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Productivity Of Bread Wheat Under Different Irrigation Levels And Splitting Nitrogen Fertilization In Newly Reclaimed Soils

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ABSTRACT

In order to study the effect of irrigation water rates and splitting nitrogen on productivity of wheat. Three field experiments were conducted at El-Wady Al-Assiuty experimental farm in new reclaimed soil during 2013/2014 and 2014/2015 seasons using cultivar Sids 12 using sprinkler irrigation system. Each experiment subjected to one level of irrigation water requirements (100%, 75% and 50%) and each experiment contains four treatments of splitting nitrogen fertilization. Results indicated that, irrigation levels had a high significant effect on yield and its components. As when 50% of the recommended irrigation requirements was applied, the reduction of grain yield reached 44.3 and 28.9% in the first and second seasons, respectively. Moreover, splitting nitrogen fertilization affected all studied traits. As splitting nitrogen fertilization to five splits recorded the highest mean value of grain and biological yields as compared with control (3 splits) in both seasons. The interaction between irrigation levels and splitting of the nitrogen fertilizer had a significant effect on grain yield. As the highest mean value of grain yield was obtained from 5 splits with 100% of irrigation requirement in the first season while in the second season the highest grain yield was obtained from 6 splits with 100% irrigation requirements. From this study, data clarify that in sandy soils about 25% of irrigation requirements could be saved without significant losses in grain yield by splitting the nitrogen fertilization. Thus we could have additional amount of water could be used for increase the cultivation area of wheat to minimize the production consumption gap of this crop.

Keywords: Wheat, Irrigation requirements, Splitting, Nitrogen fertilization

INTRODUCTION

The greatest challenge for crop production especially in aired and semiarid regions is water limitation. In Egypt it seems that in near future water deficit problem will appear because of the projects in upstream part of the Nile. Wheat is the most common crop in the world as compared with other cereals especially in developing countries (Said *et al.,* 2015). There is a big gap between wheat production and its consumption in Egypt reached about 52.1% (FAO, 2013) and one of the possible ways to fill this gap is to grow wheat in new reclaimed soils. The only challenge for this way is the limited availability of water resources. Usually in this type of soils modern irrigation systems is used on behalf of service irrigation as, these systems can serve adequate amount of irrigation water and hence, additional agricultural area could be added then additional production could be gained. A reduction in grain yield of wheat could be occurred under limited irrigation, but it depends on the time, duration and the degree of the imposed soil moisture deficit (Singh *et al.,* 1991). For more serving water the amount of irrigation water should be reassessed depend on the region and climatic factors of the cultivated area. The studies on the impact of deficit irrigation on the grain yield and the water use efficiency (WUE) of wheat reveal that in some cases, quality could be improved and grain and biological yields could be largely maintained, while substantially reduction in irrigation volume could be done (Musick *et al.,* 1994 and Zhang and Oweis, 1999). In addition, Kang *et al.* (2002) concluded that wheat could be efficiently grown over a large range of irrigation amounts and seasonal water use (ET). The most common irrigation method for wheat in sandy soil is sprinkler irrigation as it can easily distribute the irrigation water uniformly especially in slow wind conditions. In addition, Sprinkler irrigation is a technique for fertigation and accurately controlling irrigation time and water amount (Li and Rao, 2003). Study on winter wheat showed that grain yield and water use efficiency in sprinkler-irrigated fields surpassed surface irrigated fields (Yang *et al.,* 2000).

In newly reclaimed soils in addition to water stress there is a nutritional problem as all essential nutrients are in low levels, so that additional amount of fertilizers should be added. To get the total benefit of the fertilizer it should be added with the appropriate dose in the suitable growth stage (El-Agrodi *et al.,* 2011). Also, nitrogen fertilization is a key word for wheat production in sandy soils as it is an important constituent of plant protoplasm, proteins, nucleic acid and chlorophyll, which have an impact in plant growth. Nitrogen fertilization with high doses in one time may be leached to ground and surface water by continuous irrigation, so that splitting nitrogen fertilization may be reducing its leaching and hence maximize its usage which will led to good growth and high grain yield (Alcoz *et al.,* 1993). The aim of the present study is to determine the effects of irrigation water rates, splitting nitrogen fertilization and their involved interaction on yield and its components of wheat cultivated on a newly reclaimed soils.

