Effect of nitrogen fertilizer, its addition dates, and polymer gel on the yield traits and its components of bread wheat (Triticum aestivum L.)

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ABSTRACT

A field experiment for the agricultural season (2019-2020) was conducted at two locations (Al-Hamdania, Talkif) to study the effect of nitrogen fertilizer, its addition dates, and polymer gel on the yield traits and its components of bread wheat (Triticum aestivum L.) Talafar 3 cultivar. The Randomized Complete Block Design (RCBD) was used according to the split-plots system, with three replicates. The experiment included two factors, which are five levels of nitrogen fertilizer and its addition dates is zero, the control treatment, (40 kg N / H2 / 1 + 2/1), (40 kg / H3 / 1 + 3/2), (80 kg / ha 2/1 + 2/1), (80 kg / ha 3/1 + 3/2) and four levels of polymer gel (0, 0, 160, 240 kg.ha⁻¹). The nitrogen fertilizer treatments and the addition date occupied the main plots in the experiment and the polymer gel treatments occupied the subplots. The results indicated that the levels of nitrogen fertilizer and its addition date achieved a significant increase in the yield traits and its components for both locations, where the level of 80 kg.h⁻¹ and the first and second dates gave a significant superiority in most of the traits, also the levels of polymer gel caused a significant increase in the yield traits and their components for the two research locations, and there was a significant interaction in the yield traits and their components for the two research locations.

Keywords: polymer gel, nitrogen fertilization, addition dates. Research paper from the Ph.D. thesis for the second Author.

تاثير السماد النتروجيني ومواعيد اضافته والهلام المائي في صفات الحاصل ومكوناته لمحصول حنطة الخبز .) (Triticum aestivum L

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الخلاصة

اجريت تجربة حقلية للموسم الزراعي 2019–2020 في موقعين(الحمدانية ، تلكيف) لدراسة تاثير مستويات السماد النتروجيني ومواعيد اضافته والهلام المائي في صفات الحاصل ومكوناته لمحصول حنطة الخبز (Triticum aestivum L)الصنف تلعفر (3)وأستخدام تصميم القطاعات العشوائية الكامله (RCBD) وفق نظام الألواح المنشقة وبثلاثة مكررات وتضمنت التجربة عاملين وهما خمسة مستويات من السماد النتروجيني ومواعيد اضافته (صفر) معاملة المقارنة،(40كغم/Nهـ2/1+2/1)،(40كغم/هـ 3/1+3/2)،(80كغم/ه الالاراك كغم/هـ 3/1+3/2) واربعة مستويات من الهلام المائي (0، 0 ما60, 10 كغم/هـ 2/1+2/2)،(80 كغم/هـ الالاراك الالحاح الرئيسة في التجربة . Main Plot واحتلت معاملات الهلام المائي الالواح الثانوجيني وموعد الاضافة الألواح الرئيسة في التجربة . Main Plot واحتلت معاملات الهلام المائي الالواح الثانوية على النتائج ان مستويات السماد النتروجيني ومواعيد اضافته (صفر) معاملة الموانية، (160, 0 م معاملات السماد النيتروجيني وموعد الاضافة الألواح الرئيسة في التجربة . Main Plot واحتلت معاملات الهلام المائي الالواح الثانوية Sub plots المائوي المائوي الحاصل ومكوناته والنتائج ان مستويات السماد النتروجيني ومواعيد اضافته حققت زيادة معنوية في صفات المائي الالواح الثانوية Sub plot المائول اعطى المستوى (160 ، 240كغم/هـ) تفوق معنوي في اغلب صفات الحاصل ومكوناته لموقعي البحث وكان هنالك تداخل معنوي في صفات الحاصل ومكوناته لموقعي البحث . الكلمات المفتاحية : الهلام المائي ،التسميد النتروجيني مواعيد اضافته.

الكلمات المفتاحية : الهلام المائي ، التسميد النتروجيني مواعيد اضافته البحث مستل من اطروحة الدكتوراه للباحث الثاني.

1. INTRODUCTION

The cultivation of wheat (wheat bread) (Triticum aestivum L.) occupies great strategic importance in global markets, and this has prompted many developed countries to adopt important economic policies aimed at developing the crop and reducing its import for the purpose of achieving self-sufficiency, which means that countries seek to raise the competitiveness of this crop to enhance their exports and develop their security sources of cash (1). Wheat production is affected by a set of changes, the most important of which are those related to natural conditions and climatic changes related to limited rainfall, that is, fluctuations in the levels of precipitation, their distribution, timing, temperature, and drought, which leads to a decrease in the area and production of the wheat crop (12). Adding fertilizer at the basal branching encourages basal branching and any addition of fertilizer should be completed before emerging the spikes (3). Nitrogen fertilizers are considered one of the important factors that lead to an increase in the yield, and they must be applied in the specified quantities and at the dates recommended by the Ministry of Agriculture (9). The polymer gel is used to enhance the efficiency of using nutrients and water, and it is more important in areas that are almost guaranteed and not guaranteed rain, where it is able to provide water and nutrients to the plant and releasing it slowly to the plant, and it also works to aerate the soil and increasing its porosity (13). Mandil et al., (10) indicate when using the polymer gel in anvil on the wheat plant to know the moisture content of the soil, the polymer gel treatment has preserved the soil moisture content for a longer period compared to the control treatment, as well as rationalizing water consumption for the longest possible period. This research aims to test the best level of nitrogen fertilizer and its addition date, as well as testing the technique of adding polymer gel to the soil and determining the appropriate level to obtain a high yield of bread wheat cultivated in areas that are almost guaranteed to rain.

