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COMPARATIVE STUDIES ON NUMBER OF IRRIGATIONS, PLANTING METHODS AND NITROGEN LEVELS FOR WHEAT IN NORTH DELTA SOILS

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ABSTRACT

Two field experiments were carried out at the Experimental Farm of Sakha Agricultural Research Station, Agricultural Research Center (ARC), Egypt during 2010/2011 and 2011/2012 seasons to study the effect of number of irrigations (one, two and three), planting methods (bed, drilling and broadcasting) and nitrogen levels (67%, 100% and 133% of recommended rate *i.e.* 75 Kg N/fed) as well as their interaction on yield and its components of wheat Sids 12 cultivar. Each location was performed in separate experiment; every experiment was layout in strip-split plot design with three replications.

The obtained results showed that wheat yield and its components were significantly affected all main factors (number of irrigations, planting methods and nitrogen levels) in both seasons.

The highest values of yield and its components were obtained by applying the treatment of three irrigations after Mohayah irrigation as compared with other irrigation treatments (one or two irrigations) in both seasons.

The highest value of all studied characters were resulted from planting wheat by using broadcasting and bed methods as compared with drilling method in both seasons.

Mineral fertilizing with 100 % of the recommended rate *i.e.* 75 Kg N/fed gave the highest grain and straw yields and its components of wheat as compared with 67 or 133 % of the recommended rate.

Generally, it can be concluded that planting wheat by using broadcasting method and giving three irrigations after Mohayah irrigation besides fertilizing with 75 kg N/fed in order to maximizing its productivity under the environmental conditions of North and Middle Delta Soils.

Keywords: Wheat, irrigation, number of irrigation, water stress, planting methods, sowing methods, nitrogen levels, nitrogen fertilization.

INTRODUCTION

Wheat (*Triticum aestivum vulgare* L.) is considered as a strategic cereal crop and the main food for the Egyptians. More than 3 million feddans are cultivated annually with wheat crop. The average productivity is about 2.7 t/fed, where the recent high yielding wheat cultivars have been cultivated. In Egypt, the gap between wheat consumption and production is continuously increased due to steady increases in the country population with limited cultivated area. Thus increasing wheat productivity, either horizontal or vertical through scientific basis is a national target to fill this gab. Wheat yield is a function of some major variables; *i.e.* planting method, irrigation system, soil fertility and fertilization management.

Irrigation could be considered the limiting factor affecting crop production and agricultural expansion. In Egypt, especially in Nile Valley and Delta region, where farmers use extra water to irrigate their farms. So, irrigation optimization, *i.e.* applying the irrigation water timely and quantitatively will increase wheat yield and save considerable amount of water. Many researchers proved the importance of irrigation treatment to maximize wheat productivity. In this respect, Sharshar and El-Sayed (2000) showed that plant height, number of spikes/m^2, grain yield, straw yield, number of grains/spike, 1000-grain weight were significantly affected by water stress. Hassaan (2003) studied the effect of three irrigation treatments *i.e.* normal irrigation (S-0), drought stress at booting stage (S-1) and drought stress at heading and early filling stage by skipping the second and third irrigation(S-2) on four bread wheat and eight triticale genotypes. They indicated that plant height, number of grains/spike and grain yield were decreased by decreasing number of irrigations. Geniady *et al.* (2007) and Moayedi *et al.* (2010) reported that day to maturity, plant height, number of spikes/m^2, number of grains/spike, 1000-grain weight, harvest index and grain yield were significantly affected by water deficit.

Optimum planting method of wheat has a beneficial role in affecting wheat plants distribution in the field as well as water and nutrients use efficiencies for grown plants and subsequent optimum yields. Planting method in wheat like other crops responds greatly to various agro-management practices, and it affected to yield and its characters. Seadh and Badawi (2006) reported that sowing methods had a significant effect on most of the studied characters. Drilling in rows 15 cm apart produced the highest values of all studied characters 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. Abbas *et al.* (2009) found that similar 1000-grain weight was recorded in drill sowing at 30, 22.5 cm and broadcasting. The maximum grain yield was obtained through broadcasting method. They concluded that broadcast method is suitable for wheat sowing in sandy loam soils of arid area. Soomro *et al.* (2009) found that wheat sown by drilling method at the seed rate of 150 kg/ha increased the wheat plant vigor and yield. This increase in wheat yield was associated with the progressive increase in all growth components. Amin *et al.* (2013) found that sowing methods had a significant influence on biological yield of wheat crop. Wheat crop sowing by drill method produced the maximum biological yield as compared to broadcasting method.

