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ASSESSMENT OF MINERAL AND NANO-FERTILIZERS FRAGMENTATION IN WHEAT CROP (*TRITICUM AESTIVUM* L.) FERTILIZATION

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Abstract

A field experiment was carried out in one of the agricultural fields in Al-Fudaliyah city, which is located 11 km South of Dhi Qar province for an assessment study of the mineral and nano-fertilizers fragmentation (N, P) in fertilizing the winter wheat crop season 2018-2017. The experiment was carried out according to Split Plot Design and using the RCBD Design and three replications. The types marked with the symbol A (Al Rashid (A1), Bohouth 22 (A2)) were at the forefront of the main plot, while the fertilization levels marked with (B1, B2, B3, B4, B5) were placed in the sub plot. The results showed differences between Cultivars in some of the studied traits, where Al-Rashid gave the highest average in the number of days from planting to 50% of flowering stage, plant height and spike length (109.12 days, 108.38 cm, 17.252 cm), respectively. While Bohouth 22 far outnumbered in numbers of days from 50% of flowering stage to the physiological maturity, which gave an average of 44.33 days .Whereas they do not significantly differ in the total Yield of seed. The B3 fertilization level showed its superiority in most studied traits. It gave the highest average in the spike length, the flag leaf area and the total yield (15.737 cm, 60.33 cm^2, 11.20 $t.h^{-1}$), respectively and without significant difference with B1, B5, B4. The B1 fertilization level far outnumbered by giving the highest average in plant height, chlorophyll content and number of grains (103.5 cm, 0.7775, 70.67 $g.s^{-1}$), respectively, without significant difference with B3 , B5 , B4. The B1 fertilization level far outnumbered by giving the highest average in the total number of tillers and spikes produced (603.7, 540.7) $t.m^{-2}$, respectively, without significant difference with B1,B3, B5. Results showed a significant decrease in level B2 in all studied traits. The combination (A1 × B1) gave the highest average of spike length of 18.042 cm. That did not differ significantly from the combination (A1 × B3) and (A1 × B5), which gave (17.708, 17,758) cm, while the combination (A2 × B2) gave the lowest average of 12.983 cm.

***Keywords*:** Fragmentation, Mineral Fertilization, Nano-Fertilization, Combinaison.

Introduction

Agricultural systems play a major role in providing food, livelihoods and income improving for many people (Pinstrup, 2011), especially as the world's population is increasing and may reach 9 billion by 2050, as well as changes in fiscal and economic policies, climate and environmental conditions, natural disasters and wars (FAO, 2012). This requires more food in both quantitative and qualitative terms, and agricultural production depends on the provision of food requirements for cultivated crops. A fertilizer is any material of natural (organic or inorganic) or synthetic origin that is applied to soils or directly to the plant tissues in order to supply one or more plant nutrients essential for its growth. The plant needs about 16 nutrients to complete its life cycle. These nutrients should be readily available in the soil, in the required quantity and in a timely manner (Ali *et al*., 2013). Nanotechnology is a modern technique, first announced by the American physicist Richard Feynman in 1959, where he predicted the possibility of creating and inventing small and high-precision technologies in their various scientific purposes. He referred to the possibility of changing the properties of any material and maximizing its characteristics, by arranging their atoms in such a way as to obtain these proprieties which are quite different and distinct from their original characteristics before re-structuring them through the relationship between the environment and its properties (Al-Eskandarany, 2009). Nano-fertilizers play an important role in increasing the crops ability to withstand various stress conditions and increase the crops resistance to diseases, as well as to preserve the required genetic characteristics for different agricultural crops and increase the active substances in plants, in addition to their contribution in transporting compounds to the targeted places, whether leaves, roots, fruits or other parts of the plant, in the metabolic processes by increasing the activity of photosynthesis by increasing the chlorophyll content in the leaves (Lin, 2014). The aim of this research is to study the great importance of the nutrients on plants, because of their distinct role in many important processes that are carried out at the level of cell and the plant as a whole, which is positively reflected on the increase in production, but it may not be readily available in the soil and in sufficient quantity, whether if it's already in the soil or it's applied as fertilizer for exposure to adsorption, sedimentation or sequestration processes, as the need for them continues during the period of plant growth, they had to be applied as fertilizer at a level that helps to make them ready for the plant for the longest possible period of time.

