Effect of Nitrogen Fertilizer Application Dates on Growth and Yield of Six Wheat Cultivars (*Triticum aestivum* L.)

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Abstract

A field experiment was conducted during the season 2017-2018 in Al-Jadwal Al-Gharbi district - Karbala governorate, which is about 22 km away from the centre of the province to study the effect of three dates for the addition of nitrogen fertilizerT1= Adding fertilizer in two equal batches when planting and at elongation; T2= adding of fertilizer in three equal batches when planting, elongation and boot phase; T3= adding of fertilizer in four equal batches when planting, elongation, boot phase, and flowering in the growth and yield of six cultivars of bread wheat (Rashid, Ibaa 95, Ibaa 99, Abu Ghraib, Tamooz 2, Tahadi). The randomized complete block design (RCBD) was used with three replicate. The results showed the superiority of treatment T1by giving the highest rate of flag leaf area 39.89 cm^2 and the number of spikes 284.7 spikes m^2. T3 treatment was superior to the highest plant height 100.17 cm, the number of grains in the spike 41.61-grain spike $^{-1}$ and the weight of 1000 grains (36.33 g) and the grain yield 4.23 tons ha^{-1}. The results also showed the exceeding of Tamooz 2 by giving the highest rate of flag leave area 46.67 cm^2, spikes number 314.0 spikes m^{-1}, grain number in the spike 45.11 grain $spike^{-1}$, and grain yield 5.02 ton ha^{-1}.

Keywords: Chemical fertilization, Plant growth, Grains yield

تأثير مواعيد إضافة السماد النتروجيني في نمو وحاصل ستة أصناف من حنطة الخبز (*Triticum aestivum* L.)

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المستخلص:

نفذت تجربة حقلية خلال الموسم 2017 – 2018 في قضاء الجدول الغربي – محافظة كربلاء والتي تبعد حوالي 22 كم عن مركز المحافظة ، لدراسة تأثير ثلاث مواعيد لإضافة السماد النتروجيني هي T_1 إضافة السماد بدفعتين متساويتين عند الزراعة وعند الاستطالة ، T_2 إضافة السماد بثلاث دفعات متساوية عند الزراعة وعند الاستطالة وعند البطان ، T_3 إضافة السماد بأربع دفعات متساوية عند الزراعة وعند الاستطالة وعند

البطان وعند التزهير في نمو وحاصل ستة أصناف من حنطة الخبز هي رشيد ، إباء 95 ، إباء99 ، أبو غريب ، تموز2 ، تحدي. استخدم تصميم القطاعات العشوائية الكاملة (RCBD) وبثلاث مكررات . أظهرت النتائج تفوق معاملة T_1 بإعطائها أعلى معدل لمساحة ورقة العلم 39.89 سم^2 ولعدد السنابل 284.7 سنبلة م^2 ،تفوقت معاملة T_3 بإعطائها أعلى معدل لارتفاع النبات100.17 سم ولعدد الحبوب في السنبلة 41.61 حبة سنبلة$^{-1}$ ووزن 1000 حبة 36.33غم وحاصل الحبوب 4.23 طن هـ$^{-1}$. تفوق الصنف تموز2 بإعطائه أعلى معدل في مساحة ورقة العلم 46.67 سم^2 وعدد السنابل 314.0 سنبلة م$^{-1}$ وعدد الحبوب في السنبلة 45.11 حبة سنبلة$^{-1}$ وحاصل الحبوب 5.02 طن هـ$^{-1}$.

كلمات مفتاحية: التسميد الكيميائي ، نمو النبات ، حاصل الحبوب .