2. MATERIALS AND METHODS

A field experiment was conducted in two locations for the winter agricultural season (2019-2020), where the first experiment was conducted in the Jliokhan region belonging to the Al-Hamdaniyah district. It is an Anual region with almost guaranteed rain, which is 15 km from the center of Mosul city, and the other is in the Tilkaif area, which far 20 km from the center of Mosul city. It is also in the same rainy area, the Anual-region, with almost guaranteed rain to study the effect of nitrogen fertilizer, the dates of its addition on the yield, and its components for the bread wheat crop (Triticum aestivum L.). The experiment was applied using the RCBD design according to the split-plots system as reported by (Al-Rawi and Khalaf Allah, 4), with three replicates and each replicates consists of (20) experimental units and each experimental unit consist of (5) lines with a length of (5 m) and a distance (17 cm) between one line and another and the distance between one experimental unit to another is (1 m) and between one replicate and another is (1 m). The nitrogen fertilization levels and their addition dates occupied the main-plots and the levels of polymer gel occupied the sup-plots. In this study, the TalAfar (3) cultivar was used. The cultivation lines were performed with the preservative cultivation seeder (Zero Tillage) and cultivating (250 grains.m⁻²) with manual cultivation equivalent to 100 kg.ha⁻¹. The polymer gel was mixed with the first addition

date of nitrogen fertilizer and the entire phosphate fertilizer which is amounted to (90 kg.ha⁻¹ (46% P₂O₅)) when planting at a depth of (9 cm) and a seed depth (5 cm). The planting date was at 11/15/2019 in the Hamdaniya location and on 11/18/2019 for the Talkif locations, which is a variety approved by the Ministry of Agriculture. The factors used in the study were as follows:

The first factor: the levels of nitrogen fertilizer and its addition dates, which are five levels including:

The control treatment, (40 kg N/ha 2/1 +2/1), (40 kg/ha 3/1 + 3/2), (80 kg/ha 2/1 +2/1), (80 kg/ha $3 \setminus 1 + 3 \setminus 2$).

The addition dates include:

The first date is half the quantity at planting and the other half at the beginning of the appearance of three Tiller.

The second date is one-third of the amount at planting and the other two-thirds at the beginning of the appearance of the tiller. The second factor: the polymer gel with four levels (0, 80, 160 and 240 kg.ha⁻¹). Samples were taken from different locations at a depth of (0-30 cm) before planting and mixed to ensure the homogeneity of the experiment soil, it was airdried, then milled and analyzed in the Department of Environmental Protection and Improvement, Duhok Environment, Division of Laboratories. To determine the chemical and physical traits, the results of the analysis are shown in Table (1), and the averages of rainfall were taken from the two locations (Al-Hamdaniya and Talkif) for the season (2019-2020) belonging to the Directorate of Agriculture in Nineveh as shown in Table (2).

Type of Sample	Clay %	Silt %	Sand %	Textur e	Nitroge n (Ppm)	Phosphorou s (Ppm)	Potassiu m (Ppm)	Organi c matter	Р Н	EC (dS.m ⁻¹)
Al- Hamdaniy a	55.80	36.4 0	7.80	Clay	330	35.48	325	1.32	7. 8	0.168
Talkif	20.30	45.2 0	34.50	Loamy	670	48.07	260	1.22	7. 3	0.262

Table 2: Average of rainfall and temperatures of the season (2019-2020) for the two study locations (Al-Hamdaniya and Talkif).

Month-year	October (1) 2019	November (2) 2019	December 2019	January 2020	February 2020	March 2020	April 2020	May 2020	Total
Al- Hamdaniya	16	5	102	74	144	28	28	0	397
Talkif	13	3	130.5	98	225	31.5	31.5	0	532.5

Source: Directorate of Nineveh Agriculture, Department of Planning.

The following traits were studied: number of spikes per m², spike length (cm), the weight of seeds per spike (g), number of grains per spike, the weight of 1000 grains (g), grain yield (g.m⁻²), straw yield (g.m⁻²), Biological yield (g.m⁻²)

according to (2, 14), harvest index (%), percentage of protein, protein yield $(g.m^{-2})$ according to (6). The data for the studied traits were analyzed statistically by computer using SAS (5) according to R.C.B.D with the split-

plots system as reported by (Al-Rawi and Khalaf Allah, 4). The Duncan's Multiple Range Test was used to compare the averages of the treatments for each source of the variance sources with the significant effect (15). The averages followed by different letters indicate the presence of significant differences between them.

3. RESULTS AND DISCUSSION

Tables (3, 4, 5, and 6) show the response of most of the yield traits and its components for the levels of nitrogen fertilizer, its addition dates, and polymer gel, as well as the interaction between the levels of nitrogen fertilizer, its addition dates, and polymer gel levels in most of the yield traits and its components.

1- Number of spikes per m²

Tables (3, 4) shows that the level of 80 kg N.ha⁻ and the first and second addition date gave the highest average for the trait amounted to $(336.83 \text{ and } 341.33 \text{ spikes.m}^{-2})$, respectively, while the control treatment gave the lowest average of the trait amounted to (259.08 spikes.m⁻²) for Al-Hamdaniya location. As for Talkif location, the level of 80 kg N.ha⁻¹ and the second addition date gave the highest average for the trait, which amounted to (476.25 spikes.m⁻²), while the control treatment and the fertilizer level (40 kg N.ha⁻¹) and the first and second addition times gave the lowest average for the trait amounted to (384.33, 378.17, 370.83 springs.m⁻²). There was a significant effect of polymer gel on the trait of the number of spikes.m⁻² for both locations, in Al-Hamdaniya location, the level of (160, 240 kg.ha⁻¹) achieved the highest average for the trait amounted to $(311.07, 307.20 \text{ spikes.m}^{-2})$, while the control treatment gave the lowest average for the trait, which amounted to (275.80 spikes.m⁻²). As for Talkif location, the level of (240 kg.ha⁻¹) achieved the highest average for the trait, which amounted to $(426.07 \text{ spikes.m}^{-2})$, while the control treatment gave the lowest average for the trait, which amounted to (376.27

spikes.m⁻²). Tables (5,6) indicate the presence of interaction between nitrogen fertilizer and its addition dates and polymer gel in the trait of the number of spikes, the two locations (Al-Hamdaniya and Talkif), where the level of nitrogen fertilizer (80 kg N.ha⁻¹) and the second addition date, and the level of (240 kg.ha⁻¹) polymer gel gave the highest average for the trait which amounted to (368.67 and 531.67 spikes.m⁻²) for the two locations, respectively.