MATERIALS AND METHODS

Experimental and Site description

Three field experiments were carried out at El-Wady El-Assiuty Experimental Farm, Agriculture Faculty, Assiut University, Assiut Governorate (lat. 27° 16' N, long 31° 34' and alt. 53 m asl) during 2013/2014 and 2014/2015 seasons using cultivar Sids-12 to study the effect of different irrigation levels and splitting nitrogen fertilization on wheat productivity in newly reclaimed soils.

Soil type of experimental site

The mechanical and chemical analyses of the experimental sites of the soil are presented in Table 1.

Table 1. Some physical and chemical properties of experimental sites:

Properties	**2013/2014**	**2014/2015**
Mechanical analysis		
Sand	84.4	86.5
Slit	8.7	7.3
Clay	6.9	6.2
Soil type	Sandy	Sandy
Chemical analysis		
pH	8.34	8.26
Organic matter %	0.097	0.095
Total N%	0.018	0.019
Total $CaCO_3$%	20.26	19.85

Experimental design

Three separates experiments were done and each experiment was subjected to one of studded irrigation levels (I_1= 100%, I_2 = 75% and I_3= 50% of irrigation water requirements). Each experiment was done using randomized complete block design. The experimental unit dimensions were 5 x 5m. The irrigation levels were described as follows:

I_1 as 100% of recommended irrigation requirements (4800 m^3 ha^{-1} fowling Mohamed, 2007) added as sprinkler irrigation with 3-days intervals for 2 hours/irrigation after calculating the mean of sprinkler discharge.

I_2 as 75% of recommended irrigation requirements (3600 m^3 ha^{-1}) added as sprinkler irrigation with 3-days intervals for 1.5 hours/irrigation.

I_3 as 50% of recommended irrigation requirements (2400 m^3 ha^{-1}) added as sprinkler irrigation with 3-days intervals for 1 hour/irrigation.

The recommended dose of nitrogen (288 kg N ha^{-1})was split into 3, 4, 5 and 6 times under each irrigation level as follows: -

S_1, three equal splits of recommended (96 kg N ha^{-1}) starts 15 days after sowing with 15 days' intervals.

S_2, four equal splits (72 kg N ha^{-1}) starts 15 days after sowing with 15 days' intervals.

S_3, five equal splits (57.6 kg N ha^{-1}) starts 15 days after sowing with 15 days' intervals.

S_4, six equal splits (48 kg N ha^{-1}) starts 15 days after sowing with 15 days' intervals.

Agricultural practices

Sowing date was done at December 2^{st} and 4^{th} in 2013/2014 and 2014/2015 seasons, respectively,

using drilling sowing method 15 cm apart with a 150 kg ha^{-1} as a seed rate. All other cultural practices were done according to standard recommendations for sowing wheat in the sandy soil of Upper Egypt.

Characteristics measurements

After maturity, a sample of 10 guarded stems from each plot was taken and plant height in cm, number of spikes m^{-2}, spike length in cm, spikelet number $spike^{-1}$ and 1000-kernel weight in g were measured. For determine biological, grain and straw yields, one square meter was harvested and converted to ton ha^{-1}, finally harvest index was calculated in the two growing seasons.

Statistical analysis

Data were analyzed by MSTAT-C (1991) software package. Separate analysis of variance using randomized complete block design (RCBD) was carried out for each irrigation level. Bartlett's test for variance homogeneity was done following Snedecor and Cochran (1989), then combined analysis for data from all irrigation levels was also carried out for each year according to Gomez and Gomez (1984). Means were compared by revised Least Significant Difference (RLSD) at 5% level of significant (Steel and Torrie, 1981).

RESULTS AND DISCUSSIONS

A. Effect of irrigation levels:

Data presented in Table 2 revel that the plant height and spike length traits were reacted significantly to irrigation levels in the two growing seasons. Thus, wheat plants subjected to 100% of irrigation water requirement produced the highest mean values of plant height (79.17 and 82.67 cm in the first and second seasons, respectively). While the longest spikes (9.42 and 10.96 cm in the first and second seasons, respectively) were recorded from wheat plant subjected to 75% of irrigation water requirement. Similar results were obtained by El Hwary and Yagoub (2011), Abdelraouf *et al.* (2013) and Jiang *et al.* (2013).

