stage responded to the increment of nitrogen applied rate with a significant increase at the highest nitrogen rate (100 kg N/fed.).

Results also showed that the interaction between distance from drain line and N-fertilization rate on wheat yield characteristics was positive. The highest values of wheat yield characteristics and N-uptake (%) were obtained at L/4 distance from drain line and 100 kg N/fed. applied rate. In the first season, the effect of interaction on increasing wheat characteristics was significant at a rate of 100 kg N/fed., where it significantly increased 1000 grain weight (gm) and wheat grain yield (ardab/fed.) in the second season at the same nitrogen applied rate.

The obtained results revealed also that 20 m spacing in clay soils is not the proper but may be economic. In addition, distance from drain line must be taken into consideration when distributing fertilizer treatments and their replicates in fertilization experiments to obtain reliable results.

Keywords: Nitrogen rates, drain line distance, clay soil.

INTRODUCTION

Many factors are limiting crop production such as drainage and nitrogen fertilization. Tile drainage has been increased soil productivity by facing the twin problems of water logging and soil salinity and subsequently offer the suitable environments for plant growth and also for human being (Osterbaan, 1994 and Abd El-Khalek, 2000). Ramadan *et al.* (1994) indicated that, the 10 m drain spacing had the lower values of bulk density and penetrability and the higher ones of porosity and infiltration rate than the 20 m and 40 m, respectively.

The tile drainage also causes very important changes in nutrients movement which make these nutrients more available for plant growth (Balasubramanian and Chair, 1983 and Belayneh, 1986). On the other hand, nitrogen is the most important nutrients required for all plants to obtain improving yield and its quality (Rees *et al.*, 1996). Several researchers have studied the effect of nitrogen fertilizer at the different rates on growth and yield of wheat (Zebarth and Sheard, 1992; Ashok *et al.*, 1995; Rees *et al.*, 1996; Kara and Agdag, 1996 and Abd El-Monem, 1996). The previous studies for nitrogen fertilizer, reported that grain, straw yields and 1000 grains weight were significantly increased with increasing nitrogen application rate.

The effect of nitrogen fertilization on nitrogen uptake by wheat was studied by several workers (Faizy *et al.*, 1986; Rees *et al.*, 1996 and Sharma and Komal, 1998). Nitrogen uptake is a parameter expresses the value resulted from increasing both dry matter production and nitrogen concentration in any plant part. Increasing nitrogen application rates significantly increased N-concentration and uptake in grain and straw at harvest stage. Also, it significantly increased the N-concentration and its uptake in whole plant of wheat at booting stage in the two seasons (El-Naggar, 1999).

In fertilization experiments, researches usually distribute the fertilizer treatments randomly in soil despite of its position between tile drains. The objectives of the present work were to study the effect of distance from drain line on N-uptake and yield of wheat (Giza 168 variety) under different rates of applied N-fertilizer.

MATERIALS AND METHODS

Two field experiments were carried out at Sakha Agricultural Research Station, Kafr El-Sheikh Governorate, at north Delta. The field is provided with tile drains network spaced at 20 m with 1.2 m depth. Wheat (Giza 168 variety) was planted in 2003/2004 and 2004/2005 seasons. All plots received total of 100 kg Ca-superphosphate/fed. during tillage operations. Nitrogen fertilizer was used in the form of urea (46.5%) and broadcasted at a rate of 50, 75 and 100 kg N/fed. (equivalent to 66.67, 100.00 and 133.33% of the recommended rate) in two equal doses before the first and second irrigation. The aforementioned applied N-rates were disturbed at L/4 and L/2 distance of drain lines in both seasons. The different agricultural practices were done as recommended through the two growing seasons. Prior to tillage operation, the soil samples were collected in 30 cm increments to 120 cm depth for chemical and physical analysis according to Klute (1986) and Page (1982). The soil properties are shown in Table (1).