2- Spike length (cm)

Tables (3 and 4) show that the level of (80 kg N.ha⁻¹) and the first addition date achieved the highest average of the trait amounted to (8.07 cm) and It did not differ significantly from the fertilizer level of (80 kg.ha⁻¹) and the second addition date, which amounted to (7.89 cm), while the control treatment, the fertilizer level of (40 kg N.ha⁻¹), and the first addition date gave the lowest average of the trait amounted to (6.93 and 6.65 cm), respectively. As for the Talkif location, the level of nitrogen fertilizer (80 kg.ha⁻¹), and the second addition date gave the highest average for the trait amounted to (9.08 cm), while the control treatment gave the lowest average for the trait amounted to (8.01 cm). The polymer gel has significantly affected in the trait of spike length at both locations of (Al-Hamdaniya and Talkif). In Al-Hamdaniya location, the level of polymer gel (240 kg.ha⁻¹) achieved the highest average of trait amounted to (7.62 cm), and it did not differ significantly from the level of (160 kg.ha⁻¹), which amounted to (7.48 cm), while the control treatment and the level of polymer gel (80 kg.ha⁻¹) gave the lowest average for trait amounted to (7.08 and 7.17 cm). As for Talkif location, the level (240 kg.ha⁻ ¹) gave the highest average for the trait amounted to (8.99 cm), while the control treatment gave the lowest average for the trait, which amounted to (8.38 cm). Tables (5, 6) show that the interaction between the level of fertilizer (80 kg N.ha⁻¹) and the first addition date and the level of polymer gel (240 kg.ha⁻¹) achieved the highest average of spike length

amounted to (8.63 cm). As for the Talkif location, the interaction between the level of nitrogen fertilizer $(80 \text{ kg N.ha}^{-1})$ and the second addition date and the level of polymer gel (240 kg N.ha⁻¹) gave the highest average for the trait amounted to (10.66 cm).

3- weight of grain per spike (g)

Tables (3 and 4) indicate that the level of (80 kg N.ha⁻¹) and the first addition date gave the highest average for the trait amounted to (1.29 g), while the level of (40 kg N.ha⁻¹) and the first addition date gave the lowest average for the trait amounted to (0.95 g). As for the Talkif location, there were no significant differences between the levels of fertilizer and its addition dates to the trait of weight of grains in the spike. The polymer gel had no significant effect on the weight of the seeds in the spike and for the two research locations. Tables (5 and 6) indicate that the interaction between the level of nitrogen fertilizer (80 kg N.ha⁻¹), the second addition date and the level of polymer gel (240 kg.ha⁻¹) gave the highest average for the trait amounted to (1.53 g) for Al-Hamdaniya location, while at the Talkif location, there was no interaction between the factors.

4- The number of grains per spike

Tables (3, 4) indicate that the level of (80 kg N.ha⁻¹) and the first and second addition dates achieved the highest average for the trait, which amounted to (29.30 and 28.2 grains.spike⁻¹), respectively. while the control treatment gave the lowest average for the trait which amounted to (24.25). This is due to an increase in the trait of the spike length, where the number of grains in the spike is directly affected by the length of the spike (7). As for Talkif location, the level of (240 kg.ha⁻¹) achieved the highest average for the trait, which amounted to (37.42 grains.spike ¹). It did not differ significantly from the level of (160 kg.ha^{-1}) , which amounted to (35.32)grains.spike⁻¹), while the control treatment gave the lowest average for the trait amounted to (31.94 grains.spike⁻¹). Tables (5, 6) indicates that there was an interaction between the nitrogen fertilizer and its addition dates and the polymer gel in the traits of the number of grains in the spike for the two experiment locations, where the nitrogen fertilizer level (80 kg N.ha⁻¹), the second addition date and the polymer gel (240 kg.ha⁻¹) gave the highest average for the trait amounted to (32.46 grains.spike⁻¹) for Al-Hamdaniya location. At the Talkif location, there was an interaction between the nitrogen fertilizer, its addition dates, and the polymer gel, where the level of (80 kg N.ha⁻¹), the first addition date, and the polymer gel (240 kg.ha⁻¹) gave the highest average for the trait amounted to (40.40 grain.spike⁻¹).

5- Weight of 1000 grains (g)

Tables (3, 4) indicate that the weight of 1000 grains was not significantly affected by the factors of the nitrogen fertilizer, its addition dates, the polymer gel, and the interaction between them for Al-Hamdaniya location. As for the Talkif location, the level of nitrogen fertilizer (80 kg N.ha⁻¹), the first addition date gave the highest average for the trait amounted to (42.01 g), and it did not differ significantly from the rest of the levels and the adding dates, while the control treatment gave the lowest average for the trait amounted to (39.89 g). The polymer gel had no significant effect on the trait of the weight of 1000 grains for the two locations. Tables (5, 6) indicate that there was no significant interaction between the nitrogen fertilizer, its addition dates, and the polymer gel in the trait of the weight of 1000 grains for the Talkif location.

