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PRODUCTIVITY OF WHEAT AS AFFECTED BY IRRIGATION SYSTEMS, NITROGEN LEVELS AND FOLIAR APPLICATION UNDER NEWLY RECLAIMED SANDY SOILS

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ABSTRACT

Two field experiments were conducted at the Experimental Station Farm in Kalabsho and Zayian Region, Faculty of Agriculture, Mansoura University during the two successive winter seasons of 2004/2005 and 2006/2007 to determine the effect of two irrigation systems (flooding and sprinkling), four nitrogen levels (60, 80, 100 and 120 kg N/fed) and foliar application with some commercial compounds (Nervatin-vet and Maxifert) as well as their interactions on growth, yield and its components and quality of wheat (*Triticum aestivum*, L.) Sakha 93 cultivar.

The main results of this study can be summarized as follows:

- Irrigation of wheat plants through sprinkling method significantly increased all studied characters as compared with flooding irrigation in both seasons.
- Concerning the effect of nitrogen fertilizer levels the all studied characters were remarkably increased as a result of increasing nitrogen levels from 60 up to 120 kg N/fed in both seasons.
- Application of foliar compound containing macro and micro elements (Nervatin-vet) resulted in a significant increased in grain yield and straw yields and its components as compared with the compound containing microelements alone (Maxifert) and control treatment in both seasons. Maxifert exceeded control treatment in all studied characters.

It can be concluded that in order to maximizing wheat crop productivity it must be irrigated through sprinkling irrigation system and mineral fertilized with 120 kg N/fad as well as foliar fertilized with some commercial nutrient compounds that contain macro and micro elements such as Nervatin-vet under the environmental conditions of Kalabsho and Zayian district as a newly reclaimed sandy soils.

INTRODUCTION

Wheat (*Triticum aestivum* L.) is one of the most important cereal crops in Egypt and all over the world. Wheat production is not sufficient for local consumption in Egypt. Therefore, great efforts have been made to achieve suitable agronomic practices for obtaining maximum productivity with optimum quality properties.

Recent studies indicated that by year 2025 one – third of the population in the developing countries will be exposed to absolute water scarcity, in the sense that they will not have sufficient water resources to meet their agricultural demands, industrial and environmental needs. One of the ways of alleviating water scarcity, especially in the newly reclaimed areas, is by using benefit irrigation system such as sprinkling irrigation, where water is a limiting factor for producing wheat strategically. In addition, growing wheat in newly reclaimed sandy soil needs different cultural practices than from those used in old lands, especially irrigation system. In this respect,

Ghani *et al.* (2001) showed that sprinkling irrigation method performed better than surface irrigation method in terms of water conservation, growth, yield components and grain yield of wheat. Using sprinkling irrigation method, 68 % of water was conserved and 17 % increase in grain yield was obtained. Water use efficiency for sprinkling irrigation method and surface irrigation were 1.77 and 0.895 kg grain/m^3 water, respectively. More financial benefits could be obtained from sprinkling irrigation system than surface irrigation system in terms of water conservation and increase in yield. However, the capital and operating costs are higher in sprinkling irrigation method than in surface irrigation method. Hayam, Mahgoub and Sayed (2001) reported that under solid set rotary sprinkling irrigation system increasing irrigation amounts from 748-760 m^3 (I_1) to 2355-2400 m^3 (I_3) resulted in corresponding significant increases in all studied characters. Shekhawat *et al.* (2005) reported that productivity of wheat was increased under sprinkling irrigation method as compared with surface flooding.

Nitrogen fertilizer plays an important role for increasing wheat grain yield, especially in the newly reclaimed sandy soils, which is very poor in content of available nitrogen. The increase in grain yield as a result of increasing mineral nitrogen fertilizer levels may be due to the increase in the metabolic process in wheat plants and this, in turn, stimulates their growth which may account for the superiority of yield components and grain yield of wheat. There are many investigators concluded that increasing nitrogen fertilizer levels associated with significant increases in growth, yield and its components (Sayed *et al.*, 2003 ; Tammam and Tawfils, 2004 ; Allam, 2005 ; Seadh and Badawi, 2006 ; Ibrahim, 2007 and Mekhemar, 2008).

Foliar fertilization with macro and micronutrients is considered as one of the most important factors which affect 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 fed. Hussein (2005) stated that the highest values of grain and straw yields/fed (10.72 ardab/fed and 3.038 ton/fed) and yield components were favoured when wheat plants were foliar sprayed with potassium and Nervatin-vit.