To monitor water table fluctuations, observation wells were installed midway between drains at 1/2 and 1/4 distances from tile drain as recommended by Dieleman and Trafford (1976). Whole wheat plant samples at booting stage (after addition of the two nitrogen doses) were taken, dried at 70°C, grounded with a mill and its total nitrogen content was determined using Kjeldahl digestion (Cottenie *et al.*, 1982).

The experimental design was a randomized complete block with three replicates, two distances from drain line and three nitrogen fertilization rates.

Table (1): Physical and chemical properties of the soil samples before wheat planting (2003/2004 and 2004/2005 seasons).

Soil depth (cm.)	Particle size distribution			Texture class	EC (dS/m)	OM %	CaCO ₃ %	Available N, P, K (mg/kg soil)		
	Sand %	Silt %	Clay %					N	P	K
Season 2003/2004										
0-30	21.42	29.42	49.16	Clayey	1.40	0.92	3.22	46.16	5.50	273.0
30-60	20.55	27.41	52.04	Clayey	1.10	0.84	3.61	38.08	5.00	224.3
60-90	21.12	27.14	51.74	Clayey	1.40	0.61	2.71	44.80	3.50	199.0
90-120	15.95	29.48	54.62	Clayey	1.98	0.38	1.81	34.88	3.50	146.3
Season 2004/2005										
0-30	27.40	22.34	49.66	Clayey	1.58	1.52	3.81	52.64	6.50	282.8
30-60	29.27	24.76	45.97	Clayey	0.98	1.10	3.68	44.80	4.50	253.5
60-90	30.10	28.25	41.65	Clayey	1.37	0.80	2.69	48.16	4.30	195.0
90-120	30.92	29.06	40.02	Clayey	2.32	0.65	2.06	36.15	3.90	165.3

RESULTS AND DISCUSSION

1. Rate of water table draw-down:

As shown in Fig. (1), the calculated rate of draw-down in both studied seasons was decreased with increasing time after irrigation. The highest values of draw-down were found after one day from irrigation. While the lowest values were found before the next irrigation. The rate of water table draw-down near the drains (L/4) was higher than that in midway between drains (L/2). This may be due to the improved drainage near the drains than midway between it which, in return, gave the top soil chance to dry and permitted for shrinkage and formation of water passage ways and allowed a rather easier movement of water into drain pipes. Similar results were obtained by Antar (2005).

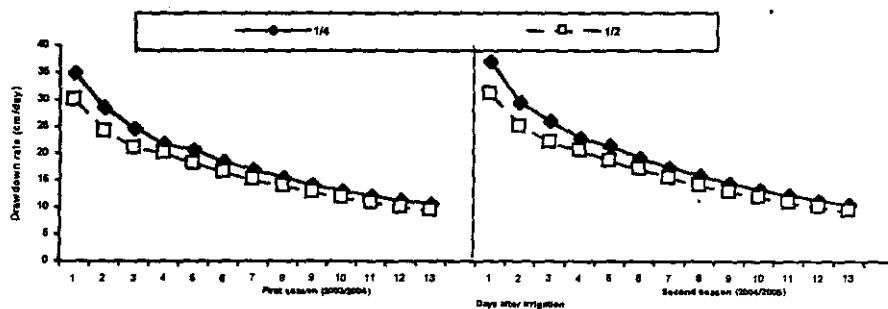


Fig. (1): Average water draw-down rate at 1/4 and 1/2 distance from tile drain under wheat crop in 2003/2004 and 2004/2005 seasons.

2. Effect of distance from drain line on wheat yield characteristics:

Data in Table (2) showed that there was a significant increase in the weight of 1000 grains with decreasing the distances form drain line. The mean values in the first season were 38.81 and 40.18 (gm), while in the second one they were 39.56 and 40.72 (gm) for the distances at L/2 and L/4

spacing between tile drains, respectively. The increment in 1000 grains weight with decreasing the distances from drain line may be discussed on the base that drainage near the drain line at 1/4 distance from the drain line is better than that at midway between drain (L/2), causing improving water-air balance in the root zone, increasing soil micro-organisms activity, developing better structure and increasing the availability of nutrients for plant roots. These results are in agreement with those obtained by El-Gohary *et al.* (1989).