Materials and Methods

A field experiment was carried out in one of the agricultural fields in Al-Fudaliyah city, which is situated 11 km South of Dhi Qar province, within (30' 57' N) and (46' 21' E) Longitude , and 5 m above sea level, during winter planting season 2017-2018. In order to study the assessment of the fragmentation mineral and nano-fertilizers in the fertilization of two varieties of wheat (Al Rashid and Bohouth 22). The soil of experiment was plowed by (Mold board plow) twice and perpendicularly, then the ground was softened by disc plow and leveled out by the leveling machine. Using Split Plot Design, RCBD Design and three replications. Replications were divided into experimental units of (2×2) m, which included ten agricultural lines and a distance of 20 cm between the lines (Advisory Bulletin, 2012) and left (1) m between the experimental units and blocks and (2)m between the main plot per block. The types marked with the symbol A (Al Rashid (A1), Bohouth 22 (A22)) were at the forefront of the main plot, while the fertilization levels were placed in the sub plot, marked with B, which included

First level B1 (N, P recommended mineral fertilizer)

- Second level B2 (N, P recommended nano-fertilizer)
- Third level B3 (0.5(N, P) mineral fertilizer + 0.5(N, P) nano-fertilizer)
- Fourth level B4 (0.25(N, P) mineral fertilizer + 0.75(N, P) nano-fertilizer)
- Fifth level B5 (0.75(N, P) mineral fertilizer + 0.25(N, P) nano-fertilizer)

The seeds of the varieties were planted on 16/11/2017 for the winter season of 2017 -2018, and at a rate of 120 kg per hectare. (Advisory Bulletin, 2012). (Mineral fertilizer) urea fertilizer 46% N, at a rate of 260 kg of urea per Ha^{-1} and Diammonium Phosphate fertilizer DAP 46% P_2O_5 at a rate of 200 kg DAP. Ha^{-1}, (Jadou and Saleh, 2013). As for the nano-fertilizer obtained from the Iranian company Sepehr Parmis, which contains 20% N as emulsifier, and 25% P as granules, that used the advisory bulletin on nano-fertilizer recommendations. The mineral and nano-fertilizer recommendations were divided according to the levels of the second factor and were applied to the four stage of growth, and according to Feekes scale (Emergency F 2.1, Tillering F 2, Stem Elongation F 4, Boot F 10). Weeding and combating bush encroachment processes were carried out during the planting seasons. The plants were harvested on 10/4/2018.Growth traits were studied (number of days from planting to 50%, number of days from 50% of flowering to full maturity, plant height, spike length, the flag leaf area and chlorophyll content (by estimating the vegetation ratio NDVI and using the Handle Green Seeker device (Trimble Navigation, Sunnyvale, CA) Total Tillers) in addition to the yield and its components (tillers produced, number of grain in spike, weight for 1000 grains and total yield). The statistical analysis of all studied traits was carried to the design used by the statistical program (Genstat version 5). The averages were compared using the less significant difference test at 0.05.

Results and Discussion

The number of days from planting to 50% of flowering

The results of Table (1) demonstrated the significant effect of the varieties in number of days from planting to 50% of flowering. Al-Rashid took a little longer to reach 50% of flowering, which averaged 109.12 days, while Bohouth 22 needed a lot less time to reach it and averaged 101.67 days. The difference in number of days from planting to 50% of flowering between varieties is due to the difference in the extent of their response to the temperature and the length of the light period in addition to the difference between varieties in periods of vegetative and reproductive growth phases, starting from germination to full maturity, this is due to the fact that the characteristics of early and delayed flowering dates and other crop growth stages are one of the genetically determined traits. This result agreed with Al-Muayni (2004), Ahmad and Al-Amiri (2012), Aboud and others (2015).