Therefore, this investigation was established to determine the effect of irrigation system, nitrogen fertilizer levels and foliar application with some commercial compounds, as well as, their interactions on growth, yield and its components, as well as, quality of wheat Sakha 93 cultivar under the environmental conditions of Kalabsho and Zayian district as a newly reclaimed sandy soils.

MATERIALS AND METHODS

Two field experiments were conducted at the Experimental Station Farm in Kalabsho and Zayian Region, Faculty of Agriculture, Mansoura University during the two successive winter seasons of 2004/2005and 2006/2007 to determine the effect of irrigation systems, nitrogen fertilizer levels and foliar application with some commercial compounds as well as their interactions on growth, yield and its components, as well as, quality of wheat Sakha 93 cultivar.

Each irrigation system (surface flooding or sprinkling irrigation) was practiced in separate experiment. Every experiment was carried out in a split – plot design with four replications. After planting, plants were irrigated regularly every 7 – 10 days in surface flooding irrigation method. Whereas, in sprinkling irrigation method, plants were irrigated by operating sprinkling irrigation system constantly six hours every three days.

The main plots were occupied with four nitrogen fertilizer levels (60, 80, 100 and 120 kg N/fed). The nitrogen fertilizer in the form of ammonium nitrate (33.0 % N) was applied in five equal doses prior every irrigation and finished before heading.

The sub plots were assigned to foliar application treatments with commercial foliar fertilizers as follows:

1- Spraying with water (control treatment).
2- Spraying with Nervatin-vet at the rate of 2 cm^3/ 1 liter water.
3- Spraying with Maxifert at the rate of 3.33 g/ 1 liter water.

Foliar fertilization treatments were carried out twice at the aforementioned rates after 30 and 50 days from sowing. The chemical composition of commercial foliar fertilizers used in this investigation is presented in Table 1.

The sub – plot are was 10.5 m^2 (3 X 3.5 m). The soil in the summer season was uncultivated in both seasons.

The experiments were carried out in a sandy soil with little fertility, which their physical and chemical properties are shown in Table 2.

Table 1: Chemical composition of the commercial foliar fertilizers.

Chemical composition	Commercial foliar fertilizers	
	Nervatin-vet	Maxifert
N	7 %	-
P_2O_5	7 %	-
K_2O	7 %	-
Mg	0.60 %	-
Fe	1.10 %	12 %
Mn	0.50 %	6 %
Zn	0.50 %	6 %
Cu	0.02 %	-
B	0.05%	0.06 %
Mo	0.02 %	0.03 %

The experimental field was well prepared through two ploughings, compacted, and then divided into the experimental units with dimensions as previously mentioned. Calcium super phosphate (15.5 % P_2O_5) was applied during soil preparation (after ploughing and before division) at the rate of 150 kg / fed . Potassium sulphate (48 % K_2O) at the rate of 50 kg/fed was broadcasted in one dose before the first irrigation. The cultivation took place on November 19th and 24th in the first and second seasons, respectively. Wheat grains at the rate of 90 kg/fed were sown by using broadcasting Afir method. The common agricultural practices for growing wheat in sandy soils according to the recommendations of Ministry of Agriculture were followed, except the factors under study.

Table 2: Mechanical and chemical soil characteristics at the experimental sites during 2004/2005 and 2006/2007.

Soil analysis	2004/2005	2006/2007
A: Mechanical analysis		
Sand (%)	89.60	90.12
Silt (%)	8.10	7.60
Clay (%)	2.30	2.28
$CaCo_3$ (%)	0.43	0.41
Soil texture class	Sandy	Sandy
B: Chemical analysis		
pH	8.49	8.43
E.C. (mho/cm at 25 °C)	9.11	8.62
Organic matter (%)	0.65	0.42
Available N (ppm)	4.11	3.65
Available P (ppm)	5.35	3.75
Available K (ppm)	250.41	208.63

Studied Characters:

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

1- Plant height (cm).
2- Number of spikes/m^2.
3- Spike length (cm).
4- Number of spikelets/spike.
5- Number of grains/spike.
6- Grains weight/spike (g).
7- 100 – grain weight (g).
8- Grain yield (ardab/fed): calculated by harvesting plants in one square meter taken from each plot and were left to dry, then they were threshed and the grains at 13 % moisture were weighted in kg. Consequently, the weight was converted to ardab per feddan (one ardab = 150 kg).
9- Straw yield (t/fed): the straw yield resulted from the previous sample was weighted in kg/plot, then it was converted to tons per feddan.
10- Crude protein percentage: was estimated by the improved Kjeldahl – method according to A.O.A.C. method (1985), modified by distilling the ammonia into saturated boric solution and titration in standard acid. Crude protein percentage was calculated by multiplying the total nitrogen values in wheat flour by 5.75.

