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ORIGINAL ARTICLE

EFFECT OF FERTILIZER FRACTIONATION AND PLANTING DATES ON YIELD AND ITS COMPONENTS OF WHEAT (*TRITICUM AESTIVUM* L.)

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Abstract: A field experiment was carried out in Al-Muthanna Governorate, Warka District, for the season 2020-2021. To find out the effect of planting dates and the splitting of nitrogen fertilizer on the yield and its components for the wheat crop, the experiment was carried out according to the arrangement of the split-plot design, using the Randomized complete block design (RCBD) with three replications. The transactions were randomly distributed within each block, the total of the experimental units was 27 experimental units. The planting dates were 15 October, 1 November and 15 November which took the symbols D1, D2 and D3 respectively, put in the main plots. At the same time, fertilizer fractionation of nitrogen into (two, three and four batches) was placed in different growth stages with a fertilizer level of 200 kg N.ha^{-1} in the sub plots. The results of the experiment showed the superiority of treatment that included four batches in most of the characteristics of the experiment, as it gave the highest averages in the characteristics of grains number, the weight of 1000 grains, grain yield, biological yield and harvest index, amounted to (49.63 grain.spike^{-1}, 38.21 g, 5.74 t.ha^{-1}, 21.02 t.ha^{-1} and 28.11%), respectively, while the treatment three batches were superior in spikes number, it gave the highest average of 439.3 spikes.m^2. As for the planting dates, the planting date D3 was significantly superior in all the characters of the experiment by giving the highest averages of (425.8 spikes.m^2, 48.20 grains. spikes^{-1}, 36.40 g, 5.65 t.ha^{-1}, 20.42 t.ha^{-1} and 27.61%) in spikes number, the number of grains per spike, the weight of 1000 grains, the grain yield, the biological yield and the harvest index on the sequence.

***Key words*:** Wheat (*Triticum aestivum* L.), Fertilizer fractionation, Randomized complete block design (RCBD), Planting dates.

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1. Introduction

Wheat crop (*Triticum aestivum* L.) is one of the main crops in the world, as it is considered a main food for more than 1.5 billion people [Jamali *et al.* (2004)]. It comes at the front of crops in cultivated areas and productivity. The wheat crop tops the list of strategic crops in Iraq, but the production per unit area is low, as it represents only 30% of the productivity of the global unit area [FAO (2017)]. Although Iraq is one of the first countries for the emergence of this crop and the availability of the main production factors such as soil, water and climatic conditions, its productivity is still low due to the failure to follow modern scientific techniques related to the cultivation of this crop.

Understanding the performance of the crop under different environmental conditions (planting dates) will lead us to know its behavior through its response to this change, enabling us to discover its genetic ability through the synchronization of the growth and formation of its various organs with the appropriate climatic conditions whose impact is reflected in increasing productivity and improving its productive qualities and leads us to choose the date that most suitable through the early or late date of transplantation.

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Nitrogen is one of the significant elements for plant growth and is included in most physiological activities and the synthesis of nucleic acids and fatty acids. To raise the efficiency of wheat utilization from nitrogen fertilizer and reduce the lost quantities, including [Hasan *et al.* (2021)], the method of adding nitrogen fertilizer at appropriate times coincides with the stages of emergence, growth and differentiation of components. The result will increase these components and then increase the yield. This experiment was carried out with the aim of knowing the effect of the appropriate number of batches on the growth of the crop and determining the optimal date to achieve the greatest possible benefit.

2. Materials and Methods

A field experiment was carried out in Al-Muthanna Governorate, in Al-Warka District, for the season 2020-2021 to know the effect of planting dates and the fractionation of nitrogen fertilizer on the yield and its components of the wheat crop in soil, showing some of its chemical and physical properties in Table 1.