For number of spikes m^{-2}, data in Table 2 show that the irrigation levels had a highly significant influence in the two growing seasons. As wheat plants irrigated with 100 % of water requirement produced the highest mean values of spikes number m^{-2} (315.25 and 355.17 in the first and second seasons), respectively. Moreover, irrigation levels had a highly and/or significant effects on number of spikelets $spike^{-1}$ in the two growing seasons and the highest mean values of spikelets number $spike^{-1}$ **(**16.67 and 18.33 in the first and second seasons, respectively) were recorded from 75% of water requirement treatment. This is to be expected since the same irrigation level produced the highest mean values of spike length and consequently produced the highest mean valued of spikelets number $spike^{-1}$. These results are agreement with those obtained by El Hwary and Yagoub (2011) and Abdelraouf *et al.* (2013). About the seed index, irrigation levels affected highly significant in the second season only as the highest mean value assigned to 100% of irrigation requirements.

Also, data reveal that irrigation levels had a highly significant effect on biological yield in both seasons. Thus, decreasing irrigation water amount from 100% to 75 and 50% led to liner decreased in biological yield. In the first season adding 100, 75 and 50% of water requirement to wheat plants produced 14.19, 10.93 and 8.35 ton ha^{-1} of biological yield, respectively, being 12.88, 10.85 and 8.52 ton ha^{-1} in the second season in the same order. This is to be logic since the 100% irrigation level produced the tallest plant and number of spikes m^{-2} mentioned before and consequently gained the highest biological yield. These

results are in harmony with those obtained by Abdelraouf *et al.* (2013).

Table 2. Effect of irrigation levels on all studied characters during the two growing seasons

Season	Irrigation	Plant height in cm	Spike length in cm	Number of spikes m^{-2}	Spikelets number $spike^{-1}$	1000 kernel weight in g	Biological yield (ton ha^{-1})	Grain yield (ton ha^{-1})	Straw yield (ton ha^{-1})	Harvest index
2013/2014	I_1	79.17	8.54	315.25	15.83	25.13	14.19	4.92	9.6	32.37
	I_2	72.89	9.42	253.08	16.67	21.45	10.93	3.64	7.29	33.01
	I_3	59.33	7.54	244.92	14.33	20.57	8.35	2.74	5.61	33.04
	F test	**	**	**	**	NS	**	**	**	NS
	RLSD	2.03	0.77	56.96	0.99	-	2.25	0.96	1.29	2.11
2014/2015	I_1	82.67	9.54	355.17	17.5	28.44	12.88	4.19	8.78	32.13
	I_2	75.82	10.96	297.83	18.83	25.76	10.85	3.98	6.87	36.63
	I_3	61.75	8.75	255.42	16.5	24.01	8.52	2.98	5.54	35.42
	F test	**	**	**	*	**	**	**	**	**
	RLSD	2.12	1.21	37.54	1.48	0.20	1.04	0.37	0.73	1.62

NS,*; **: Not significant, Significant at the 0.05 and 0.01 probability levels, respectively
RLSD: Revised least significant differences at 0.05 probability level I_1= 100%,I_2 = 75% and I_3= 50% of irrigation water requirements

Exhibited data in Table 2 indicate that irrigation levels had a highly significant effect on grain and straw yields in both seasons. The highest grain and straw yields (4.92 and 9.60 ton ha^{-1}) in the first season, being 4.19 and 8.78 ton ha^{-1} in the second season were obtained from wheat plants which irrigated by 100% irrigation level. this is to be expected since the same irrigation level gained the highest mean values with regard to biological yield and consequently produced the maximum mean values of grain and straw yield. These results are in a same trend with those obtained by El Hwary and Yagoub (2011), Abdelraouf *et al.* (2013) and Jiang *et al.* (2013).

Illustrated data in Table 2 show that levels of irrigation affected harvest index highly significant in season 2014/2015 only. The highest mean values of harvest index were recorded from 50 and 75% irrigation levels in the first and second seasons, respectively. These results are in agreement with those obtained by El Hwary and Yagoub (2011), Abdelraouf *et al.* (2013) and Jiang *et al.* (2013).

B. Effect of splitting of nitrogen fertilization:

Nitrogen splitting had a high significant effect on plant height and spike length (Table 3). As, the tallest plants (72.85 and 76.10 cm in the first and second seasons, respectively) were registered from wheat plants fertilized by S_2 treatments (nitrogen fertilizer split into four equal doses) but, the longest spikes (9.44 and 10.61 cm in the first and second seasons, respectively) were recorded from wheat plants subjected to five equal doses of nitrogen fertilizer (S_3). These results are in a good line with those obtained by Wagan *et al.* (2002), Ali (2010) and Amanullah *et al.* (2015).