Nitrogen is a key factor in achieving optimum grain yield. Plant use efficiency of nitrogen depends on several factors including application time, rate of nitrogen applied, cultivars and climatic conditions. Genaidy (1994) and Allam (2005) showed that increasing nitrogen fertilization levels significantly increased wheat growth and yield and its components as compared to the control which fertilized with 30 kg N/fed. Nitrogen fertilizer at the level of 90 kg N/fed gave the best results for spike length, number of spikes/m^2, number of grains/spike, grain yield and protein percentage as well as 1000-grain weight and straw yield. However, the superiority of the application of 120 kg N/fed was noticed only with plant height and spike length. Abu-Grab *et al.* (2006)

stated that adding nitrogen fertilizer at the level of 90 kg N/fed increased number of spikes/m^2, number of grains/spike, plant height, grain, straw yields and grain protein content. Seadh and Badawi (2006) showed that nitrogen fertilizer levels significantly affected all studied characters. All studied characters gradually increased by increasing nitrogen fertilizer levels from 50 up to 110 kg N/fed. The highest values of studied characters resulted from fertilizing wheat plants by 110 kg N/fed. Modhej and Lack (2011) found that highly significant differences among nitrogen levels in number of spikes/m^2, number of grains/spike and grain yield. While, the effect of nitrogen levels on 1000-grain weight and harvest index were not significant.

Therefore, the objective of this research was to evaluate the effect of number of irrigations, planting methods and nitrogen fertilizer levels as well as their interaction on growth and yield of wheat under two experimental locations.

MATERIALS AND METHODS

Two field experiments were conducted at the Experimental Farm of Sakha Agricultural Research Station, Agricultural Research Center (ARC), Egypt during 2010/2011 and 2011/2012 seasons. The objective of this study was to determine the effect of number of irrigations, planting methods and nitrogen fertilizer levels as well as their interaction on growth and yield of wheat Sids 12 cultivar.

The experiment was layout in strip-split plot design with three replications. The numbers of irrigations after Mohayah irrigation (one, two and three irrigations) were represented in the vertical plots. The planting irrigation has been done directly after Mohayah irrigation. The treatment of number of irrigations has been applied according to the recommended irrigation intervals exactly.

While, planting methods (bed, drilling and broadcasting) were occupied in the horizontal plots. The above mentioned planting methods were applied according to the applied recommendation that reported by Wheat Research Department, FCRI, ARC.

Nitrogen fertilizer levels *i.e.* N_1 = 67 %, N_2 =100 % and N_3 =133% of the optimum recommended rate of (75 kg N/fed) were assigned in the sub plots. Nitrogen fertilizer in the form of Urea (46.5 % N) was applied with above mentioned rates twice in two equal doses. The first nitrogen addition was at the Mohayah irrigation, and the second was at the second irrigation after Mohayah irrigation directly, and for the two experimental sites and two seasons.

The soil samplings (0-30 cm depth of plough layer) representing the two experimental sites of Sakha and El-Gemmeiza Res. Stations were taken before wheat planting for determining some important soil fertility characteristics according to the standard methods mentioned by Chapman and Pratt (1961) and Black (1965) and that could be summarized in Table 1.

Table 1: Some soil fertility characteristics for the two seasons.

Soil fertility characteristics:	2010/2011	2011/2012
Soil texture class	(19 % Sand , 24.3 % Silt, 55.7 % Clay) clayey texture	
Soil salinity index (EC at 25^0 C) ($dS.m^{-1}$)	2.02	2.30
Soil-pH (1: 2.5 susp.)	8.00	8.20
$CaCO_3$ (Calcimeter method)%	2.30	2.00
O.M. (Walkly & Black method) %	1.56	1.50
Available-N (K-sulfate extract) ppm	45.13	50.39
Available P (Olsem extract.P) ppm	9.00	10.17
Available K (Am-acetate extract.) ppm	423.00	500.73
Available Zn (DTPA- extract) - ppm	0.85	0.96

Experimental plot area was 12.6 m^2, the plot of Bed in planting method was three Beds, and the wide for each Bed was 120 cm.

After application of better soil tillage and addition of recommended rate of phosphorus fertilization (30 kg P_2O_5/fed as super phosphate, 15.5 % P_2O_5), wheat seeds were sown at the rate of 45 kg seed/fed on 30/11/2010 and 2/12/2011 at Sakha site and also on 30/11/2010 and 30/11/2011 at El Gemmeiza site, and for the two seasons, respectively. All the agronomic practices for wheat growing were conducted according to the recommended methods of wheat applied researches.