Introduction

Wheat is one of the most important cereal crops in most countries of the world because it is the main source of daily energy needed by the human. Due to the low rate of the wheat production in Iraq, the addition of nitrogen fertilizer at appropriate times, which coincides with stages of emergence and growth of grain yield components lead to increase these components and thus increase the yield (Mohammed, 2000) and (Reynolds, Rajaram, & Sayre, 1999). Nitrogen is an essential element for the growth and production of wheat. Mineral fertilization suffers from several problems, especially in Iraqi soils, which have high calcium carbonate content and relatively high pH value. The properties of these soils cause nitrogen loss through water erosion and wind erosion or may be lost in the form of gases by ammonia volatilization and denitrification, causing environmental pollution (Narula, 2000). The addition of nitrogen in one batch has a negative effect on the plant and thus adversely affects the growth and yield characteristics (Cox & Reisenauer, 1973)and (Mattas, Uppal, & Singh, 2011). The addition of nitrogen at different stages of growth of the crop leads to good growth of the plant and thus increase the grain yield of wheat (Amer, 2004) and (Anonymous, 2000) indicated that the addition date of fertilizers is more important than the amount of fertilizers added to the plant. Therefore, researchers are constantly looking for possible ways to increase the productivity of wheat and improve its quality through the use of fertilizers, especially nitrogenous and additional dates during the stages of plant growth. Nitrogen has a positive role in increasing production and improving its quality through its role in improving the physiological growth of the plant when it available in the stages of growth, this depends on factors such as cultivar and date of addition (H. K. M. A. Al-Haidari & Al-Baldawi, 2010)and (H. K. M. Al-Haidari & Mohammed, 2007) revealed a significant difference in the response of wheat cultivars to dates of nitrogen fertilizer application. This study was conducted with the aim of finding the appropriate date for the addition of nitrogen fertilizer with the best variety for optimal growth and consequently an increase in the quantity and quality of production.

Materials and Methods

A field experiment was conducted during the season 2017 -2018 in Al-Jadwal Al-Gharbi district - Karbala governorate which is about 22 km from the centre of the province to study the effect of three additional dates of nitrogen fertilizer on the growth and yield of six cultivars of wheat. The randomized complete block design (RCBD) was used with three replicate and two factors. The first was the addition rates of nitrogen fertilizer (T1= Adding fertilizer in two equal batches while planting and at elongation; T2= adding of fertilizer in three equal batches when planting, elongation and boot phase; T3= adding of fertilizer in four equal batches when planting, elongation and boot phase, and flowering) while the second factor was six wheat cultivars (Rashid, Ibaa 95, Ibaa 99, Abu Ghraib, Tamooz 2, Tahadi). Soil preparation operations were carried out including ploughing, harrowing and levelling .The experimental unit was divided into experimental units in the form of slabs. The area of the experimental unit was 4 m^2 (2m×2m) by 54 experimental units, thus the total area of the experiment (216 m^2) and then the seeds were sowed on 15 November 2017. Nitrogen fertilizer was added in the form of urea fertilizer which contains 46% N by 80 $kg.ha^{-1}N$ according to the recommendations of the Ministry of Agriculture (Al-Kubaisi & Saleh, 2000). Irrigation and weeding services were carried out as needed and the plants were harvested at full maturity.

Studied traits in the experiment

Plant height (cm): Plant height of 10 plants were chosen randomly was measured from the soil surface to the end of the spike of the main branch without awn at the 100 % flowering stage using measuring tape then their average was taken (Wiersma, Oplinger, & Guy, 1986).

Flag leaf area (cm^2): It was calculated for ten flag leaves representing ten plants and then their average was taken according to the following equation of Thomas (Thomas, 1975).

Area of flag leave (cm^2) = Flag leaf length (cm)+ Maximum width of flag leaf(cm)x0.95

Spike length (cm): This was measured by a measuring ruler for ten spikes of ten plants at physiological maturity then their average was taken.

Spike number ($spike.m^2$): This was calculated at the physiological maturity stage by determining one square meter and taking into account the number of spikes in it for each experimental section then its average was taken.

Grains number in each spike ($grain.spike^{-1}$): The number of grains was estimated for 10 spikes from each section at random, then their average was taken.

Weight of 1000 seed (g): the weight of 1000 seeds were calculated by hands randomly from spike's seeds that have was weighed to calculate the total plant product for each experimental section then was weighed with an accurate electronic scales.

Grain yield ($tons\ ha^{-1}$): It was calculated from the average grain yield per square meter (gm^{-1}) and adjusted based on 14% moisture and then converted to $tonsha^{-1}$ (Briggs & Ytinfisu, 1980).

Statistical analysis

The data were analyzed statistically using the analysis of variance according to the Randomized Complete Block Design (RCBD) with a factorial experiment. The means of the treatments were compared using the least significant difference (LSD) at the probability level (0.05) between the treatments using the statistical software (Genstate) to find out the nature of the differences between the treatments (Steel & Torrie, 1981).