Table 3. Effect of splitting nitrogen fertilization on all studied characters during the two growing seasons

Season	Number of Splitting	Plant height in cm	Spike length in cm	Number of spikes m^{-2}	Spikelets number $spike^{-1}$	1000 kernel weight in g	Biological yield (ton ha^{-1})	Grain yield (ton ha^{-1})	Straw yield (ton ha^{-1})	Harvest index
2013/2014	S_1	68.11	8.28	305.33	14.33	21.29	10.03	3.54	6.76	32.50
	S_2	72.85	8.18	257.44	15.67	25.75	10.83	3.68	7.11	34.27
	S_3	70.44	9.44	279.11	17.22	20.56	13.44	4.47	9.34	30.48
	S_4	70.44	8.11	242.44	15.22	21.93	10.34	3.37	6.80	33.97
	F test	**	**	**	**	**	**	**	**	**
	RLSD	0.71	0.26	26.55	0.57	0.13	0.51	0.29	0.33	2.11
2014/2015	S_1	71.67	9.44	296.67	16.56	25.37	9.50	3.48	6.14	35.38
	S_2	76.10	9.62	281.56	16.78	27.65	10.40	3.74	6.63	36.21
	S_3	72.67	10.61	342.45	19.22	23.89	12.73	4.01	8.77	31.58
	S_4	73.22	9.33	290.56	17.89	27.37	10.36	3.64	6.71	35.75
	F test	**	**	**	**	**	**	NS	**	**
	RLSD	0.68	0.41	11.59	0.61	0.11	0.77	-	0.44	2.82

NS,*; **: Not significant, Significant at the 0.05 and 0.01 probability levels, respectively
RLSD: Revised least significant differences at 0.05 probability level
S_1= three splits, S_2 = four splits, S_3= five splits and S_4 = six splits of 288 kg N ha^{-1}.

The presented data in Table 3 clear that the highest mean values of spikes number m^{-2} (305.33 and 342.44 in the first and second seasons, respectively) were obtained from S_1 and S_3 fertilizer treatments, respectively while, the highest mean values of spikelets number $spike^{-1}$ (17.22 and 19.22 in the first and second seasons, respectively) were registered from S_3 fertilizer treatment but, the highest mean values of 1000 kernel weight (25.75 and 27.65 g in the first and second seasons, respectively) were obtained from S_2 fertilizer treatment. These results are in agreement with those obtained by Amanullah *et al.* (2015).

Data shown in Table 3 revel that the nitrogen splitting had a highly significant influence in this respect. Split nitrogen fertilizer into five equal doses produced the highest mean values of biological yield in both seasons (13.44 and 12.73 ton ha^{-1}). Similar results were obtained by Sahar and Ghadiri (2012) and Amanullah *et al.* (2015). On the same trend, the highest mean values of grain yield (4.47 and 4.01 ton ha^{-1} in the first and second seasons, respectively) were obtained from wheat plants fertilized with S_3 treatment. Moreover, the highest mean values of straw yield (9.34 and 8.77 ton ha^{-1} in the first and second seasons, respectively) were registered from S_3 fertilizer treatment. These results are in agreement with those obtained by Amanullah, *et al.* (2015).

Splitting nitrogen fertilizer to four equal doses (S_2) produced the highest mean values of harvest index (34.27 and 36.21 in the first and second seasons, respectively) as shown in Table 3. These results are in accordance to those obtained by Amanullah, *et al.* (2015).

C. Effect of interaction between irrigation levels and splitting nitrogen fertilization:

The exhibited data in Table 4 reveal that the interaction between irrigation levels and nitrogen splitting had a highly significant effect on plant height, spike length and number of spikes m^{-2} in the two growing seasons. Thus, the tallest plants (82.67 and 86.33 cm) were produced from wheat plants irrigated with 100% of water requirement and S_2 treatment in the first season and S_4 one in the second season. On the other hand, the longest spikes (12.17 and 13.33 cm in the first and second seasons, respectively) were obtained from wheat plants irrigated by 75% of water requirement and fertilized by S_1 treatment. Concerning number of spikes m^{-2}, wheat plants irrigated by 100% of water requirement and fertilized with S_1 treatment in the first season produced the maximum spikes number m^{-2} (330.67), while in the second season the highest mean value was obtained from 100% of water requirement and fertilized with S_3 treatment (389.67).