6- grain yield (g.m⁻²)

Tables (3,4) show that the level of fertilizer (80 kg N.ha⁻¹), the first and second addition date achieved the highest average for the trait amounted to (390.50, 370.83 g.m⁻²), respectively, while the control treatment and the level of fertilizer (40 kg N.ha⁻¹) and the date of the first and second addition gave the lowest average for the trait amounted to (216.17,

234.00, and 253.17 g.m⁻²), respectively. At the Talkif location, the level of nitrogen fertilizer (80 kg N.ha⁻¹), the second addition date gave the highest average for the trait amounted (616.00 $g.m^{-2}$), while the control treatment gave the lowest average for the trait amounted to (478.67 g.m⁻²), the level of polymer gel (160, 240 kg.ha⁻¹) gave the highest average for the trait, which amounted to $(310.93, 321.60 \text{ g.m}^{-2})$, while the control treatment gave the lowest average for the trait amounted to (250.53 g.m⁻²) at Al-Hamdaniya location. As for Talkif location, the highest grain yield was at the level of polymer gel (240 kg.ha⁻¹), which amounted to (580.27 $g.m^{-2}$), while the lowest average for the trait was at the control treatment amounted to (501.73 $g.m^{-2}$). Tables (5,6) indicate that there is an interaction between the nitrogen fertilizer, its addition dates, and the polymer gel in the trait of the grain yield in the two locations of the experiment. The highest average for the trait was at the level of nitrogen fertilizer (80 kg N.ha⁻¹). The first and second addition date and the level of polymer gel (240 kg.m⁻²) amounted to (445.33, 434.00 g.m⁻²), respectively for Al-Hamdaniya location. As for Talkif location, the highest average for the trait was at the interaction between the level of nitrogen fertilizer (80 kg N.ha⁻¹), the second addition date, and the level of polymer gel (240 kg.ha⁻¹) which amounted to $(703.33 \text{ g.m}^{-2})$.

7- Straw yield (g.m⁻²)

Tables (3 and 4) show that the level of fertilizer (80 kg N.ha⁻¹) and the first and second addition dates achieved the highest average for the trait amounted to (621.50 and 601.83 g.m⁻²) respectively, while the control treatment, the level of fertilizer (40 kg N.ha⁻¹), and the first and second addition date gave the lowest average for the trait amounted to (359.42, 351.33, 407.00 g.m⁻²), respectively. At Talkif location, the level of nitrogen fertilizer (80 kg N.ha⁻¹) and the first and second addition dates gave the highest average for the trait amounted to (1071.92 and 1134.50 g.m⁻²), respectively,

while the control treatment gave the lowest average for the trait amounted to $(831.67 \text{ g.m}^{-2})$. At Al-Hamdaniya location, the level of polymer gel (160, 240 kg.ha⁻¹) achieved the highest average amounted to $(501.20 \text{ and } 514.53 \text{ g.m}^{-2})$, respectively. while the control treatment gave the lowest average for the trait amounted to $(410.20 \text{ g.m}^{-2})$. At the Talkif location, the highest average for straw yield was at the level of polymer gel (240 kg.ha⁻¹) amounted to $(1021.20 \text{ g.m}^{-2})$, and the lowest average for the trait was at the control treatment, which amounted to $(913.80 \text{ g.m}^{-2})$. Tables (5, 6) indicate that the interaction between the level of nitrogen fertilizer (80 kg N.ha⁻¹), the first and second addition dates, and the level of polymer gel (240 kg.ha⁻¹) achieved the highest average for this trait amounted to (708.00 and 706.00 g.m⁻²), respectively, for Al-Hamdaniya location. At Talkif location, the highest average for the trait was at the interaction between the level of nitrogen fertilizer (80 kg N.ha⁻¹), the second addition date, and the level of polymer gel (240 kg.ha⁻¹) amounted to (1303.33 g.m⁻²).

8- Biological yield (g.m⁻²)

Tables (3 and 4) show that the level of nitrogen fertilizer (80 kg N.ha⁻¹) and the first and second addition dates achieved the highest average for the trait amounted to $(1013.6, 975.5 \text{ g.m}^{-2})$, respectively, while the control treatment, the level of fertilizer (40 kg N.ha⁻¹), and the first and second addition dates gave the lowest average for the trait amounted to (575.4, 596.0, 660.1 g.m^{-2}), respectively. As for the Talkif location, the level of (80 kg N.ha⁻¹) and the second addition date gave the highest average for the trait amounted to $(1752.2 \text{ g.m}^{-2})$, and it did not differ significantly from the first addition date to the same level, which amounted to $(1648.3 \text{ g.m}^{-2})$ and the lowest average for the trait was at the control treatment which amounted to (1307.8 g.m⁻²). As for the Talkif location, the level of (80 kg N.ha⁻¹), the second addition date, and the level of polymer gel (160, 240 kg.ha⁻¹) gave the highest average for the

trait, which amounted to $(815.4, 836.1 \text{ g.m}^{-2})$, while the control treatment gave the lowest average for the trait amounted to (664.2 g.m^{-2}) at Al-Hamdaniya location. At the Talkif location, the highest average of biological yield was at the level of polymer gel (240 kg.ha⁻¹) amounted to $(1598.9 \text{ g.m}^{-2})$, while the lowest average for the trait was at the control treatment amounted to $(1415.6 \text{ g.m}^{-2})$. Tables (5 and 6) indicate that the highest average for the trait was at the interaction of the level of (80 kg N.ha⁻¹) for the first and second addition dates and the level of polymer gel (240 kg.m^{-2}) , which amounted to (1153.3,1140.0 $g.m^{-2}),$ respectively. As for Talkif location, the highest average for the trait was at the interaction between the level of nitrogen fertilizer (80 kg N.ha⁻¹) for the second addition date and the level of polymer gel (240 kg.ha⁻¹), which amounted to $(2006.7 \text{ g.m}^{-2}).$