Result and Discussion

Plant height (cm)

The results demonstrated in the table (1) indicated that there was a significant effect of nitrogen fertilizer application dates, the cultivars and their interaction. The treatment of T3 gave the highest plant height, that which was (100.17 cm) whereas T1 gave the lowest plant height (93.06 cm) with an increasing plant height of 7.64 %. These results were also indicated that there was a significant difference among cultivars where Abu Ghareeb gave the highest plant height which was 104.00 cm while Abaa 95 gave the lowest plant height (89.56 cm) with an increasing plant height of 16.12 %. The reason for that may be attributed to the genetic variation between of two cultivars in the length of internodes, in particular the higher internode which represents about half the height of the wheat plant (Al-Baldawi, 2006). As for the interaction, Abu Ghareeb cultivar grown in T3 treatment gave the highest plant height (108.00 cm) while T1 treatment with Abaa 95 gave the lowest for plant height (87.33 cm) which was significantly different compared with other treatments.

Table1: Effect of nitrogen fertilizer addition dates and cultivars on plant height (cm)

Cultivars	Nitrogen fertilizer addition dates			The average
	T_1	T_2	T_3	
Rasheed	95.33	98.33	103.67	99.11
Abaa 95	87.33	89.67	91.67	89.56
Abaa 99	95.33	102.67	102.67	100.22
Abu Ghareeb	99.33	104.67	108.00	104.00
Tamuz 2	91.33	92.67	99.33	94.44
Tahadi	89.67	93.33	95.67	92.89
LSD 0.05 of interaction	**2.30**			LSD 0.05 of Cultivars **1.33**
The average	93.06	96.89	100.17	
LSD 0.05 of Nitrogen fertilizer addition dates	**0.94**			

Flag leaf area (cm^2):

The results in a table (2) clarified that there were significant effects for the additional dates of nitrogen fertilizer and cultivars in the f flag leaf area, but there was no significant effect for their interactions in this trait. The treatment of T1 gave the high-

est rate of the flag leaf area, that which was 39.89 cm^2 while T3 gave the lowest rate of the flag leaf area (37.11 cm^2) with an increasing ratio reached 7.52 %. The results also indicated that there were significant differences among cultivars where Tamoz2 gave the highest rate of flag leaf area (46.67cm^2) while Rasheed gave the lowest rate (31.89cm^2) with an increasing ratio reached 46.35 % (Table 2). These results could be attributed to the genetic differences among wheat cultivars and these outcomes agreed with previous studies (Al-Aseel, Al-Obaidi, & Al-Qadi, 2018).

Table2: Effect of nitrogen fertilizer addition dates and cultivars on flag leaf area (cm^2)

Cultivars	Nitrogen fertilizer addition dates			The average
	T_1	T_2	T_3	
Rasheed	33.00	31.67	31.00	31.89
Abaa 95	37.67	37.67	32.67	36.00
Abaa 99	44.33	43.67	39.33	42.44
Abu Ghareeb	39.67	41.33	38.00	39.67
Tamuz 2	47.33	45.67	47.00	46.67
Tahadi	37.33	36.33	34.67	36.11
LSD 0.05 to the interaction	**Ns**			LSD 0.05 of Cultivars **3.04**
The average	39.89	39.39	37.11	
LSD 0.05 of Nitrogen fertilizer addition dates	**2.15**			

Spike length (cm):

The results showed no significant effect on the dates of application of nitrogen fertilizer on the spike length (Table 3). On the other hand, wheat cultivars had a significant effect on the spike length rate, while Rasheed had the highest spike length rate (13.21 cm) relative to the spike length average. with Abu ghareeb which gave the lowest rate (8.40 cm) with an increasing ratio by 49.94% (Table 3). These results could be attributed to the genetic differences among wheat cultivars and these results agreed with previous researchers (Jbeil & Faleh, 2014). The interaction also was significant as overlapping with Rasheed cultivar grown in T_3 treatment was superior by giving the highest rate of spike length which was 13.57 cm whereas Abu Ghareeb cultivar grown in T_1 treatment gave the lowest rate (8.07 cm).

Table 3: Effect of nitrogen fertilizer addition dates and cultivars on spike length (cm)

Cultivars	Nitrogen fertilizer addition dates			The average
	T_1	T_2	T_3	

Rasheed	13.00	13.07	13.57	13.21
Abaa 95	8.23	9.23	8.97	8.81
Abaa 99	12.13	11.90	10.50	11.51
Abu Ghareeb	8.07	8.30	8.83	8.40
Tamuz 2	11.10	11.33	8.73	10.39
Tahadi	9.27	9.40	10.33	9.67
LSD 0.05 To the interaction	**1.07**			LSD 0.05 of Cultivars **0.62**
The average	10.30	10.54	10.16	
LSD 0.05 of Nitrogen fertilizer addition dates	**Ns**			