Table 1 : Mean comparison of Number of days from planting to 50% flowering

Treatment	B1	B2	B3	B4	B5	Mean	LSD
A1	109.25	109.58	108.83	109.08	108.83	**109.12a**	
A2	01.83	101.17	102.33	101.25	101.75	**101.67b**	**2.865**
Mean	105.54	105.38	105.58	105.17	105.29		
LSD			**0.816**				**LSD of A×B8.455**

Means followed the same letter within a column are not significantly different (p≤0.05)

The number of days from 50% of flowering to physiological maturity

This trait is very important in determining the amount of crop, as it represents the period of dry matter accumulation in grains. The longer this period is the more positive it will be reflected on the amount. It is noted that Bohouth 22 had the highest average in number of days from 50% of flowering to physiological maturity, reaching 44.33 days, while Al-Rashid had the lowest average of 36.88 days (Table 2). The reason for the difference in number of days from 50% of flowering to physiological maturity between varieties is due to the difference in the period of vegetative growth, which in turn is due to differences in their genetic structures (Table 1). This result agreed with Franklin *et al.* (1993), Al-Aseel (1998), Daoud (1999), Al-Rifai (2000), Al-Zuhairi (2005), Aboud *et al.* (2015) who pointed out the between varieties used in their studies throughout the period of flowering and physiological maturity.

Table 2 : Mean comparison of Number of days from 50% flowering to full maturity

Treatment	B1	B2	B3	B4	B5	Mean	LSD
A1	36.75	36.42	37.17	36.92	37.17	**36.88b**	
A2	44.17	44.83	43.67	44.75	44.25	**44.33a**	**2.865**
Mean	40.46	40.62	40.42	40.83	40.71		
LSD			**0.818**				**LSD of A×B8.455**

Means followed the same letter within a column are not significantly different ($p \leq 0.05$)

Plant Height

The result of (Table 3) shows the significant effect of both varieties and fertilization in this trait. Al-Rashid far outnumbered by achieving an average height of 108.38 cm, while Bohouth 22 gave an average height of 94.12 cm. This coincides with the findings of Al-Aseel (1998), Al-Anbari (2004), Al-Baldai (2006), Al-Hassan (2011), Al-Refai (2015), Al Salem *et al.* (2017), who pointed out that the wheat varieties plants vary in height. Moreover, this variation is due to the fact that this trait is under the influence of the extra gene action as well as the genetic variance in the number of internodes and their lengths especially the upper ones, which represent about half to one third of the plant height. It may also be due to the difference in content of the hormones of oxyin and Algebraline responsible for the elongation of the cells and their expansion, which has a great effect on the height of the plant. In addition, the extension of the period from planting to 50% of flowering for Al-Rashid (Table 1) may be another reason to increase the level of plant height due to the major role of this period in the creation of better plant growth resulted in better exploitation of growth factors, which led to the increase in the manufacture of materials and this reflected on the plant height. The average height was significantly affected by the different levels of fertilization, Level B1 gave the highest average height with 103.56 cm. which did not differ significantly from the levels B3 and B5, that gave an average height of (103.10, 102.83) cm respectively, while the level B2 gave the lowest average height of 96.42 cm. This may be due to the fact that the level B1, B3 has provided the necessary nutrients to increase the concentrations of oxytin and Algebraline, which play an important role in the elongation of plant cells, the activity of the meristematic tissues and the cell division. As nitrogen is one of the fast moving elements within the plant and is transported to the new parts such as meristems responsible for the plant growth, which in turn leads to increase cell division and their elongation, and thus increase plant height. This result agreed with Al-Lami (2004), Al-Nuri (2005), Hussain *et al.* (2006), Mattas *et al.* (2011) and Al-Abdullah (2015).