All obtained data were statistically analyzed according to the technique of analysis of variance (ANOVA) for the split – plot design to each experiment (irrigation system), then combined analysis was done between irrigation systems by means of "MSTAT-C " computer software package as published by Gomez and Gomez (1984). Least Significant Difference (LSD) method was used to test the differences between treatment means at 5 % level of probability asdescribed by Waller and Duncan (1969).

RESULTS AND DISCUSSION

I- Effect of irrigation systems:

Data in Tables 3, 4 and 5 show that sprinkling irrigation resulted in significant increases in plant height (cm), number of spikes/m^2, spike length (cm), number of spikelets/spike, number of grains/spike, grains weight/spike (g), 100 – grain weight (g), grain yield (ardab/fed) and straw yield (t/fed) as well as crude protein percentage compared with flodding irrigation in the two growing seasons. These results may attributed to the favourable available soil moisture in root zone by sprinkling irrigation, thereby enhancing vegetative growth attributes and resulting in highest yields and quality. Similar results were recorded by Ghani *et al.* (2001).

II- Effect of nitrogen fertilizer levels:

Data presented in Tables 3, 4 and 5 revealed that the effect of nitrogen fertilizer levels on grain yield and its components as well as quality characters under study was significant in the two seasons. It can be stated that all studied characters of wheat plants gradually increased as a result of increasing nitrogen fertilizer levels from 60 up to 120 kg N/fed. Maximum values of all studied characters were produced from wheat plants received 120 kg N/fed, while the lowest values were obtained from those received 60 kg N/fed in both seasons. The desirable effect of higher nitrogen fertilizer level can be easily ascribed to the nitrogen which consider as one of the major elements for plant nutrition and it increases the vegetative cover for plant and forms strong plants with long spikes. Moreover, nitrogen encourages plant to uptake other elements activating, thereby growth of plants, consequently enhancing most growth measurements and yield components. These results agree with those reported by Tammam and Tawfils (2004), Seadh and Badawi (2006), Ibrahim (2007) and Mekhemar (2008).

III- Effect of Foliar spraying:

Relevant data presented in Tables 3, 4 and 5 revealed that, the effect of foliar fertilization treatments on wheat grain yield and its components as well as quality characters was significant in both seasons of this investigation. There were substantial differences in all studied characters among all foliar fertilization treatments (spraying with water and two commercial foliar fertilizers *i.e.* Nervatin-vet and Maxifert) in both seasons. Since, spraying wheat plants with Nervatin-vet foliar fertilizer produced the highest values of these characters in both seasons.

Table 3: Plant height, number of spikes/m^2, spike length, number of spikelets/spike as affected by irrigation systems, nitrogen fertilizer levels and foliar fertilization treatments of wheat during 2004/2005 and 2006/2007 seasons.

Characters / Treatments	Plant height (cm)		Number of spikes/m^2		Spike length (cm)		Number of spikelets /spike	
	2004/ 2005	2006/ 2007	2004/ 2005	2006/ 2007	2004/ 2005	2006/ 2007	2004/ 2005	2006/ 2007
A- Irrigation system:								
Flooding	99.2	94.87	262.2	252.8	8.79	8.62	14.29	13.72
Sprinkling	111.2	107.45	307.6	296.5	10.09	9.86	16.00	15.43
F. test	*	*	*	*	*	*	*	*
B- Nitrogen levels (kg N/fed):								
60	83.7	77.5	184.1	175.0	8.31	8.12	12.70	12.16
80	100.5	97.3	256.8	245.6	9.05	8.86	14.33	13.79
100	113.8	110.4	337.1	327.5	9.82	9.61	16.33	15.79
120	122.8	119.3	361.6	350.5	10.58	10.37	17.20	16.58
F. test	*	*	*	*	*	*	*	*
LSD 5 %	1.7	5.1	5.5	5.7	0.24	0.25	0.42	0.45
C- Foliar spraying:								
Tap Water (Control)	97.6	94.2	248.5	238.3	8.82	8.63	13.65	13.15
Nervatin-vet	112.0	106.1	313.1	302.6	9.94	9.73	16.50	16.00
Maxifert	106.0	103.0	293.2	283.0	9.56	9.36	15.28	14.59
F. test	*	*	*	*	*	*	*	*
LSD 5 %	0.8	3.6	3.9	4.0	0.07	0.07	0.20	0.26

Table 4: Number of grains/spike, grains weight/spike, 100 – grain weight as affected by irrigation systems, nitrogen fertilizer levels and foliar fertilization treatments of wheat during 2004/2005 and 2006/2007 seasons.