Table (2): Effect of spacings from drain line on yield components and N-uptake at booting stage of wheat crop.

Treatment	Grains/yield (ardab/fed.)	Straw yield (Heml/fed.)	1000 grain weight (g)	N-uptake %
Season 2003/2004				
⁽¹⁾ L/2	17.29	17.35	38.81	0.758
⁽²⁾ L/4	18.72	19.04	40.18	0.775
F-test 0.05	**	**	**	N.S
L.S.D. 0.05	0.797	0.978	0.827	-
Season 2004/2005				
⁽¹⁾ L/2	19.83	20.53	39.56	0.829
⁽²⁾ L/4	21.72	21.88	40.72	0.852
F-test 0.05	**	**	**	*
L.S.D. 0.05	1.345	1.071	0.825	0.022

(1) L/2 = 1/2 distance from tile drain

(2) L/4 = 1/4 distance from tile drain

Results in Table (2) showed also that there was a significant increase in wheat grain yield with the decrease in the distance from drain line. The values near the drain line (L/4) were higher by about 1.43 and 1.89 ardab/fed. than that far from it (L/2), for the first and second season, respectively. Similar results were found by Antar (2005). He attributed that to the favourable soil physical and chemical conditions such as water-air relationships in the root zone, root penetration which leads to more water intake and nutrients absorption. Data also revealed that wheat straw yield (Heml/fed.) behaved the same trend of wheat grain yield with distance from drain line. The values near the drain (L/4) were higher than that far from it (L/2) by about 1.69 and 1.35 Heml/fed., for the first and second season, respectively. This is due to the effect of drainage on conditioning water-air relationship in the root zone and its effect on mobility of nutrients to the plant roots which cause more vegetative growth and subsequently produce a higher straw yield. These results are in accordance with Ibrahim *et al.* (2003) and Antar (2005). Results also showed that, N-uptake by wheat plants at booting stage increased as the distance from drain line decreased in both studied seasons. These increases were significant in the second season with high yield, Table (2). The increment in N-uptake near tile drain than far from it may be ascribed to increasing wheat root biomass as a result of favorable soil physical properties such as soil structure, aeration due to the relatively higher rate of water table drawdown (Fig. 1), near tiles than that far from it.

3.Effect of N applied rate on wheat yield characteristics:

Results in Table (3) showed that 1000 grain weight (gm) significantly increased as the nitrogen applied rates increased in the two studied seasons up to 100 kg N/fed. The mean values of 1000 grain weight, for the two

seasons, were 38.36 and 41.57 gm for 50 and 100 kg N/fed., respectively. The increment in 1000 grains weight as a result of increasing N-fertilization rate may be due to the role of nitrogen in increasing the amount of metabolites liable to transport to the grains, El-Yamany (1994), Mostafa *et al.* (1997) and Abd El-Khalek (2000).

Table (3): Effect of N-rates on yield, yield components and N-uptake % at booting stage of wheat crop.

N-rate (kg N/fed)	Grain yield, (ardab/fed.)	Straw yield, (Heml/fed.)	1000 grain weight (gm)	N-uptake %
Season 2003/2004				
50	16.27 c	16.66 c	37.94 b	0.709 b
75	17.39 b	18.89 b	39.12 b	0.733 b
100	20.35 a	20.03 a	41.13 a	0.859 a
Season 2004/2005				
50	18.67 c	18.78 c	38.775 b	0.792 b
75	20.67 b	21.03 b	39.638 b	0.859 a
100	22.99 a	23.83 a	42.010 a	0.870 a

