

The effect of adding mineral and organic fertilizers on the growth of two wheat varieties

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Abstract

A field experiment was conducted in the 2024-2025 agricultural season at the College of Agriculture, Al-Qasim Green University, located at a latitude of 32.04° North and a longitude of 44.39° East, on soil with a loamy-silty texture. The objective was to examine the responses of various bread wheat cultivars to distinct chemical and organic fertilisers and to assess the impact of these fertilisers on growth and yield. The distinct plates established the experiment. Employing the design of completely gridded sections (Randomised Complete Block Design) and executing it thrice. Two varieties of bread wheat were utilised. It is denoted by (A1) (Faithful) and (A2) (Abaya 99). The primary boards (Principal plots) The fertiliser mixtures occupied the secondary panels. The secondary panels (subplots) were occupied by the fertiliser combinations. It comprises a complete chemical fertiliser designated as B0, a biofertilizer referred to as B1, and a purely DAP fertiliser identified as B2.

The study shows the following results

1. The A1 variety (Abba 99) outperformed the Wafi variety by providing the highest average plant height.

2. The variety (Wafiya) excelled by producing the highest average for flag leaf area, number of tillers, number of grains, 1000-grain weight, and grain yield. The variety (Wafiya) excelled by providing the highest average for leaf area, number of tillers, number of grains, 1000-grain weight, and grain yield.

A spraying of biofertilizer in the vegetative part increased the leaf area, spike volume, number of tillers, number of grains, 1000-grain weight, and grain yield.

3. The interaction treatment of biofertilizer and the variety "Wafiya" excelled in all vegetative and yield traits. The interaction treatment of biofertilizer and the variety Wafiya excelled in all vegetative and yield traits.

Introduction

Wheat is considered as one of the most important strategic crops for most of the world's population, as its grains form the basic foundation for human nutrition. It is a vital crop that receives significant attention from researchers specializing in field crops due to its nutritional importance as one of the leading crops that ensure global food security. Therefore, it is essential to rely on sufficient and technologically advanced means to increase production and productivity by

applying programd scientific methods when cultivating it at the lowest costs with the highest yield (Alaamer et al. 2024). In Iraq, wheat is sown by hand and irrigated by flooding, especially in the central and southern regions. These methods lead to significant losses of seeds, water, and added fertilizers. Therefore, these methods are costly because the final yield does not cover the expenses. The Ministry of Agriculture has adopted the technological methods to improve the productivity of field crops by providing all the requirements for plant growth, enhancing

the physical properties of the soil using machines that prepare the soil for growth, and determining the planting depth and spacing, allowing for the execution of all crop service operations without any obstacles. Therefore, experts have been keen to conduct awareness courses on the use of modern technologies that achieve the best growth characteristics with the highest productivity (Alsharifi et al., 2022).

A study by Chen et al. (2019) shows that mineral fertilizers are among the most important elements necessary for the growth of agricultural crops, as plants require chemical fertilizers in large quantities, since crop yield increases with the addition of more fertilizers. The economic yield of any crop is influenced by genetic factors represented by the genetic makeup of the planted variety and various environmental factors, in addition to the type of fertilizers and the methods of applying them to the plants in accordance with the response conditions, with little to no effect on the plant, as the amount of fertilizers is determined by the type, fertility, and texture of the soil. Li et al. (2023) found that the adoption of precision methods led to positive results in improving growth traits and yield productivity with minimal agricultural operations during the growing season until full maturity. Chemical fertilization is considered as one of the technological inputs to increase crop productivity. However, its excessive and repeated use has negative effects on human health and the biological processes of the soil due to the changes caused by chemical fertilizers, which create a partial biological void in the soil (Abril et al., 2007; Ibraheem, 2018). Adopting modern agricultural systems and focusing on the use of nitrogenous fertilizers at optimal levels for any crop prepares a good growth environment for the plant, which is reflected in the improvement of the vegetative growth characteristics of the higher-yielding plant

(Mohammed et al., 2014). Mohammed et al. (2014). One of the available mechanical options to reduce the use of chemical fertilizers is recycling plant and animal waste, which is of high value and low cost, to nourish plants and improve soil properties. The environmental conditions of the agricultural area significantly affect the plant's water needs, Alkhateeb (2014), states that plants are often exposed to harsh conditions due to high temperatures during the flowering stage, which primarily affects growth characteristics and final yield. These characteristics are related to the number of grains, branches, and ears per plant. The decrease in these characteristics leads to a reduction in final yield. Additionally, the field practices used to prepare soil suitable for germination have a direct impact on growth and yield characteristics.

The grain yield is the main goal that both plant breeders and producers strive to achieve. It is considered as a function of the plant yield as well as the number of plants per unit area, and it depends on three main factors: genetic, environmental, and managerial. It is the most important field measure because it reflects the final result of the vital activities performed by the plant. During the growth stage until full maturity and harvest (Alaamer et al. 2021), the biological yield is the sum of the dry matter produced by the plant in all its parts, and it holds high value in scientific standards in the field of the plant's productivity capacity to convert the largest amount of vegetative dry matter into the reproductive part (Mandal et al. 2016).

The objective of the study:
1. The main objective of this research is to study the effect of mineral and organic fertilizers on the growth traits of the two local varieties (Abba and Wafiya). The main objective of this research is to study the effect of mineral and organic fertilizers on the growth traits of the two local varieties (Abba and Wafie).