9- Harvest index (%)

Tables (3 and 4) show that there was no significant effect for the nitrogen fertilizer, its application dates, and polymer gel on the trait of the harvest index at Al-Hamdaniya location. As for Talkif location, the level of fertilizer (40 kg N.ha⁻¹) for the second addition date gave the highest average for the trait amounted to (37.48%). As for the level of $(80 \text{ kg N.ha}^{-1})$, the first and second addition date gave the lowest average for the trait amounted to (34.91 and 35.09%), respectively. The reason for this is attributed to the increase in the vield of seeds not commensurate with the increase in the biological yield. This was reflected in the reduction of the Harvest Index values, and the trait of Harvest Index was not significantly affected by the polymer gel factor at the Talkif location. Tables (5 and 6) show that the interaction between the level of nitrogen fertilizer (80 N kg.ha⁻¹), the first addition date and the level of polymer gel (80 kg.ha⁻¹) achieved the highest average for this trait amounted to (40.85). At the Talkif location, the interaction between the level of nitrogen fertilizer (40 kg N.ha⁻¹), the second addition date, and the level of polymer gel (240 kg.ha⁻¹) achieved the highest average for the trait, which amounted to (38.63%).

10- the Percentage of protein (%)

Tables (3 and 4) indicate that there was no significant effect of the nitrogen fertilizer and its addition dates on the trait of the percentage of protein for Al-Hamdaniya location. As for the Talkif location, the fertilizer level (80 kg N.ha⁻¹) and the second addition date gave the highest average for the trait amounted to (11.03%). While the control treatment gave the lowest average for the trait, which amounted to (10.45%). The reason for this may be attributed to the increased provision of the nitrogen element as well as the increase in the total amount of nitrogen at this location as shown in Table (1), and then increasing its absorption by the plant, where the nitrogen element enters the composition of the amino acids that represent the basic stone in building protein (16), which led to Increasing the percentage of protein, the polymer gel had no significant effect on the percentage of protein for both locations. Tables (5 and 6) show that there is an interaction between nitrogen fertilizer, its addition dates, and polymer gel in the percentage of protein for Al-Hamdaniya location, where the level of nitrogen fertilizer (80 kg N.ha⁻¹), the second addition date and the level of polymer gel (240 kg.ha⁻¹) gave the highest average for the percentage of protein, which amounted to (11.13%). As for the Talkif location, there was no significant interaction between the nitrogen fertilizer and its addition dates and the polymer gel for this trait.

11 - protein yield

Tables (3 and 4) indicate that the level of fertilizer (80 kg N.ha⁻¹), the first and second addition date achieved the highest average of protein yield amounted (40.41, 40.3 g.m⁻²), while the control treatment, the level of fertilizer (40 kg N.ha⁻¹), and the first and second addition

date gave The lowest average for the trait amounted to $(22.88, 25.69 \text{ and } 26.48 \text{ g.m}^{-2})$, respectively. At the Talkif location, the level of fertilizer (80 kg N.ha⁻¹) and the second addition date gave the highest average for the trait amounted to (68.13 g), while the control treatment gave the lowest average for the trait amounted to (49.75 g). The effect of polymer gel significantly affected the protein yield in both locations. In Al-Hamdaniya location, the level of polymer gel (80, 160, 240 kg.ha⁻¹) gave the highest average for the trait amounted to $(31.51, 33.09, \text{ and } 33.46 \text{ g.m}^{-2})$, while the control treatment gave the lowest average for the trait amounted to (26.56 g.m^{-2}) . As for the Talkif location, the highest average of protein vield was at the level of polymer gel (240 kg.ha⁻ ¹) amounted to (63.01 g.m^{-2}) , and it was not significantly different from the levels of (80, 160 kg.ha⁻¹). As for the lowest average for the trait, it was at the control treatment which amounted to (52.72 g.m^{-2}) . This was due to the increase in the trait of grain yield, which was positively reflected in increasing the protein yield. Tables (5 and 6) show the presence of an interaction between the nitrogen fertilizer and its addition dates and the polymer gel in the trait of protein vield for the two locations of the experiment. The highest average of the trait was at the level of nitrogen fertilizer (80 kg.ha-1) for the second addition dates and the level of polymer gel (240 kg.m⁻²) which amounted to (48.51 g.m⁻²) for AL-Hamdaniya location, While the highest average for the trait was at the level of the fertilizer and the two addition dates at the same level of polymer gel, with an average of amounted to (79.86 g.m^{-2}) .