The experiment was carried out according to the arrangement of the split-plot design, using the Randomized complete block design (RCBD) with three replications, the transactions were randomly distributed within each block. Where the planting dates 15 October, 1 November and 15 November which took the symbols D1, D2 and D3 respectively were put in the main plots, while fertilizer fractionation of nitrogen into (two, three and four batches) was placed in different growth stages with a fertilizer level of 200 kg N.ha^{-1}, in the sub-plots. Then the soil was smoothed with disc harrows and then it was levelled by a levelling machine. The field experimental area was divided according to the design used to panels with an area of (2*2 m) and the planting was done on lines with a distance between them by 20 cm. The secondary plots were separated from each other (0.5 m).

Table 1: Some chemical and physical properties of the field soil.

No.	Season (2017-2018)		
	Analysis type	Value	Unit
1	EC	7.3	Desmans.M^{-1}
2	pH	7.1	
3	Available N.	19.7	
4	Available P.	30.7	Mg.kg^{-1} soil
5	Available K.	125.5	
6	Sand	285	
7	Loam	585	g.kg $^{-1}$ soil
8	Clay	130	
9	Soil Texture	silty loam	

Studied traits

Spikes number.m^2: The number of spikes was calculated after they reached the stage of complete exudation for all harvested plants from two middle lines from each experimental unit.

The number of grains per the spike^{-1}: It was calculated from the average number of grains for ten spikes after manually discarding these spikes and calculating their grains.

Weight of 1000 grains (g): It was calculated from the weight of 1000 grains randomly for each experimental unit using a sensitive electronic balance.

Grain yield (t.ha^{-1}): The grain yield of the harvested plant group was estimated from the two middle lines after manual separation of the plants from each experimental unit. After isolating the straw from the grains, it was weighed and the grain yield (t.ha^{-1}).

Biological yield: It was obtained from the dry matter yield (grain + straw) from an area of 0.45 m^2 from three guarded median lines inside each experimental sub-unit and converted the weight to t.ha^{-1} [Donald and Hamblin (1976)].

6. Harvest index %: It was calculated from the following equation:

$$Harvest\ index\% = \frac{Economic\ yield}{Biological\ yield} \times 100$$

3. Results and Discussion

3.1 Spikes Number.m^2

The statistical analysis results showed that treatment of N3 was significantly superior by giving the highest average of 439.3 spikes.m^2, while the two batches of fertilization treatment N2 gave the lowest average of 398.3 spikes.m^2. This is due to the role of fragmentation of the high fertilizer levels of nitrogen at the stages of growth through which the ribs and ears develop during the branching stage and the elongation stage. This result is consistent with the findings of Al-Haidari and Mohamed (2010) and Abedi *et al.* (2011). The results also showed significant differences between planting dates; the planting date D3 significantly outperformed it by giving it the highest average of 425.8 spikes.m^2. Whereas the planting date D1 gave the

lowest average of 406.4 spikes.m^2 that suited the environmental conditions for a sufficient growth period to transform a more significant number of vegetative branches to bearing spikes, especially in the second planting date, which was associated with an excellent vegetative group and a high level of photosynthesis that provides a sufficient amount of food for distribution among the root and vegetative total, which increases the number of spikes formed and this result agreed with Al-Asil *et al.* (2018) who indicated the effect of planting dates on the number of spikes. It was noted that there was a significant interaction between the two factors, as the combination (D3 X N3) gave the highest average of 454.3 spikes.m^2 (Table 2).

3.2 Grains number.Spike^{-1}

The analysis results in Table 3 showed significant differences between the sowing dates, as the planting date D3 was significantly superior by giving the highest average of 48.20 spikes^{-1}, while the planting date D1 gave the lowest average of 45.23 spikes^{-1}. The reason for the decrease in the number of grains on the first and second dates is attributed to the decrease in low temperatures during the flowering date, which led to the failure of the process of pollination and fertilization and thus led to the formation of semi-empty spikes, especially the spikes of the main stem and primary branches. This result agreed with Jassim *et al.* (2016) who found significant differences between planting dates in the number of grains. The result also showed a significant difference between the fertilization treatments, as the N4 fertilization treatment was significantly superior to four batches by giving it the highest average of 49.63 spikes^{-1}, while D2 gave the lowest average of 44.49 spikes. The reason for this is attributed to the addition of the fertilizer in four batches that was more appropriate in terms of the quantity and time during the stages of emergence and development of the spike and grains had a positive effect in increasing the number of grains, in addition to that, the addition of nitrogen fertilizer during the post-branching stages is important in ensuring the success of the insemination process in most of the flowers and then increasing the number of grains. This result is agreed with Abedi *et al.* (2011).