Table 3 : Mean comparison of plant height

Treatment	B1	B2	B3	B4	B5	Mean	LSD
A1	111.21	102.25	111.17	106.33	110.96	**108.38a**	
A2	95.92	90.58	95.04	94.33	94.71	**94.12b**	**9.005**
Mean	**103.56a**	**96.42c**	**103.10a**	**100.33b**	**102.83a**		
LSD			**2.35**				**LSD of A×B20.824**

Means followed the same letter within a column are not significantly different ($p \leq 0.05$)

Spike Length

The results of (Table 4) show the significant effect of both varieties and fertilization and the interference between them in this trait. Al-Rashid far outnumbered in Spike Length, as it gave an average length of 17.252 cm, while Bohouth gave an average length of 13.317 cm. This variability in the spike length may be due to the genetic differences between the varieties, because this function may be more related to the genetic factor (number of grains in the spike) (Al-Anbari, 2004) and

(Al-Baldawi, 2006). The difference in spike length of the may be due to the difference in the length time, from planting until the emergence of the table spike (Table 1), in which the flag leaf is located and expanded. This result agreed with Ali (2009), Al-Kubaisi (2010), Hassan and Khadr (2012). The B3 fertilization level far outnumbered by giving the highest average in spike length which reached 15.737 cm, that did not differ significantly from the level B1, B5, B4, which gave the average length (15.654, 15.646, 15.121) cm, respectively, while the level B2 gave the lowest average length of 14.262 cm. The significant effect of fertilizer in the spike length trait coincides with the spike emergence and development stages, which extends from the formation of the tillers to the boot stage, which means creating a better incentive for the spike growth and development, as a result of the availability of food supply on the one hand, and the effect of these nutrients in raising the photosynthesis efficiency on the other hand, thereby encouraging a better spike growth and was clearly reflected in increasing its length. The decrease in the spike length may be due to the increase in the number of tillers in the unit area (Table 7, 8), which provided such a competition for nutrients and led to a reduction in the spike length. This result agreed with Al-Lami (2004), Al-Nouri (2005), Al-Badrani and Al-Roumi (2013) and Hassan Al-Dawoudi (2014). The effect of bilateral interference between varieties and levels of fertilization was significant, where Al-Rashid far outnumbered at level B1 and gave the highest average length of spike of 18.042 cm, which did not differ significantly from the level B3, B5, which gave (17.758, 17.708) cm, respectively. While the treatment between Bohouth 22 and level B2 gave the lowest average length of 12.983 cm. The increase in spike length may be due to nutrient utilization during the spike growth phase and the low probability of competition between vegetative and reproductive parts. This result agreed with Faleh *et al.* (2003), Laghani *et al.* (2010), Hassan and Khader (2012), Al-Shabib (2013), Al-Nouri and Anas (2013).

Table 4 : Mean comparison of length of spike

Treatment	B1	B2	B3	B4	B5	Mean	LSD
A1	18.042	15.542	17.758	17.208	17.708	**17.252a**	
A2	13.267	12.983	13.717	13.033	13.583	**13.31b**	**2.314**
Mean	**15.654a**	**14.262b**	**15.737a**	**15.121a**	**15.646a**		
LSD			**0.616**				**LSD of A×B 1.75**

Means followed the same letter within a column are not significantly different ($p \leq 0.05$)

Flag Leaf Area

In this trait, the significant effect was limited to the fertilizing factor. (Table 5) showed that the level B3 gave the highest average flag leaf area of 60.33 cm^2, which did not differ significantly from the level B1, which gave an average area of 58.93 cm^2, while the level B2 gave lowest average area of 52.94 cm^2, which did not differ significantly from level B4, which gave an average area of 55.71 cm^2. This may be due to the fact that the combination of B3 fertilizer has provided nutrients (N, P) from planting until the flowering phase. N is necessary in the metabolic processes that occur within the entire plant. It has a significant effect on cell division and increased the meristematic activity and so the surface area of the leaves. As the abundance of N works to increase the color of chlorophyll in the leaves table (6), then increase the efficiency of photosynthesis, which is positively reflected it the leaf area. N, P also play a major role in roots growth, especially root hairs, and thus increasing their water and nutrients absorptive capacity, which is reflected in increased plant growth and surface area of leaves (Al-Alusi, 2009).