Table 3: The effect of nitrogen	fertilizer and its addition dates on	the traits of vield and its	components for the two locations.
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(Al-Hamdaniya location)												
Yield traits (nitrogen fertilizer and its addition dates)	Number of spikes (m ²)	Spike length (cm)	Grain weight (g.spike ⁻ ¹)	Number of grains (grain.spike ⁻ ¹)	weight of 1000 grains (g)	Grain yield (g.m ⁻²)	Straw yield (g.m ⁻²)	Biological yield (g.m ⁻²)	Harvest index (%)	Percentage of protein (%)	Protein yield (g.m ⁻²)	
0	259.08b	6.93c	1.01ab	24.25b	40.63a	216.17b	359.42b	575.42b	37.27a	10.56a	22.88b	
40(2\1+2\1)	266.67b	6.65c	0.95b	26.28ab	42.05a	234.00b	351.33b	596.0b	38.35a	10.62a	25.69b	
40(3\1+3\2)	281.67b	7.15bc	1.08ab	25.58ab	41.30a	253.17b	407.00b	660.1b	38.07a	10.40a	26.48b	
80(2\1+2\1)	336.83a	8.07a	1.29a	29.30a	41.96a	390.50a	621.50a	1013.6a	38.30a	10.69a	40.41a	
80(3\1+3\2)	341.33a	7.89ab	1.25ab	28.24a	41.50a	370.83a	601.83a	975.5a	37.98a	10.80a	40.30a	
					Talkif l	ocation						
0	384.33 b	8.01 b	1.41 a	33.05 a	39.89 b	478.67 b	831.67 b	1307.8 c	36.46 ab	10.45 b	49.75 b	
40(2\1+2\1)	378.17 b	8.75 ab	1.43 a	33.50 a	40.57 ab	511.83 ab	890.83 b	1407.7 bc	36.57 ab	10.64 ab	54.024 ab	
40(3\1+3\2)	370.83 b	8.75 ab	1.49 a	34.19 a	41.26 ab	525.83 ab	872.50 b	1398.3 bc	37.48 a	10.84 ab	57.048 ab	
80(2\1+2\1)	427.3 3 ab	8.83 ab	1.58 a	35.69 a	42.01 a	577.00 ab	1071.9 a	1648.3 ab	34.91 b	10.69 ab	60.49 ab	
80(3\1+3\2)	476.25 a	9.08 a	1.57 a	36.16 a	41.08 ab	616.00 a	1134.5 a	1752.2 a	35.09 b	11.03 a	68.13 a	

The numbers have the same letter do not differ significantly at the probability level (5%).

	(Al-Hamdaniya location)											
Yield traits (polymer gel (kg.ha ⁻¹))	Number of spikes (m ²)	Spike length (cm)	Grain weight (g.spike ⁻ ¹)	Number of grains (grain.spike ⁻ ¹)	weight of 1000 grains (g)	Grain yield (g.m ⁻²)	Straw yield (g.m ⁻²)	Biological yield (g.m ⁻²)	Harvest index (%)	Percentage of protein (%)	Protein yield (g.m ⁻²)	
0	275.80 b	7.08 b	1.03 a	25.10 a	41.13 a	250.53 b	410.20 b	664.2 b	37.45 a	10.56 a	26.55 b	
80	294.40 ab	7.17 b	1.05 a	26.50 ab	41.48 a	288.67 ab	446.93 ab	740.8 ab	38.61 a	10.54 a	31.51 a	
160	311.07 a	7.48 ab	1.12 a	27.23 ab	41.54 a	310.93 a	501.20 a	815.4 a	37.75 a	10.61 a	33.09 a	
240	307.20 a	7.62 a	1.20 a	28.48 a	40.79 a	321.60 a	514.53 a	836.1 a	37.17 a	10.75 a	33.46 a	
					Talkif	location						
0	376.27 b	8.38 c	1.49 a	31.94 c	41.03 a	501.73 b	913.80 b	1415.6 b	35.50 a	10.71 a	52.72 b	
80	409.87 ab	8.54 bc	1.42 a	33.39 bc	41.25 a	537.20 ab	929.60 b	1466.8 b	36.51 a	10.64 a	57.09 ab	
160	417.33 ab	8.82 ab	1.51 a	35.32 ab	40.20 a	548.27 ab	976.53 ab	1530.1 ab	36.06 a	10.74 a	58.73 a	
240	426.07 a	8.99 a	1.56 a	37.42 a	41.38 a	580.27 a	1021.20 a	1598.9 a	36.35 a	10.83 a	63.01 a	

Table 4: The effect of polymer gel and its addition dates on the traits of yield and its components for the two locations.

The numbers have the same letter do not differ significantly at the probability level (5%).

(Al-Hamdaniya location)												
The nitrogen fertilizer and its addition dates	The level of polyme r gel (kg.ha ⁻ 1)	Numbe r of spikes (m ²)	Spike lengt h (cm)	Grain weight (g.spik e ⁻¹)	Number of grains (grain.spik e ⁻¹)	weigh t of 1000 grain s (g)	Grain yield (g.m ⁻²)	Straw yield (g.m ⁻²)	Biologic al yield (g.m ⁻²)	Harves t index (%)	Percentag e of protein (%)	Protei n yield (g.m ⁻²)
	0	226.33 e	6.10 f	1.17 a-c	22.76 d	40.43 a	194.00 e	316.33 f	509.7 g	37.70 a b	10.70 ad	20.67 f
0	80	256.67 d e	7.26 c- e	0.95 c	22.63 d	40.30 a	218.00 d e	352.00 f	570.0 e-g	37.90 ab	10.50 c-d	23.05e f
U	160	291.33 b-e	7.36 b-e	1.03 c	25.90 a-d	41.20 a	237.33 d-e	396.67 d-f	634.0 e-g	37.20 ab	10.60 a-d	25.16 e f
	240	262.00 de	7.00 d e	0.90 c	25.73 a-d	40.60 a	215.33 d-e	372.67 e-f	588.0 e-g	36.30 b	10.46 c-d	22.65 e f
	0	236.00 e	6.56 ef	0.90 c	23.76 cd	42.00 a	209.33 d-e	324.00 f	550.0 fg	37.60 ab	10.30 c-d	21.58 e-f
40(2\1	80	291.33 b-e	6.56 fe	0.95 c	28.23 a-d	42.66 a	216.67 de	318.00 f	560.07 fg	38.56 a b	10.60 a-d	26.36 e-f
+2\1)	160	268.67 de	6.60 f-e	1.02 c	27.83 a-d	42.33 a	280.67 c-e	.420.00 c - f	700.7 c-g	37.26 ab	10.73 a-d	29.95 c-f
	240	270.67 de	6.86 d-f	0.94 c	25.30 b-d	41.20 a	229.33 de	343.33 f	572.7 e-g	39.96 ab	10.86 a-c	24.88 ef
	0	289.33 b-e	6.56 d e	0.96 c	23.23 c d	40.76 a	213.33 d e	350.00 f	563.3 f g	37.53 a b	10.73 a-d	22.95 e f
40	80	276.67 d e	7.13 d-f	1.04 c	24.73 c d	42.03 a	248.67 d e	410.67 d – f	659.3 d - g	37.50 a b	10.30 c d	25.73e f
40 (3\1+3\2)	160	282.00 c — e	7.60 a – e	1.11 b- c	27.16 a – d	40.93 a	266.67 с — е	424.67 c − f	691.3 c - g	38.60 a b	10.36 c d	27.83 d -f
	240	278.67 d e	7.33 b - e	1.20 a - c	27.20 a – d	41.46 a	284.00 с — е	442.67 c − f	726.3 c - g	38.03 ab	10.20 d	29.43 c-f