Spikes number (spike.m^2)

The results of table (4) indicated that there was a significant effect of nitrogen fertilizer addition dates, the cultivars, and their interaction on the rate of spikes number, where T1 gave the highest rate of spike number reached 284.7 spike.m^2, while T2 gave the lowest rate of spike number which was only 265.1 spike.m^2 with an increasing rate by 7.39%. The superiority of the date of addition (T1) may be due to the fact that the plant exploited a greater amount of nitrogen in the formation of a greater number of tillers, which in turn gave a greater number of spikes as in the later stages the plant has completed its vegetative growth and the added nitrogen to the plant is used to develop other plant characteristics and this result agreed with previous studies (Al - Azzawi, 2005)and (Wali,2000). The results also indicated that there were significant differences among the cultivars where Tamoz2 gave the highest rate of spikes number (314.0 spike.m^2) while Rasheed gave the lowest rate (224.8 spike.m^2) with an increasing rate by 39.68 %.Variation of the cultivars in the number of spikes m^2 may be attributed to the ability of Tamuz2 cultivar to produce fertile tillers, in addition to the difference among cultivars in the ability to absorb nitrogen during the stages of growth (Noulas, 2002), which is reflected positively in increasing spike number m^2.These results were consistent with previous studies by (Abdel-Rahman, 2009), (Saleem, 2003) and (Sangtarash, 2010). The interaction also was significant, where Abaa99 cultivar with T1 treatment gave the highest rate of spike number (345.0 spike.m^2) while Rasheed cultivar grown in T3 treatment gave the lowest rate (212.8 spike.m^2).

Table 4: Effect of nitrogen fertilizer addition dates and cultivars on spikes number (spike.m^2)

Cultivars	Nitrogen fertilizer addition dates			The average
	T_1	T_2	T_3	
Rasheed	232.3	229.7	212.3	224.8

Abaa 95	298.7	265.3	283.0	282.3
Abaa 99	345.0	289.7	295.7	310.1
Abu Ghareeb	235.3	247.0	260.7	247.7
Tamuz 2	329.0	284.7	328.3	314.0
Tahadi	268.0	274.3	259.3	267.2
LSD 0.05 to the interaction	**35.4**			LSD 0.05 of Cultivars **20.4**
The average	284.7	265.1	273.2	
LSD 0.05 of Nitrogen fertilizer addition dates	**14.5**			

Grain number in each spike (grains.spike^{-1})

The result of the table (5) indicated that there were significant effects of nitrogen fertilizer addition dates and the cultivars on the rate of grain number in the spike, but there was no significant effect of the interaction between them in this trait. The T3 treatment gave the highest rate of grain number in the spike (41.61 grains.spike^{-1}), while T1 gave the lowest rate of grains number in the spike (37.22 grains.spike^{-1}) with an increasing rate was11.79%. The superiority of treatment (T3) may be attributed to the fact that the plant absorbs most of the nitrogen from the beginning of the tillering stage to the flowering stage, which coincides with the emergence and development of sites and setting of cereals in the spikes, which increases the rate of pollination and fertilization and thus leads to an increase in the number of grains in the spikes. These results were indicated previously by (H. K. M. A. Al-Haidari & Al-Baldawi, 2010) and (Mercedes, Frank, & Cincent, 1993). The results also showed that there was a significant difference among the cultivars where Tamuz2 gave the highest rate of grain number in the spike (45.11 grains.spike^{1}) while Rasheed gave the lowest rate (35.22 grains.spike^{-1}) with an increasing ratio of 28.08%. The reason of these results could be due to the genetic differences among wheat cultivars and these results agreed with the results of (Al - Azzawi, 2005), (Al-Aseel et al., 2018)and (Al-Mohammadi, 2011).