Characters / Treatments	Number of grains/spike		Grains weight/spike (g)		100 – grain weight (g)	
	2004/ 2005	2006/ 2007	2004/ 2005	2006/ 2007	2004/ 2005	2006/ 2007
A- Irrigation system:						
Flooding	42.0	40.6	2.46	2.41	4.19	4.13
Sprinkling	45.9	44.0	2.67	2.62	5.07	5.02
F. test	*	*	*	*	*	*
B- Nitrogen levels (kg N/fed):						
60	38.4	36.9	2.04	2.00	3.82	3.76
80	42.3	40.6	2.52	2.48	4.34	4.28
100	46.4	44.7	2.76	2.71	5.09	5.04
120	48.8	47.0	2.92	2.87	5.27	5.22
F. test	*	*	*	*	*	*
LSD 5 %	1.0	1.2	0.06	0.07	0.06	0.06
C- Foliar spraying:						
Tap Water (Control)	41.2	39.5	2.36	2.31	4.31	4.25
Nervatin-vet	46.2	44.5	2.72	2.67	4.86	4.80
Maxifert	44.5	43.0	2.60	2.56	4.72	4.67
F. test	*	*	*	*	*	*
LSD 5 %	0.3	0.5	0.03	0.03	0.04	0.04

Table 5: Grain and straw yields/fed as well as crude protein percentage as affected by irrigation systems, nitrogen fertilizer levels and foliar fertilization treatments of wheat during 2004/2005 and 2006/2007 seasons.

Characters / Treatments	Grain yield (ardab/fed)		Straw yield (t/fed)		Crude protein percentage (%)	
	2004/ 2005	2006/ 2007	2004/ 2005	2006/ 2007	2004/ 2005	2006/ 2007
A- Irrigation system:						
Flooding	12.41	12.37	1.489	1.468	10.04	10.01
Sprinkling	13.15	13.11	1.658	1.627	10.70	10.65
F. test	**	*	*	*	*	*
B- Nitrogen levels (kg N/fed):						
60	8.85	8.81	1.283	1.263	8.99	8.96
80	12.09	12.05	1.510	1.485	10.17	10.13
100	14.91	14.86	1.649	1.620	11.07	11.03
120	15.28	15.24	1.854	1.823	11.24	11.21
F. test	*	*	*	*	*	*
LSD 5 %	0.21	0.21	0.040	0.039	0.32	0.32
C- Foliar spraying:						
Tap Water (Control)	12.11	12.08	1.395	1.371	9.89	9.85
Nervatin-vet	13.31	13.27	1.730	1.702	10.74	10.70
Maxifert	12.91	12.87	1.596	1.570	10.48	10.44
F. test	*	*	*	*	*	*
LSD 5 %	0.10	0.10	0.021	0.021	0.08	0.08

On the other wise, control treatment (spraying with tap water) gave the lowest values of these characters in the two seasons. However, plants sprayed with the Maxifert foliar fertilizer came in the second rank after those sprayed with Nervatin-vet. Such these effects of foliar nutrition might have been due to the improvement in early growth, more dry matter accumulation and stimulated the building of metabolic products accompanying with foliar nutrition, which contains macro and microelements. Similar results were reported by several researchers such as El-Hawary (1999), El-Kalla *et al.* (2002) and Hussein (2005).

IV- Effect of interactions:

The triple interaction effect among studied factors was significant on grain yield (ardab/fed) in both seasons. Data presented in Table 6 show that the highest values of grain yield were produced from wheat plants irrigated by sprinkling system + 120 kg N/fed with foliar fertilized Nervatin-vet. Corresponding data were 16.37 and 16.33 ardab/fed in the first and second seasons, respectively. On the other hand, the lowest values of grain yield (7.83 and 7.78 ardab/fed) were resulted from the control treatment of these factors in the first and second seasons, respectively.

The interaction between nitrogen fertilizer levels X foliar fertilization treatments had a significant effect on straw yield (t/fed) in both seasons of this study. Relevant data in Table 7 show that the highest values of straw yield (2.00 and 1.96 t/fed) were produced due to mineral fertilization of wheat plants by 120 kg N/fed in addition to Nervatin-vet as a foliar fertilizer in the

first and second seasons, respectively. On the contrary, the lowest values of straw yield (1.09 and 1.07 t/fed) were obtained due to the control treatment of both factors in the first and second seasons, respectively.

It can be concluded that irrigating of wheat plants through sprinkling irrigation system and mineral fertilization with 120 kg N/fad as well as foliar spraying with some commercial nutrient compounds that contain macro and micro elements such as Nervatin-vet were the favourable treatments to maximizing wheat productivity under the environmental conditions of Kalabsho and Zayian district as a newly reclaimed sandy soils.