Data in Table (3) revealed also that wheat grain yield (ardab/fed.) significantly increased as the nitrogen applied rate increased up to 100 kg N/fed. The mean values of wheat grain yield varied from 16.27 to 20.35 and from 18.67 to 22.99 ardab/fed. in the first and second season, respectively. N-fertilization rates of 75 and 100 kg N/fed. were higher than 50 kg N/fed. in the first seasons by about 1.12 and 4.08 ardab/fed., while they were 2.0 and 4.32 ardab/fed. in the second season, respectively. The increment in grain yield due to nitrogen fertilizer may be explained by the increase in most correlated yield components, which increase the final yield. Results also showed a significant increase in straw yield as a result of increase nitrogen application rate up to 100 kg N/fed. The increment in straw yield/fed. may be attributed to the beneficial effect of added available nitrogen on wheat vegetative growth through the increase in total nitrogen uptake. These results are in harmony with those obtained by Ibrahim (1998) Abd El-Khalek (2000).

As to N-uptake, data showed that wheat plants (Giza 168 variety) at booting stage responded to the increase in nitrogen applied rates up to 100 kg N/fed. in both seasons. The increases in N-uptake with increasing the added N-fertilizer were significant at 100 kg N/fed. in the first season and 75, 100 kg N/fed. in the second season. Sarhan and Abd El-Salam (1999), El-Naggar (1999) and Abd El-Khalek (2000) noticed that nitrogen fertilization increased the capability of wheat plants to absorb more nutrients. This might be attributed firstly to the increases in the root surface and enrichment of soil solution with nitrogen which reflects its influence on N-concentration in plant tissues. This raising in N % in plant tissues may be contributed in building up metabolites and subsequently increasing dry matter production up to full growth stage and then increases nutrients uptake by wheat plant.

4. Interactions between N-applied rates and distances from drain line:

Data in Table (4) showed that, weight of 1000 grains, grain yield, straw yield and N-uptake % by wheat plants at booting stage increased with increasing N-fertilization rates up to 100 kg N/fed. and decreasing the distance from drain line.

Table (4): Interaction between N rate and distance from drain line on wheat yield characteristics.

N-rate (kg N/fed.)	1000-grain weight (g)				Grains yield (ardab/fed.)				Straw yield (Heml/fed.)				N-uptake %			
	L/2	L/4	F-test	L.S.D.	L/2	L/4	F-test	L.S.D.	L/2	L/4	F-test	L.S.D.	L/2	L/4	F-test	L.S.D.
			0.05	0.05			0.05	0.05			0.05	0.05			0.05	0.05
Season (2003/2004)																
50	37.23 b	38.65 b	N.S	-	15.86 b	16.69 b	N.S	-	16.21 b	17.12 b	N.S	-	0.707 b	0.710 b	N.S	-
75	38.53 b	39.7 b	N.S	-	17.08 b	17.71 b	N.S	-	17.23 ab	18.56 b	N.S	-	0.730 b	0.735 b	N.S	-
100	40.68 a	42.18 a	*	1.43	18.93 a	21.76 a	**	1.38	18.62 a	21.45 a	**	1.694	0.837 a	0.880 a	*	0.041
Season (2004/2005)																
50	38.13 b	39.43 b	N.S	-	18.07 b	19.27 b	N.S	-	18.05 c	19.51 c	N.S	-	0.775 b	0.808 b	N.S	-
75	39.28 b	40.0 b	N.S	-	20.00 ab	21.33 b	N.S	-	20.32 b	21.74 b	N.S	-	0.853 a	0.865 a	N.S	-
100	41.28 a	42.73 a	*	1.43	21.42 a	24.56 a	**	2.33	23.22 a	24.43 a	N.S	-	0.858 a	0.883 a	N.S	-

The increases of 1000 grain (gm) and grain yield (ardab/fed.) were significant at 100 kg N/fed. applied rate and decreasing distance from drain line from L/2 to L/4 in both studied seasons. Data also cleared that wheat straw yield (Hemi/fed.) and N-uptake % significantly increased at 100 kg N/fed. and L/4 distance from drain line in 2003/2004 season, while the increases of such values in 2004/2005 season were insignificant.