Data allocated in table 5 declare that the interaction between irrigation levels and nitrogen splitting had a highly significant effect on spikelets number $spike^{-1}$, 1000 kernel weight and biological yield in both seasons. The maximum mean values of spikelets number $spike^{-1}$ (21.00 and 22.33 in the first and second seasons, respectively) were recorded from 75% irrigation levels with S_3 fertilizer treatment. This is to be logic since the same interaction produced the highest mean values with regard to spike length and consequently gave the highest mean values of spikelets number $spike^{-1}$. On the other hand, wheat plants irrigated by 100% of water requirement and fertilized with S_2 treatment gained the highest mean values of 1000 kernel weight (28.30 and 30.63 g in the first and second seasons, respectively).Wheat plants irrigated by 100% irrigation level and fertilized with S_3 in the first and second season, respectively produced the highest mean values of biological yield(15.46and 14.77ton ha^{-1}).

Table 4. Effect of interaction between irrigation levels and nitrogen splitting on plant height, spike length and number of spikes m^{-2}

Season	Irrigation / Splitting	Plant height in cm			Spike length in cm			Number of spikes m^{-2}		
		I_1	I_2	I_3	I_1	I_2	I_3	I_1	I_2	I_3
2013/2014	S_1	76.67	71.00	56.67	9.17	8.67	7.00	330.67	258.33	327.00
	S_2	82.67	76.56	59.33	8.67	8.19	7.67	326.33	257.67	188.33
	S_3	76.67	70.33	64.33	8.50	12.17	7.67	325.00	293.33	219.00
	S_4	80.67	73.67	57.00	7.83	8.67	7.83	279.00	203.00	245.33
	F test		**			**			**	
	RLSD		1.22			0.44			47.33	
2014/2015	S_1	79.00	74.67	61.33	9.67	10.33	8.33	368.00	316.33	205.67
	S_2	85.67	80.97	61.67	9.83	10.53	8.50	339.00	291.00	214.67
	S_3	79.67	73.00	65.33	9.33	13.33	9.17	389.67	312.00	325.67
	S_4	86.33	74.67	58.67	9.33	9.67	9.00	324.00	272.00	275.67
	F test		**			**			**	
	RLSD		1.19			0.71			20.75	

NS,*; **: Not significant, Significant at the 0.05 and 0.01 probability levels, respectively
RLSD: Revised least significant differences at 0.05 probability level

Table 5. Effect of interaction between irrigation levels and nitrogen splitting on spikelets number spike-1, 1000 kernel weight and biological yield

Season	Irrigation / Splitting	Spikelets number spike^{-1} I$_1$	I$_2$	I$_3$	1000 kernel weight in g I$_1$	I$_2$	I$_3$	Biological yield (ton ha^{-1}) I$_1$	I$_2$	I$_3$
2013/2014	S$_1$	15.00	15.00	13.00	21.30	21.47	21.11	12.17	9.43	8.48
	S$_2$	16.33	15.67	15.00	28.30	23.19	25.77	14.71	11.30	6.47
	S$_3$	16.33	21.00	14.33	25.04	22.29	14.34	15.46	13.63	11.23
	S$_4$	15.00	15.00	15.67	21.07	18.84	25.88	7.22	9.37	14.41
	F test		**			**			**	
	RLSD		1.01			0.24			0.93	
2014/2015	S$_1$	17.00	17.00	15.67	26.71	27.73	21.68	10.56	9.74	8.21
	S$_2$	17.00	17.67	15.67	30.63	25.10	27.21	12.53	11.70	6.96
	S$_3$	18.33	22.33	17.00	26.02	26.22	19.43	14.77	11.85	11.58
	S$_4$	17.67	18.33	17.67	30.41	24.00	27.70	13.66	10.10	7.32
	F test		**			**			**	
	RLSD		1.16			0.20			1.45	

NS,*; **: Not significant, Significant at the 0.05 and 0.01 probability levels, respectively
RLSD: Revised least significant differences at 0.05 probability level

Data in Table 6 highlighted that, the interaction between irrigation levels and nitrogen splitting had a highly and/or significant effect on grain yield, Straw yield and harvest index in the two growing seasons as the highest mean values of grain and straw yields in the first season were obtained from 100% irrigation level with S$_3$ fertilizer treatment. Meanwhile, the corresponding values in the second season were obtained from 100% with S$_4$ for grain yield and 100% with S$_3$ for straw yield. On the other hand, wheat plants received 50% of water requirement and fertilized with S$_4$ nitrogen treatment registered the highest mean values of harvest index i.e. 35.75 and 39.25 in the first and second seasons, respectively.

Table 6. Effect of interaction between irrigation levels and nitrogen splitting on grain yield, Straw yield and harvest index.