Table 5: The effect of the interaction between the nitrogen fertilizer and its addition dates and the polymer gel for the yield trait and its components.

	Δ	314.00	7.76	1.29 a -	26.56a d	<i>4</i> 1 10	318.67	552.67	871.3 a	36.20	10.26a d	33.57
	U	a -d	a – d	с	20.30a - u	41.10	b -d	a– e	- e	b	10.30 c u	b- f
	6 0	324.00	7.50	1.17 a-	20.020 d	41.23	398.67	570.00	968.7 a	10.950	10.52h d	42.88
80(2\1+2\1	80	a – d	b -е	с	28.83a - a	а	a b	a – d	- c	40.85 a	10.55 D-a	a b
)	160	353.33	8.40 a	1.27 a	20.060 0	42.66	399.33	655.33	1061.3 a	38.13	10.76 a –	43.34
	100	a – c	b	b	50.00a - c	а	a b	a b	b	a b	d	a b
	240	356.00	8.63	1.45 a	21.72a b	42.86	445.33	708.00	1153.3	38.03 a	11 10a b	41.85
	240	a b	a	b	51.75 a D	а	a	a	а	b	11.10 a D	a -c
	0	313.33	8.40	1.16 a –	20.20a d	41.36	317.33	508.00	826.7 b –	38.23	10.70a d	34.00 b
	U	a – d	a b	с	29.20 a – u	а	b-d	b-f	f	ab	10.70 a– u	-d
	00	323.33	7.40 b	1.15 a -	28.06a d	41.20	361.33	584.00	945.3 a	38.23	10.76a.d	39.52
80(3\1+3\2	80	a – d	-е	с	28.00 a – u	а	a– c	a– d	$-\mathbf{d}$	ab	10.70 a- u	a -d
)	160	360.00	7.46	1.17 a-	27.220 d	40.60	370.67	609.33	990.0 a -	37.56	10.60 a-	39.16
	100	a b	b-e	с	27.23a - u	а	a – c	a - c	С	a b	d	a– d
	240	368.67	8.30	1.520	22.460	42.83	434.00	706.00	1140.00	37.90	11 12	48.51
	240	а	a – c	1.558	52.40 a	а	a	a	1140.0 a	a b	11.15 a	а
					Tal	kif locati	on					
	0	376.27	8.38	1.400	a 31.94 c	41.03	501.73	913.80	1415 6 b	35.50	10.716	52.72
		b	c	1.49 a		a	b	b	1415.00	a	10.71 a	b
	80	409.87	8.54	1.420	22.20h a	41.25	537.20	929.60	1466 8 b	36.51	10.646	57.09
0	00	a b	b c	1.42 a	55.590 C	a	a b	b	1400.80	a	10.04 a	a b
U	160	417.33	8.82	1510	25.22a h	40.20	548.27	976.53	1530.1 a	36.06	10.746	58.73
	100	a b	a b	1.31 a	55.52 a D	a	a b	a b	b	а	10.74 a	a
	240	426.07	8.99	1.560	27 120	41.38	580.27	1021.20	1508.00	36.35	10.820	63.01
	240	a	a	1.30 a	37.42 a	a	a	a	1396.98	a	10.65 a	a
	Δ	372.67	6.50	1 220	20.824	39.47	393.33	746.67	11/2 2 f	34.70	10.40a	10.060
	U	b c	d	1.23 a	29.83 u	a	d	e	1145.51	b-d	10.40 a	40.900
	80	382.00	7.96	1 200	20.004	39.76	467.33 c	782.67	. 1250 e -	37.26 a	10.400	47.69
40(2\1 +2\1)	00	b c	c	1.29a	29.90 u	a	d	e	f	- c	10.40 a	d-e
	160	386.00	8.80 b	1 579	35.16a d	39.47	511.33	868.67	1376.7	37.100	10.405	53.17
	100	b c	c	1.3/a	55.10 a – u	a	b-d	c-e	b-f	a – c	2 10.40 a	с–е
	240	396.67	8.80 b	1 570	37.33 a – c	41.10	542.67	928.67	1461.3	36.86	6 10.639	57.19
	24 0	b c	c	1.37 a		a	bc	b-e	b-f	a – c	10.05 a	b-d