A significant interaction between the two factors was also observed, as the combination (D3 X N4) gave the highest average of 49.46 spikes^{-1}. In contrast, the combination (D1 X N2) gave the lowest average of 43.64 spikes^{-1}. This is attributed to what was discussed in the results of the factors, which are individual.

Table 2: The effect of planting dates and the fractionation of nitrogen fertilizer on the characteristic of spikes number of crop wheat.

Planting dates (D)	Nitrogen fractionation (N)			Mean D
	N2	N3	N4	
D1	389.3	425.6	404.2	406.4
D2	396.3	438.0	411.7	415.3
D3	409.3	454.3	413.7	425.8
Mean N	398.3	439.3	409.8	
L.S.D.	N	D	D × N	
0.05	6.58	11.40	12.85	

Table 3: The effect of planting dates and the fractionation of nitrogen fertilizer on grains number.

Planting dates (D)	Nitrogen fractionation (N)			Mean D
	N2	N3	N4	
D1	43.64	43.78	48.27	45.23
D2	44.12	46.17	49.46	16.58
D3	45.71	46.17	49.46	48.20
Mean N	44.49	45.90	49.63	
L.S.D.	N	D	D × N	
0.05	0.6	0.6	0.95	

3.3 The weight of 1000 grains (g)

The results showed that there were significant differences between the sowing dates in this trait, as the planting date D3 significantly outperformed the other two dates by giving it the highest average of 36.40 g as the planting date, while D1 gave the lowest average of 34.68 g and without a significant difference with the date D2 and the reason for this is due to the appropriate environmental conditions for the third date, which led to the success of the process of pollination and fertilization and thus an increase in the number of grains in the spike. This result agreed with Hashem and Hana (2012) and Alam *et al.* (2013).

The results also showed a significant difference in the fertilization treatments, as the N4 fertilization treatment with four batches was significantly superior to the rest of the treatments by giving it the highest average of 38.21 g, while the N2 treatment gave the lowest average of 33.12 g. The reason for this is that giving nitrogen fertilizer in four batches increased the efficiency of exploiting it, especially the fruit phase, by increasing the process of photosynthesis by keeping the flag leaf for a longer period, as well as early

flowering, which prolonged the watery period of the grains. It was also noted that there was a significant interaction between fertilization treatments and planting dates, as the combination (D3 X N4) gave the highest average of 40.01 g. In comparison, the combination (D1 X N2) gave the lowest average of 33.15 g.

3.4 Grain yield (t.ha^{-1})

The results in Table 5 showed that there were differences in the sowing dates in the yield trait, as the third sowing date, D3, was significantly superior by giving the highest average of 5.65 t.ha^{-1}, while the date D1 recorded the lowest average of 4.42 t.ha^{-1}. The reason for the superiority of the third date is due to the sufficient number of fertile spikes and the number of grains in the spike (Table 3), as well as the increase in the rate and period of grain filling, which was positively reflected in the weight of the grain (Table 4) as for the decrease in the grain yield for the first and second dates due to the failure of the process of pollination and fertilization, which led to a defect in the number of grains in the spike. This result agreed with Noaema *et al.* (2020). It was also noted that there was a significant difference between the fertilization treatments among themselves, as the N4 fertilization treatment with four batches gave the highest average of 5.74 t.ha^{-1}, while the fertilization treatment of the two batches N2 gave the lowest average of 4.33 t.ha^{-1}. The increase in yield when the nitrogen fertilizer is split and added in four batches is due to its original superiority in the number of grains (Table 3) and the quality of 1000 grains (Table 4). This result agreed with Rahman *et al.* (2011) and Mattas *et al.* (2011), who noted that there was a significant interaction between the two factors, the combination (D3 X N3) gave the highest average of 6.36 t.ha^{-1}, while the combination (D1 X N1) gave the lowest average of 3.91 t.ha^{-1}. This is due to what was discussed in the results of the employees individually.