Table 6: Grain yield/fed as affected by the interaction among irrigation systems, nitrogen fertilizer levels and foliar fertilization treatments during 2004/2005 and 2006/2007 seasons.

Irrigation	Kg N/fed	2004/2005 season			2006/2007 season		
		Control	Nervatin-vet	Maxifert	Control	Nervatin-vet	Maxifert
Flooding	60	7.83	8.93	8.46	7.78	8.88	8.42
	80	11.16	12.30	11.84	11.12	12.27	11.80
	100	13.65	15.03	14.84	13.61	15.00	14.81
	120	14.25	15.45	15.20	14.22	15.41	15.16
Sprinkling	60	8.72	9.71	9.45	8.68	9.67	9.41
	80	11.81	12.91	12.53	11.77	12.86	12.49
	100	14.64	15.80	15.47	14.60	15.76	15.41
	120	14.86	16.37	15.53	14.83	16.33	15.49
F. test		*			*		
LSD 5 %		0.29			0.28		

Table 7: Straw yield/fed as affected by the interaction between nitrogen fertilizer levels and foliar fertilization treatments during 2004/2005 and 2006/2007 seasons.

Kg N/fed	2004/2005 season			2006/2007 season		
	Control	Nervatin-vet	Maxifert	Control	Nervatin-vet	Maxifert
60	1.09	1.43	1.32	1.07	1.41	1.30
80	1.32	1.66	1.54	1.29	1.64	1.51
100	1.45	1.81	1.67	1.42	1.78	1.64
120	1.71	2.00	1.84	1.68	1.96	1.81
F. test	*			*		
LSD 5 %	0.04			0.04		

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تأثر إنتاجية القمح بنظم الري ، مستويات النيتروجين ومعاملات التسميد الورقى تحت ظروف الأراضي حديثة الإستصلاح

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اقيمت أربعة تجارب حقلية بمحطة التجارب والبحوث الزراعية بقلابشو وزيان – كلية الزراعة – جامعة المنصورة خلال موسمى ٢٠٠٤/٢٠٠٥ و ٢٠٠٦/٢٠٠٧ م لدراسة تأثير نظم الرى ، مستويات التسميد النيتروجينى ومعاملات التسميد الورقى على نمو ومحصول القمح صنف سخا ٩٣. ونفذت التجارب فى تصميم القطع المنشقة مرة واحدة ذو أربع مكررات لكل نظام رى ثم أجرى التحليل التجميعى لنظم الرى. ويمكن تلخيص أهم النتائج المتحصل عليها فيما يلى:

أدى رى نباتات القمح باستخدام نظام الرى بالرش إلى الحصول على أعلى القيم لجميع الصفات تحت الدراسة فى حين أن أقل القيم لتلك الصفات نتجت من معاملة الرى بالغمر فى موسمى الدراسة.

وجد أن جميع الصفات تحت الدراسة زادت زيادة تدريجية بزيادة مستويات السماد النيتروجينى من ٦٠ إلى ٨٠ ، ١٠٠ و ١٢٠ كجم نيتروجين/فدان حيث كانت الفروق بين تلك المستويات معنوية لجميع الصفات فى موسمى الدراسة. عموما نتجت أعلى القيم لجميع الصفات تحت الدراسة من تسميد نباتات القمح بـ ١٢٠ كجم نيتروجين/فدان.

أدى رش نباتات القمح بالسماد الورقى التجارى نيرفاتين – فيت الى الحصول على أعلى القيم لجميع الصفات المدروسة خلال موسمى الدراسة. فى حين ان أقل القيم لتلك الصفات نتجت من معاملة المقارنة (الرش بالماء فقط). أما الرش بالسماد الورقى التجارى مكسيفيرت جاء فى المرتبة الثانية من حيث التأثير على الصفات المدروسة بعد معاملة الرش بسماد النيرفاتين – فيت خلال موسمى الدراسة.

عموما يمكن التوصية بإتباع نظام الرى بالرش حيث يوفر هذا النظام مياه الرى علاوة على تلبية إحتياجات النبات المائية فى جميع مراحل النمو مما يؤدى إلى تحسين نمو وإنتاجية محصول القمح بالإضافة إلى تسميد نباتات القمح بالسماد النيتروجينى بمعدل ١٢٠ كجم نيتروجين للفدان مع الرش بالأسمدة الورقية خاصة سماد النيرفاتين – فيت تحت ظروف الأراضى الرملية حديثة الإستصلاح بمنطقة قلابشو وزيان – محافظة الدقهلية.