Table 5 : Mean comparison of leaf flag area

Treatment	B1	B2	B3	B4	B5	Mean	LSD
A1	63.69	53.85	62.91	58.87	59.08	**59.68**	
A2	54.18	52.03	57.75	52.56	52.88	**53.88**	**8.291**
Mean	**58.93ab**	**52.94c**	**60.33a**	**55.71c**	**55.98bc**		
LSD			**3.075**				**LSD of A×B 12.327**

Means followed the same letter within a column are not significantly different ($p \leq 0.05$)

Chlorophyll

The results in Table (6) indicated the effect of the fertilizing factor in this trait. The B1 fertilization level far outnumbered by giving the highest average of 0.7775, which did not differ significantly from level B5, B3, which gave the average (0.7715, 0.7656), respectively, while level B2 gave the lowest average of 0.7046. This may be due to the fact that level B1, B5, B3 achieved the required amount of N,P, and since N is one of the important compounds involved in the synthesis of the Porphirin ring involved in making the chlorophyll molecule. This result agreed with Al-Saidi (2002) and Al-Haidari (2003).

Table 6 : Mean comparison of content of chlorophyll

Treatment	B1	B2	B3	B4	B5	Mean	LSD
A1	0.8042	0.7183	0.7879	0.7654	0.7979	0.7747	
A2	0.7508	0.6908	0.7433	0.7250	0.7450	0.7310	**0.073**
Mean	**0.7775a**	**0.7046c**	**0.7656a**	**0.7452b**	**0.7715a**		
LSD			**0.012**				**LSD of A×B 0.16**

Means followed the same letter within a column are not significantly different ($p \leq 0.05$)

Total Tillers

The results showed the significant effect of fertilization levels (Table 7). The B5 fertilization level far outnumbered by giving the highest average of 603.7 tiller. m^{-2}, which did not differ significantly from level B1, B3, B4, which gave the average of (602.2, 590.1, 584.0) tiller. m^{-2}, respectively, while level B2 gave the lowest average of 529.5 tiller. m^{-2}. This may be due to the effect of fertilization in the largest possible number of tillers production, as the availability of fertilizer at the beginning of growth encourages the roots and primary and secondary tillers growth and development, while the availability of fertilizer in the elongation phase and beyond, causes a decrease in the rate of some tillers death, while their survival causes an increase in number of tillers. This result agreed with Alam *et al.* (2007), Al-Rafia and Al-Anbari (2013) and Al-Abdullah (2015).

Table 7 : Mean comparison of Total tillers

Treatment	B1	B2	B3	B4	B5	Mean	LSD
A1	586.1	498.8	561.2	563.1	571.1	556.0	
A2	618.3	560.2	619.1	604.8	636.2	607.8	**83.92**
Mean	**602.2a**	**529.5b**	**590.1a**	**584.0a**	**603.7a**		
LSD			**33.70**				**LSD of A×B 165.12**

Means followed the same letter within a column are not significantly different ($p \leq 0.05$)

Produced Tillers

Table (8) shows a significant increase in the number of tillers produced with fertilization levels. Level B5 gave the highest average number of produced tillers which reached 540.7 tiller. m^{-2}, that did not differ significantly from the levels B1, B3 B4, that gave an average number of (538.1, 529.2, 523.6) tiller.m^{-2} respectively, while the level B2 gave the lowest average of 476.3 tiller.m^{-2}. The fertilization improves vegetative plant growth in general and especially when applied in different stages of growth, which leads to improve the utilization of the effective radiation of photosynthesis, which in turn increases the availability of representative substances that support the emergence of the tillers and the success of their continuous growth (Table 7) which is reflected in the increase in the number of tillers produced in the unit area. This result agreed with Al-Haidari and Baker (2006), Abedi *et al.* (2010), Shahzadi *et al* (2013), Al-Abdullah (2015), Al-Jabouri *et al.* (2017).