Season	Irrigation / Splitting	Grain yield (ton ha^{-1}) I$_1$	I$_2$	I$_3$	Straw yield (ton ha^{-1}) I$_1$	I$_2$	I$_3$	Harvest index I$_1$	I$_2$	I$_3$
2013/2014	S$_1$	4.76	3.03	2.84	8.23	6.40	5.64	32.24	31.97	33.28
	S$_2$	4.97	3.88	2.20	9.64	7.41	4.27	34.48	34.31	34.03
	S$_3$	5.45	4.66	3.30	11.12	8.97	7.92	28.10	34.26	29.08
	S$_4$	4.50	3.00	2.61	9.42	6.37	4.61	34.65	31.51	35.75
	F test		**			**			*	
	RLSD		0.59			0.60			3.99	
2014/2015	S$_1$	3.93	3.68	2.84	6.99	6.06	5.37	33.75	37.77	34.61
	S$_2$	4.20	4.49	2.53	8.25	7.22	4.43	34.18	38.19	36.26
	S$_3$	4.05	4.32	3.66	10.84	7.53	7.93	26.62	36.53	31.58
	S$_4$	4.59	3.45	2.88	9.03	6.65	4.45	33.96	34.03	39.25
	F test		*			**			**	
	RLSD		0.78			0.81			2.82	

NS,*; **: Not significant, Significant at the 0.05 and 0.01 probability levels, respectively
RLSD: Revised least significant differences at 0.05 probability level

CONCLUSION

Over this study, by using 75% of the irrigation requirements with 5 splits of nitrogen fertilization the reduction of grain yield did not exceed 14.5% in the first season, while in the second season we have extra grain yield about 6.6% as compared with 100% irrigation requirements. This clarify that, we can save about 25% of irrigation requirements without significant losses in grain yield by modify the nitrogen fertilizer. Thus we could have additional amount of water could be used for increase the cultivation area of wheat.

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إنتاجية محصول قمح الخبز تحت مستويات ري مختلفة وتجزئة التسميد النيتروجيني في الأراضي المستصلحة حديثا

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أجريت ثلاث تجارب حقلية تمثل ثلاث مستويات من الري بالرش بمزرعة الوادي الأسيوطي التابعة لكلية الزراعة جامعة أسيوط خلال موسمي الزراعة ٢٠١٤/٢٠١٣ و ٢٠١٥/٢٠١٤، وهي تمثل تربة رملية حديثة الاستصلاح باستخدام الصنف سدس ١٢. اشتملت كل تجربة علي عامل تجزئة السماد النيتروجيني الي ٣ و ٤ و ٥ و ٦ جرعات باستخدام تصميم القطاعات العشوائيه بثلاث مكررات. أشارت النتائج أن معاملات الري كان لها أثرا معنويا على المحصول ومكوناته. حيث أوضحت النتائج ان تطبيق المعامله ٥٠٪ من احتياجات الري الموصى بها ادي الي انخفاض في محصول الحبوب بمقدار ٤٤.٣ و ٢٨.٩٪ في الموسمين الأول والثاني على التوالي. لقد أدي تقسيم السماد النيتروجيني علي جميع الصفات المدروسة. حيث وجد ان تقسيم الجرعه السمادية علي خمس دفعات أعطي أعلى محصول حبوب والمحصول البيولوجي بالمقارنة مع المعامله القياسية (التقسيم علي ثلاث دفعات) في كلا الموسمين. كما حقق التفاعل بين مستويات الري وتقسيم الجرعة السماديه من النيتروجين تأثيراً معنويا على محصول الحبوب خلال موسمي الزراعة. حيث تم الحصول على أعلى قيمة محصول الحبوب من تقسيم السماد الي خمس دفعات مع معاملة ١٠٠٪ من متطلبات الري في الموسم الأول، بينما في الموسم الثاني تم الحصول علي أعلى محصول الحبوب من تقسيم الجرعة السماديه الي ست دفعات مع معاملة ١٠٠٪ من متطلبات الري. و خلاصة القول من نتائج هذه الدراسة انه يمكن الحفاظ على ٢٥% من احتياجات الرى لمحصول القمح في الاراضى الرملية دون فقد معنوى في محصول الحبوب عن طريق تجزئة السماد النتروجينى. يمكن استخدام هذه الكمية من المياه في زيادة الرقعة المنزرعة من القمح لتقليص الفجوه بين الإنتاج والاستهلاك لهذا المحصول

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