Table (5): Effect of nitrogen fertilizer addition dates and cultivars on grain number in the spike (grains.spike^{-1})

Cultivars	Nitrogen fertilizer addition dates			The average
	T_1	T_2	T_3	
Rasheed	32.67	34.67	38.33	35.22
Abaa 95	39.00	40.67	42.00	40.56

Abaa 99	38.33	43.67	45.67	42.56
Abu Ghareeb	35.67	37.67	37.00	36.78
Tamuz 2	43.67	44.00	47.67	45.11
Tahadi	34.00	38.67	39.00	37.00
LSD 0.05 to the interaction	**Ns**			LSD 0.05 of Cultivars **3.31**
The average	37.22	39.78	41.61	
LSD 0.05 of Nitrogen fertilizer addition dates	**2.34**			

weight of 1000 grains (g)

The result of the table (6) showed that there were significant effects of nitrogen fertilizer addition dates and the cultivars on the rate of the weight of 1000 grains, but there was no significant effect of the overlapping between them. The treatment of T3 gave the highest rate of the weight of 1000 grains (36.33 g) while T1 gave the lowest rate (30.44 g) with an increasing rate by 19.35 %. The results also indicate that there were significant differences among the cultivars as Rasheed gave the highest rate of the weight of 1000 grains 38.89 g compared with Abaa 95 which gave the lowest rate (26.56 g) with an increasing rate of 46.42%. The reason of these results could be caused by the genetic differences among wheat cultivars and these results were mentioned previously by (Hussain, Shah, Hussain, & Iqbal, 2002)and (Johari, Qasimov, & Maralian, 2010).

Table 6: Effect of nitrogen fertilizer addition dates and cultivars in weight of 1000 grains (g)

Cultivars	Nitrogen fertilizer addition dates			The average
	T_1	T_2	T_3	
Rasheed	35.67	39.33	41.67	38.89
Abaa 95	25.67	25.67	28.33	26.56
Abaa 99	33.00	36.33	39.67	36.33
Abu Ghareeb	29.67	32.67	34.67	32.33
Tamuz 2	31.33	34.33	43.33	36.22
Tahadi	27.33	30.33	30.67	29.44
LSD 0.05 to the interaction	**Ns**			LSD 0.05 of Cultivars **2.99**
The average	30.44	33.11	36.33	
LSD 0.05 of Nitrogen fertilizer addition dates	**2.11**			

Grain yield (ton.ha^{-1})

The result of the table (7) showed that there were significant effects of nitrogen fertilizer addition dates, the cultivars, and their interaction on grain yield. The treatment of T3 gave the highest rate of grain yield (4.23 tons.ha^{-1}) while T1 gave the lowest rate of it (3.22 tons.ha^{-1}) with an increasing rate reached 31.37%. The reason for the superiority of T3 treatment may be due to its superiority in the number of

grains in the spike (Table 5) and the weight of 1000 grains (Table 6). The result also revealed that there were significant differences among the cultivars where Tamuz2 gave the highest rate of grain yield (5.02 tons.ha^{-1}) while Tahadi gave the lowest rate (2.90 tons.ha^{-1}) with an increasing rate by (73.10 %) (Table 7). This may be due to the highest average area of the flag leaf (Table 2), the number of spikes (Table 4) and the number of grains in the spike (Table 5) of Tamuz2 cultivar. These results are consistent with (Al-Mohammadi, 2011), that was indicated of wheat varieties were different in grain yield. There was significant interaction on grain yield, where T3 with Tamuz2 cultivar gave the highest rate of grain yield (6.72 tons.ha^{-1}) while T1 with Tahadi gave the lowest rate (2.49 tons.ha^{-1}) (Table7).

Table 7: Effect of nitrogen fertilizer addition dates and wheat cultivars on grain yield (ton.ha^{-1})

Cultivars	Nitrogen fertilizer addition dates			The average
	T_1	T_2	T_3	
Rasheed	2.83	3.11	3.39	3.11
Abaa 95	2.65	2.82	3.34	2.94
Abaa 99	4.73	4.66	5.36	4.92
Abu Ghareeb	2.50	3.04	3.49	3.01
Tamuz 2	4.11	4.21	6.72	5.02
Tahadi	2.49	3.15	3.06	2.90
LSD 0.05 to the interaction	**0.72**			LSD 0.05 of Cultivars **0.41**
The average	3.22	3.50	4.23	
LSD 0.05 of Nitrogen fertilizer addition dates	**0.29**			

Based on the results of this study, it can be concluded that the dates of the addition of nitrogen fertilizers clearly affect the grain yield of wheat crops. The addition of nitrogen in four equal lots was found to be optimal for achieving the highest rates of grain-related traits. .It can also be concluded that the cultivars vary in the properties studied at the different fertilizer addition dates when it was found that tamuz2 has the potential to provide optimum growth rates and yield grains, But it wasn't significantly different to Abaa 99. It can, therefore, be proposed that the cultivars of Tamuz2 and Abaa 99 can be planted in four equal amounts with the addition of nitrogen fertilizers to achieve the highest yield of grain.

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