Table 8 : Mean comparison of produced of teliers

Treatment	B1	B2	B3	B4	B5	Mean	LSD
A1	523.5	449.1	500.8	504.8	509.7	497.6	
A2	552.7	503.6	557.8	542.3	571.8	545.6	**73.84**
Mean	**538.1a**	**476.3b**	**529.2a**	**523.6a**	**540.7a**		
LSD			**29.77**				**LSD of A×B 157.36**

Means followed the same letter within a column are not significantly different ($p \leq 0.05$)

Number of grains in spike

The results of (Table 9) indicate the significant effect of the fertilization levels on the number of grains in the spike. The B1 fertilization level far outnumbered by giving the highest average number of grains of 70.67 grain. spike^{-1}, which did not differ significantly from level B3, B5, B4 which gave the average of (70.58, 69.12, 66.04) grain. spike^{-1}, respectively. while level B2 gave the lowest average of 60.71 grain. spike^{-1}. This may be due to the fact that the increase in the number of grain results from the availability of nutrients, especially nitrogen, in the first crop growth stages, which helps to increase the efficiency of photosynthesis process and increase the representative substances as well as increase the content of chlorophyll (Tale 6), leading to increase growing spikelet that make up grains, and to find an appropriate opportunity to reduce abortion in florets by reducing the competition between them for the food produced. The increase in the number of grains per spike was associated with an increase in spike length (Table 4). This result agreed with Alam *et al*. (2007), Shahzadi *et al*. (2013) and Hassan and Al-Daoudi (2014).

Table 9 : Mean comparison of Number of Seed

Treatment	B1	B2	B3	B4	B5	Mean	LSD
A1	71.58	55.75	71.08	63.58	68.83	66.17	
A2	69.75	65.67	70.08	68.50	69.42	68.68	**10.014**
Mean	**70.67a**	**60.71b**	**70.58a**	**66.04a**	**69.12a**		
LSD			**5.126**				**LSD of A×B 18.480**

Means followed the same letter within a column are not significantly different (p≤0.05)

Weight for 1000 Seed

The results of (Table 10) showed no significant differences in the factors studied in this trait.

Table 10 : Mean comparison of Weight for 1000 seed

Treatment	B1	B2	B3	B4	B5	Mean	LSD
A1	42.53	44.32	42.73	43.11	42.74	43.09	
A2	41.65	41.90	41.39	41.22	41.27	41.48	**4.307**
Mean	42.09	43.11	42.06	42.16	42.00		
LSD			**1.949**				**LSD of A×B3.35**

Means followed the same letter within a column are not significantly different (p≤0.05)

Total Yield of wheat

The results of Table (11) indicated that the level B3 far outnumbered by giving the highest average yield of 11.20 tons. Ha^{-1}, which did not differ significantly from level B1, B5 which gave the average of (11.05, 10.75) tons. Ha^{-1}, respectively. While level B2 gave the lowest average of 9.44 tons. Ha^{-1}. The increase in grain yields is due to the positive effect of fertilizer levels and their ability to provide nutrients and increase the efficiency of photosynthesis, thus, its positive effect in the increase of total and produced tillers (Table 7, 8), leaf area (Table 5) and chlorophyll (Table 6), and then increase the grain yield, this result confirmed the positive correlation between the mentioned traits and grain yield. This result agreed with Ottman *et al*. (2000), Staggenbong *et al*. (2003) and Williaun *et al*. (2008).

Table 11 : Mean comparison of Yield of Wheat

Treatment	B1	B2	B3	B4	B5	Mean	LSD
A1	10.69	9.24	10.88	9.56	10.86	10.25	
A2	11.41	9.64	11.53	10.65	10.64	10.77	**3.18**
Mean	**11.05a**	**9.44c**	**11.20a**	**10.10bc**	**10.75ab**		
LSD			**0.79**				**LSD of A×B 2.425**

Means followed the same letter within a column are not significantly different (p≤0.05)

Conclusions

The same effect was applied to the process of the use and fragmentation of mineral and nano-fertilizers, and the stages of supplying them to the varieties together with no differences in the total yield. Obtain highest grain yield at B3 fertilization level. The process of use and fragmentation of mineral and nano-fertilizers was so effective that there were no significant differences between levels in most of the studied traits.

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