Finally, the obtained data in this study revealed that 20 m spacing from tile drains in the area investigated is not the optimum, but may be economic. On the other hand, to obtain reliable results in fertilization experiments, the space from drain line must be taken into consideration when distributing fertilizer treatments and its replicates in the fields provided with tile drain networks.

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تأثير المسافة من المصرف على محصول القمح تحت مستويات مختلفة من التسميد الأزوتي في الأراضي الطينية
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في دراسة لتقييم تأثير المسافة من المصرف على إستجابة القمح (صنف جيزه ١٦٨) لمستويات مختلفة من السماد الأزوتي في الأراضي الطينية ، أجريت تجربتين بالحقل خلال موسمي ٢٠٠٣/٢٠٠٤م ، ٢٠٠٤/٢٠٠٥م وذلك في حقل تجريبي به مصرف مغطى على أبعاد ٢٠م وعلى عمق ١,٢٠م من سطح التربة بالمزرعة البحثية بمحطة البحوث الزراعية بسخا. وقد أضيف السماد الأزوتي في صورة يوريا في ثلاث مستويات هي: ٥٠ ، ٧٥ ، ١٠٠ كجم/ن/فدان على مسافة ربع ، نصف المسافة بين المصرفين في دفعتين متساويتين بعد الري الأولى والثانية على التوالي.
وقد أظهرت نتائج الدراسة ما يلي:

- زاد وزن الهـ ١٠٠٠ حبة من القمح (جم) ومحصول الحبوب (أردب/فدان) ومحصول التبن (حمل/فدان) زيادة معنوية بنقص المسافة من المصرف من نصف إلى ربع المسافة بين المصرفين وتقدر هذه الزيادة بمقدار ١,٣٧ ، ١,١٦ (جم) ، ١,٤٣ ، ١,٨٩ (أردب/فدان) ، ١,٦٩ ، ١,٣٥ (حمل/فدان) في الموسمين الأول والثاني على التوالي ، في حين زاد امتصاص القمح للنيتروجين في مرحلة طرد السنابل بنقص المسافة من المصرف من نصف إلى ربع المسافة بين المصرفين وكانت هذه الزيادة معنوية في الموسم الثاني (٢٠٠٤/٢٠٠٥) ذو المحصول المرتفع من القمح.
- إستجاب محصول القمح من الحبوب والقش ووزن الهـ ١٠٠٠ حبة لزيادة معدلات التسميد حيث زادت زيادة معنوية بزيادة التسميد الأزوتي ، في حين زاد امتصاص النبات للنيتروجين بزيادة معدل السماد الأزوتي المضاف وكانت هذه الزيادة معنوية عند المستوى المرتفع من التسميد (١٠٠ كجم/ن/فدان).
- أظهرت نتائج الدراسة أيضا أن تأثير التفاعل بين المسافة من المصرف ومستوى التسميد الأزوتي على خصائص محصول القمح كان إيجابيا وكانت أعلى قيم لخصائص المحصول وزن ١٠٠٠ حبة (جم) ، محصول الحبوب (أردب/فدان) محصول القمح (حمل/فدان) عند ربع المسافة بين المصرفين ومستوى السماد الأزوتي المرتفع (١٠٠ كجم/ن/فدان) حيث كانت الزيادة في هذه الخصائص معنوية في الموسم الأول بينما كانت الزيادة في وزن الهـ ١٠٠٠ حبة قمح ومحصول الحبوب معنوية عند هذا المستوى في الموسم الثاني.
- تبين من النتائج المتحصل عليها أن مسافة ٢٠م بين المصارف في الأراضي الطينية ليست مناسبة ولكنها قد تكون اقتصادية ، كما أوضحت النتائج أيضا ضرورة أخذ المسافة من المصرف في الاعتبار عند توزيع معاملات ومكررات التسميد الأزوتي في تجارب التسميد للحصول منها على نتائج مرضية أو موثوق بها.