	Δ	366.00	8.60 b	1 2 2 2	22 (0a d	39.53	512.67	884.67	1397.3	36.90	10.00-	55.41
	U	b c	с	1.558	32.00 C-Q	a	b-d	c-e	c-f	a – c	10.90 a	b– e
	00	377.33	8.33 b	151-	22 (2- 4	40.36	492.67	864.00	1356.7	36.200	10.50-	51.71 c
40	80	b c	с	1.51 a	33.03 a-a	a	c d	c-e	c-f	a – c	10.50 a	e
(3\1+3\2)	1(0	385.33	9.30 a	1.520	22 ((a.d.	40.40	520.00	908.00	1448.0	36.73	10.70-	54.29
	100	b c	b	1.32 a	32.00 C-Q	a	$\mathbf{b} - \mathbf{d}$	b-e	c-f	a – c	10.70 a	c-e
	240	384.00	8.76 b	1 20-	25.10- 1	41.73	522.00	906.67	1428.7	36.46 a	10.46-	54.69
	240	b c	с	1.38a	33.10 a – a	a	b-d	b-e	c–f	- c	10.40 a	b– e
	Δ	362.67	8.76	1510	21.16 a.d.	41.86	493.33 c	851.33	1344.7	36.70 a	10.70-	52.88 c
	U	b c	b c	1.31 a	31.10 C-Q	a	d	d e	d-f	- c	10.70 a	—е
	00	256,000	8.66 b	1 420	22.26h d	42.00	502.67	840.67	1343.3 e	37.26	10.52	52.60 c
80(2\1+2\1	80	330.00 C	с	1.42 a	33.30 D-Q	a	b-d	d e	f	a – c	10.5 5a	-е
)	160	408.69	9.13 a	1.60 a	27.90-	40.13	554.67	924.67	1478.7 b -	37.33 a	10.00-	60.58
		b c	b		37.80 a – C	a	b c	b-e	е	- c	10.90 a	b– d
	240	356.00	8.43 b	1 4 4 2	34.43 a – d	41.06	552.67	874.00	1426.7	38.63	11.23 a	62.11
	240	c	с	1.44 a		a	b c	c-e	b-f	a		b-d
	0	463.33	9.33	1.00	22.76	43.00	579.33	1006.33	1586.0 b -	36.46	10.46	55.34 c
	U	a – c	a b	1.888	33./0 a - u	a	a – c	b-d	d	a – c	10.40 a	—е
	00	428.00	8.56	1.460	24.70a.d	42.40	581.33	1099.33	1680.7 b	34.10 b	10.00	63.48
80(3\1+3\2	80	a-c	b c	1.40 a	34.70 a -u	а	a – c	b	с	с	10.90 a	b c
)	1(0	256,000	8.53	1.40a	22.00a d	40.46	566.67	1088.67	1655.3 b	34.33 b	10.00	61.95
	100	330.00 C	b c	1.40 a	33.90 a – a	а	b c	b	$-\mathbf{d}$	с	10.90 a	b-d
	240	462.00	8.90	1 (0 a	a 40.40a ⁴	42.00	580.67	1093.33	1671.3	34.76	76 - c 11.50 a	61.18
	240	a – c	b c	1.00 a		a	a-c	b	b-d	a – c		b-d

The numbers have the same letter do not differ significantly at the probability level (5%).

					(Al-H	amdaniy	a location)					
			-		The Mean Sq	uare of t	he deviation	s M.S.				
Sources of differen ce	Degree s of freedo m	Number of spikes (m ²)	Spike length (cm)	Grain weight (g.spike ⁻¹)	Number of grains (grain.spik e ⁻¹)	weight of 1000 grains (g)	Grain yield (g.m ⁻²)	Straw yield (g.m ⁻²)	Biologica l yield (g.m ⁻²)	Harve st index (%)	Percenta ge of protein (%)	Protein yield (g.m ⁻²)
Sectors	2	8032.31	0.40066	0.0333	25.0803	7.5705	35580.06	54306.516	184575.6 50	4.5909	10.6446 **	788.4845 *
Nitroge n fertilizer and its addition dates (A)	4	18434.9 **	4.55708 *	0.2636	60.9770	3.9326 6	79605.93 **	211787.483 **	544903.8 50 **	2.2410	0.2662	867.8285 **
Nitroge n fertilizer x sectors (error 1)	8	2133.02	0.77233	0.09794	19.7091	6.0721 6	11068.48	14004.558	46036.40 0	10.995 1	0.1898	120.7562
polymer gel (B)	3	3790.28	0.99527 *	0.06253	32.1882	1.1122	14808.71 **	35260.238 *	91751.12 8 *	3.8131	0.1388	151.7404 *
A x B	12	881.92	0.58319	0.040933	8.1110	1.7038	1809.26	3936.238	10055.29 4	3.6736	0.1745	22.6591
Nitroge n fertilizer x polymer gel x sectors (error 2) A x B	30	1397.99	0.33244	0.037590	12.0058	1.6947	3164.22	10187.705	24277.09 4	3.5778	0.08594	43.9051

Appendix 1: Table of variance analysis, the traits of yield and its components for the two locations of the experiment.

error												
Total							59					
					r	Falkif loc	ation					
Sectors	2	4787.11 6	0.2461	0.000015 00	2.8101	16.911 *	2172.466	32210.216	43143.26 7	14.791	7.1451**	72.7213
Nitroge n fertilizer and its addition dates (A)	4	23584.3 16	1.9073	0.074085	22.1069	7.5454	35650.23 3	215654.733 **	424017.9 00	14.071 4	0.5625	580.7213
Nitroge n fertilizer x sectors (error 1)	8	7472.24 1	0.9215	0.13072	18.2682	3.0042	16000.13 3	25797.008	82466.35 0	3.9492	0.2472	213.3287
polymer gel (B)	3	7112.41 6	1.1364*	0.050888	84.7606**	4.2262	15739.91 1*	35385.350 *	94442.75 6 *	2.9822	0.08977	271.240*
A x B	12	2195.25 00	1.3008* *	0.081945	11.1976	1.7538	4276.633	8688.266	19913.36 7	4.9859	0.1711	60.6100
Nitroge n fertilizer x polymer gel x sectors (error 2) A x B error	30	3657.88 3	0.3231	0.043166	12.1691	5.6683 3	5016.822	10330.716	28254.97 8	2.7525	0.2923	58.2884
Total							59					

*Significant at 5% probability level.

** Significant at 1% probability level.

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