Wheat harvesting time has been done (5/5/2011 and 10/5/2012 at Sakha site) and on (7/5/2011 and 11/5/2012 at Gemmeiza site) for measuring wheat yield characters as follows: plant height (cm), number of spikes/m^2, grains weight/spike (g), 1000-grain weight (g), grain yield (ton/fed) and straw yield (t/fed).

All obtained data were statistically analyzed according to the technique of analysis of variance (ANOVA) for the strip-split plots design to each experiment (locations), and then combined analysis was done between location experiments as published by Gomez and Gomez (1984). Least Significant of Difference (LSD) method was used to test the differences between treatment means at 5 % level of probability as described by Snedecor and Cochran (1980).

RESULTS AND DISCUSSION

1- Effect of number of irrigations:

Number of irrigations after Mohayah irrigation treatments (one, two and three) exhibited significant effect on all studied yield and its components (plant height, number of spikes/m^2, grains weight/spike, 1000-grain weight, grain and straw yields/fed) in both seasons as shown in Tables 2 and 3. It can be observed that from obtained results, three irrigations after Mohayah irrigation associated with significant increase in all studied characters and resulted in the highest values in both growing seasons of this research. However, two irrigations after Mohayah irrigation followed by this treatment with significant differences in both seasons. Increasing water stress by giving one irrigation after Mohayah irrigation resulted in the lowest values of all

studied traits in both seasons. It can be concluded that the decreases in grain yield as a results of giving two irrigation were 20 and 25 % as well as these decreases reached about 27 and 40 % due to giving one irrigation as compared with three irrigation in the first and second seasons, respectively. This increase in growth and productivity of wheat due to increasing irrigation by three irrigation may be due to provide moisture for wheat plants continuously which allows better growth, thereby enhancement yield components resulting in increments in plant height, number of spikes/m^2, grains weight/spike, 1000-grain weight and grain yield. These findings are in good conformity with those reported by Sharshar and El-Sayed (2000), Hassaan (2003), Geniady *et al.* (2007) and Moayedi *et al.* (2010).

Table 2: Plant height, number of spikes/m^2, grains weight/spike as affected by number of irrigations, planting methods and nitrogen levels as well as their interactions during 2010/2011 and 2011/2012 seasons.

Treatments	Plant height (cm)		Number of spikes/m^2		Grains weight/spike (g)	
	2010/2011	2011/2012	2010/2011	2011/2012	2010/2011	2011/2012
A- Number of irrigations:						
One	99.54	92.79	326.17	242.24	2.82	2.39
Two	101.76	93.59	350.98	267.889	3.58	2.97
Three	104.07	94.72	411.09	345.33	4.43	3.41
F-test	*	NS	*	*	*	*
LSD at 0.05	1.31	-	11.71	4.69	0.17	0.10
B- Planting methods:						
Bed	100.93	92.87	336.67	271.40	3.55	2.76
Drilling	101.57	93.06	345.78	265.79	3.55	2.95
Broadcasting	102.87	95.19	405.80	318.30	3.71	3.06
F-test	NS	*	*	*	NS	*
LSD at 0.05	-	1.44	10.94	4.38	-	0.10
C- Nitrogen levels (kg N/fed):						
50	97.87	86.48	334.76	250.54	3.03	2.51
75	101.57	95.00	362.85	286.57	3.59	2.93
100	105.93	99.63	390.63	318.35	4.20	3.33
F-test	*	*	*	*	*	*
LSD at 0.05	0.53	0.79	10.42	4.73	0.09	0.05
D- Interactions:						
A X B	NS	NS	*	*	*	
A X C	NS	NS	NS	*	*	*
B X C	NS	NS	NS	*	NS	*
A X B X C	NS	NS	NS	*	*	*

Table 3: 1000-grain weight, grain yield and straw yield as affected by number of irrigations, planting methods and nitrogen levels as well as their interactions during 2010/2011 and 2011/2012 seasons.