Table 4: The effect of planting dates and the fractionation of nitrogen fertilizer on the weight of 1000 grains (g).

Planting dates (D)	Nitrogen fractionation (N)			Mean D
	N2	N3	N4	
D1	33.15	33.33	37.56	34.68
D2	31.85	35.34	37.07	34.75
D3	34.34	34.85	40.01	36.40
Mean N	33.12	34.51	38.21	
L.S.D.	N	D	D × N	
0.05	1.22	1.75	3.34	

Table 5: The effect of planting dates and the fractionation of nitrogen fertilizer on Grain yield (t. ha^{-1}).

Planting dates (D)	Nitrogen fractionation (N)			Mean D
	N2	N3	N4	
D1	3.91	4.39	4.96	4.42
D2	4.37	5.37	5.91	5.22
D3	4.70	5.88	6.36	5.65
Mean N	4.33	5.21	5.74	
L.S.D.	N	D	D × N	
0.05	0.21	0.27	0.35	

Table 6: The effect of planting dates and the fractionation of nitrogen fertilizer on Biological yield (t. ha^{-1}).

Planting dates (D)	Nitrogen fractionation (N)			Mean D
	N2	N3	N4	
D1	16.26	17.31	19.57	17.72
D2	17.19	18.42	21.26	18.96
D3	19.08	19.96	21.26	20.42
Mean N	17.51	18.56	21.02	
L.S.D.	N	D	D × N	
0.05	0.60	0.23	N.S.	

3.5 Biological yield (t.ha^{-1})

Table 6 showed significant differences between the planting dates, as the D3 planting date was significantly superior by giving the highest average of 20.42 t.ha^{-1}, while the planting date D1 gave the lowest average of 17.72 t.ha^{-1}. This result is in agreement with the findings of Hashem and Hana (2012) and Jassim *et al.* (2016) that planting the crop at the right time leads to giving plants to high growth rates and thus a high biological yield.

The results also showed that the N3 fertilizer fractionation treatment was superior to the rest of the experimental treatments, as it gave the highest average of 21.02 t.h^{-1}, while the fractionation treatment of fertilizers for the two batches gave the lowest average

Table 7: The effect of planting dates and the fractionation of nitrogen fertilizer on Harvest Index %.

Planting dates (D)	Nitrogen fractionation (N)			Mean D
	N2	N3	N4	
D1	24.02	25.39	25.36	24.93
D2	25.50	29.38	27.83	27.57
D3	24.65	29.56	28.60	27.61
Mean N	24.72	28.11	27.26	
L.S.D.	N	D	D × N	
0.05	0.83	1.48	1.65	

of 17.51 t.ha^{-1}. The reason for this is that the addition of four batches of fertilizer increased vegetative growth and led to increased fruit growth by increasing the number of grains in the spike **(**Table 3). This result agreed with the findings of the Al-Haidari and Mohamed (2010) and Aliawi and Edan (2019).

3.6 Harvest Index %

The results of the statistical analysis in Table 7 indicated that there was a significant effect of planting dates in this trait, as the planting date D3 was significantly superior to giving the highest average of 27.61% without a significant difference with planting date D2, which gave an average of 27.57%, while the planting date D1 gave the lowest average of 24.93 and the increase is due to the planting date D3, the increase in grain yield and biological yield (Tables 5 & 6) and that its increase has a positive effect on increasing the harvest index. It was also observed that there was a significant difference between the fertilizer fractionation treatments, as the hashing N3 treatment outperformed it by giving it the highest average of 28.11% and without a significant difference to the N4 hashing treatment. The results showed a significant interaction between the experimental factors, as the combination (D3 X N2) was superior by giving it the highest average of 29.56% and without significant difference with some combinations. In comparison, the combination (D1 X N1) gave the lowest average of 24.02%.

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