factors	1000-grain weight (g)		Grain yield (t/fed)		Straw yield (t/fed)	
season	2010/2011	2011/2012	2010/2011	2011/2012	2010/2011	2011/2012
A- Number of irrigations:						
One	44.38	49.04	3.06	2.52	3.46	3.38
Two	43.30	47.99	3.70	3.15	3.97	3.69
Three	42.69	45.09	3.91	3.54	5.25	4.39
F-test	NS	*	*	*	*	*
LSD 0.05	-	0.42	0.07	0.06	0.7	0.41
B- Planting methods:						
Bed	42.91	47.39	3.56	2.78	4.62	3.94
Drilling	43.71	47.09	3.38	2.62	4.05	3.72
Broadcasting	44.07	47.64	3.75	3.05	4.01	3.78
F-test	NS	NS	*	*	*	NS
LSD 0.05	-	-	0.05	0.63	0.72	-
C- Nitrogen levels (kg N/fed):						
50	45.38	48.44	3.24	2.58	3.82	3.00
75	43.66	47.38	3.56	3.08	4.29	3.88
100	41.34	46.30	3.88	3.55	4.56	4.56
F-test	*	*	*	*	*	*
LSD 0.05	0.29	1.04	0.04	0.05	0.25	0.27
D- Interactions:						
IxM	NS	*	*	*	*	*
IxN	NS	NS	NS	*	NS	NS
MxN	NS	NS	NS	*	NS	NS
IxMxN	NS	NS	NS	*	NS	NS

2- Effect of planting methods:

The obtained results showed in Tables 2 and 3 that planting methods were significantly affected plant height and grains weight/spike in the second season, straw yield/fed in the first season and number of spikes/m^2 and grain yield in both seasons. Planting wheat by using broadcasting method produced the highest values of plant height, number of spikes/m^2, grains weight/spike, 1000-grain weight and grain yield/fed in both growing seasons. The obtainable increments in grain yield due broadcasting method over the lowest one of drilling method were 10 and 15% for both seasons, respectively. With respect of straw yield/fed, the highest values were realized by applying the bed method treatment in both seasons. The relative increments were 14% and 4% over drilling method in the first and second seasons, respectively. The broadcasting method is the best method, because it is the common method at farmers in north delta specially and in Egypt generally. The obtained results of this study are partially agreement with those noticed and discussed by Seadh and Badawi (2006), Abbas *et al.* (2009), Soomro *et al.* (2009) and Amin *et al.* (2013).

3- Effect of nitrogen fertilizer rates:

The data in Tables 2 and 3 illustrated that nitrogen fertilizer levels significantly affected plant height, number of spikes/m^2, grains weight/spike, grain and straw yields/fed) in both seasons. The highest values of these parameters were realized by applying 100 kg N/fed in both seasons, except 1000-grain weight. The parallel increments were [(8, 3 %) and (4, 11 %)]; [(17, 4 %) and (7, 11 %)]; [(40, 33 %) and (20, 15%)]; [(19, 6 %) and (32, 18%)] ; [(20, 9 %) and (37, 15%)] over that obtained by the treatments of 50 and 75 Kg N/fed for such parameters in the first and second seasons, respectively. The 100 kg N/fed is the best level, because the planted increased by applying this level. The nitrogen fertilization level is very important for grain wheat to farmers. The promoting effects of nitrogen on yield characters were reported also by Genaidy (1994), Brady and Weil (2002), Allam (2005), Abu-Grab et al(2006), Seadh and Badawi (2006) and Modhej and Lack (2011).

4- Effect of interactions:

Regarding the effect of interactions, there are many significant effects of the interactions among studied factors on studied characters. We reported enough the significant interactions on grain yield only.

Grain yield was significantly affected by the interaction between number of irrigations x planting in both seasons (Table 4), number of irrigations x nitrogen fertilization rates interaction in the second season (Table 5), planting methods x nitrogen fertilization rates in the second season (Table 6) and irrigation numbers x planting methods x N-fertilizer rates in the second season (Table 7). The highest values of grain yield were realized by applying the treatment of (three irrigations x bed method for both seasons. In Tabe 5 the highest values were obtained by applying the treatment of (three irrigations x100 Kg N/fed) for second season. The highest values of wheat grain yield Table 6 have been obtained by applying (broadcasting method x100 Kg N/fed.) treatments for second season. The highest values of wheat grain yield Table 7 have been obtained by applying (one irrigation x broadcasting method x 100 Kg N/fed.) treatments for second season.

Table 4: Grain yield (t/fed) as affected by number of irrigations x planting method interaction at both seasons.

Plant Methods	No. of irrigations					
	2010/2011			2011/2012		
	One	Two	Three	One	Two	Three
Bed	2.39	2.81	3.37	3.27	3.79	4.14
Drilling	2.58	3.15	3.45	2.93	3.53	3.68
Broadcosting	2.60	3.49	3.79	3.00	3.78	3.92
LSD at 0.05	0.34			0.33		

Table 5: Grain yield (t/fed) as affected by number of irrigations x nitrogen fertilization rates interaction at second season.

Nitrogen Levels	No. of irrigations		
	One	Two	Three
50	2.12	2.79	2.86
75	2.61	3.18	3.43
100	2.84	3.48	4.32
LSD at 0.05	0.07		

Table 6: Grain yield (t/fed) as affected by planting methods x nitrogen fertilization rates interaction at second season.

Nitrogen Level	Plant Methods		
	Bed	**Drilling**	**Broadcosting**
50	2.44	2.59	2.73
75	2.87	3.03	3.34
100	3.28	3.55	3.82
LSD at 0.05	0.28		

Table 7: Grain yield (t/fed) as affected by irrigation numbers x planting methods x N-fertilizer rates interaction at second season.

	One			Two			Three		
N-Levels	Bed	Drilling	Broad.	Bed	Drilling	Broad.	Bed	Drilling	Broad.
50	2.01	2.12	2.22	2.48	2.79	3.08	2.81	2.86	2.89
75	2.51	2.66	2.68	2.81	3.23	3.50	3.28	3.21	3.82
100	2.66	2.95	2.92	3.14	3.42	3.88	4.02	4.28	4.65
LSD at 0.05	0.09								

Similar results were reported by Genaidy 1994; Wang 1997, Saleh and Hussein 2004, Genaidy *et al.*, 2007, Jaz *et al* 2007, Wang 2007 and Sonbol 2011 who indicated that the highest water use efficiency and highest nitrogen use efficiency for wheat crop are positively related to optimum irrigation water requirements; optimum N-fertilization rate; and soil tillage concerning soil leveling and planting methods. On the opposite direction, water defect (by reducing irrigations number) may lead to dangerous effects on water and nutrients availabilities in soil and subsequent lowest wheat production.

CONCLUSION

From the obtained results of this study it could be concluded that planting wheat cultivar Sida 12 by using broadcasting method and giving three irrigations after Mohayah irrigation besides fertilizing with 100 kg N/fed in order to maximizing its productivity under the environmental conditions of North Delta Soils.

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دراسات مقارنة فى طرق الزراعة والرى ومعدلات التسميد النتروجينى على محصول القمح فى أراضى شمال الدلتا

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أقيمت تجربتان حقليتان بمحطة بحوث سخا بمحافظة كفر الشيخ خلال موسمى ٢٠١٠/٢٠١١ و ٢٠١١/٢٠١٢ لدراسة تأثير عدد الريات بعد رية الزراعة (رية واحدة ، ريتان و ثلاث ريات)، طرق الزراعة (المصاطب، التسطير والبدار) ومستويات التسميد النتروجينى (٦٧%، ١٠٠% و ١٣٣% من المعدل الموصى به وهو ٧٥ كجم ن / فدان) والتفاعل بينهم و وذلك على المحصول ومكوناته لصنف القمح سدس ١٢. وتم استخدام تصميم الشرائح المتعامدة المنشقة فى ثلاث مكررات.

أوضحت النتائج المتحصل عليها أن جميع الصفات تحت الدراسة قد تأثرت معنوياً بالعوامل المدروسة (عدد الريات ، طرق الزراعة ومستويات التسميد النتروجينى) فى كلا الموسمين.

أعطت المعاملة بثلاث ريات بعد رية المحاياه أفضل النتائج للمحصول ومكوناته مقارنة بمعاملات الرى الأخرى (رية واحدة وريتان) فى كلا الموسمين.

نتجت أعلى القيم لجميع الصفات المدروسة من الزراعة البدار والزراعة المصاطب مقارنة بطريقة الزراعة التسطير فى كلا الموسمين.

أدى التسميد المعدنى بإضافة ١٣٣% من المعدل الموصى به (٧٥ كجم نيتروجين/فدان) للحصول على أعلى القيم لصفات محصول الحبوب والقش ومكوناتهما مقارنة بالتسميد المعدنى بـ ٦٧ أو ١٠٠% من المعدل الموصى به.

وبصفة عامة ، توصى الدراسة بزراعة القمح صنف سدس ١٢ بإستخدام طريقة الزراعة البدار مع الرى ثلاث ريات بعد رية المحاياه والتسميد المعدنى بـ ١٠٠ كجم نيتروجين/فدان للحصول على أعلى إنتاجية تحت الظروف البيئية لأراضى شمال الدلتا.

قام بتحكيم البحث

أ.د / محسن عبد العزيز بدوى	**كلية الزراعة – جامعة المنصورة**
أ.د / محمد الرفاعى البيلى	**كلية الزراعة – جامعة عين شمس**