2. Discussing the extent of the impact of NPK chemical fertilizers on the growth and productivity traits of the plant. Addressing the extent of the impact of NPK chemical fertilizers on the growth and productivity characteristics of the plant.
3. The best indicators of growth and

Material and Methods

3-1 Experiment Location
 A field experiment was conducted during the 2024-2025 agricultural season in the fields of the College of Agriculture – Al-Qasim Green University, located in the southern part of Babil Governorate at a latitude of 32.40° North and a longitude of

productivity for the Bio Health fertilizer used in this study. The best growth and productivity indicators for the Bio Health biofertilizer used in this study.

the experimental design. The experiment was carried out using a split-plot design, where bread wheat varieties occupied the main plots and fertilizer combinations occupied the sub-plots. The field soil was divided into three sectors. The number of experimental units was 6 experimental units with three replicates, resulting in a total of 18 experimental units.

Table 1. Some physical and chemical properties of field soil

soil texture	Soil Separators (g kg ⁻¹)			Organic matter g kg ⁻¹ soil	available elements (mg kg ⁻¹)			Electrical conductivity (EC) ds.m ⁻¹	pH	sample
	Sand	silt	clay		K	P	N			
loamy	25	33	40	7.23	187.2	15.71	31.4	3.72	7.2	soil
	5	6	9		1					

The laboratory test was conducted to determine the germination rates of the two wheat varieties. For the local wheat variety, a quantity of seeds was taken and placed in Petri dishes. Each variety had three test dishes, with each dish containing ten seeds spaced evenly apart. Each dish also contained two sheets of filter paper, which were moistened with distilled water. The dishes were then closed and placed in a dark incubator to monitor germination. After four days, the germination rate for the wheat variety (Wafi) was 96.4%, while the germination rate for the wheat variety (Abba 99) was 91.6%.

3-2 Farming Operations
 Before planting, the field soil was prepped by ploughing it across the field using It was smoothed out using disc harrows and levelled off with hand tools after being

ploughed with a reversible moldboard plough.

Hand tools were employed to split the experimental area into plots, open ditches, and make ridges between them. The planting was done. With a planting depth of 3 cm and a seeding rate of 120 kg ha⁻¹. Each experimental unit was 4 m², had 10 rows, and the space between each row was 20 cm. And the experimental land was watered after the plants were put in.

3-3 Added fertilizers
3-3-1 Ground fertilization with chemical NPK fertilizer
 Use DAP fertilizer (18-46-0) as a source of nitrogen and phosphorus at a rate of 200 kg.

3-3-2 Ground fertilization with biofertilizer
 The BioHealth biostimulant was used, which is produced by Humintech, a

German company, and it consists of water-soluble granules. It contains 75% Humic, 10% of the fungus *Tirchoderma harzianum*, and the bacteria *Bacillus Subtilis*, 5% of seaweed extract, 10-12% moisture, and 11% water-soluble potassium, with a cation exchange capacity greater than 400meq/100g.

3-4 The studied traits

3-4-1 Vegetative growth traits

3-4-1-1 Plant height (cm)

Measure the plant height as the average of five plants in each experimental unit at the milk stage from

From the soil surface to the beginning of the ear

3-4-1-2 Leaf area (cm²)

It was calculated from the average of five plants per experimental unit, and the area was extracted according to the equation (Thomas, 1975).

Leaf area = Leaf length * Width at midpoint * 0.95

3-4-1-3 Number of shoots per m²

The total number of shoots is calculated from the area of one square meter of each experimental unit at the stage 100% preparation

3-4-2 Characteristics of the yield and its components

Number of spikes (m²)

The number of spikes for all harvested plants was calculated per square meter for each experimental unit.

Number of grains per ear (grains per ear - 1)

The average number of grains in ten ears per experimental unit was calculated after threshing and cleaning.

Weight of 1,000 grains (g)

The grain yield of the harvested plants was calculated by measuring the square meter area of each experimental unit, separating the straw from the seeds, weighing the grains, and converting the weight to tonnes per hectare.

Grain yield (tonne ha⁻¹)

It was determined by measuring one square meter of each experimental unit of grain yield from the harvested plants, separating the straw from the seeds, weighing the grains, and converting the weight to tonnes per hectare.

3-5 Statistical Analysis

The statistical analysis was conducted after data collection and tabulation according to the Randomized Complete Block Design (RCBD) with a Split-plot arrangement, using the GenStat statistical software at a 5% significance level. The means were compared using the Least Significant Difference (L.S.D).

Results and Discussion

4-1 The effect of varieties and fertilizer combinations on the vegetative growth traits of wheat crop.

4-1-1 Plant height (cm)

The results of Table 1 indicate a significant difference between the varieties and fertilizer combinations, as well as the interaction between them, in the average plant height characteristic.

The results of Table 1 showed a significant difference between the varieties in the average plant height, with the variety A1 achieving the highest average of 98.63. The reason for the difference in plant height among the varieties is attributed to the genetic variation in the number of internodes and their lengths, especially the upper ones, which have a significant impact on plant height.

The results of Table 1 showed a significant difference between the fertilizer combinations, with the B2 combination giving the highest average. This is attributed to the addition of NPK fertilizer, which increases the rate of material transfer represented by the increase in stem diameter and the transport of materials through the vascular vessels, such as the xylem, which transports water and minerals to the

leaves (Grover et al. 2012). The results in Table 2 also showed a significant interaction between the varieties and the A1B1 fertilizer combinations, attributed to the role of biofertilizers that secrete growth

regulators, which help in cell elongation and increase the activity of meristematic tissues, thereby increasing plant height, in addition to the combined effect of the fertilizers.

Table 1. The effect of varieties and fertilizer combinations and their interaction on plant height (cm)

Varieties	Fertilizer formulations			
	B0	B1	B2	average
A1	89.94	104.09	101.86	98.63
A2	89.19	87.98	90.64	89.7
Average	89.565	96.03	96.25	
L.S.D (0. 05)				
Varieties	Fertilizer formulations		Interference	
1.79	2.06		3.45	

4-1-2 Flag Leaf Area (cm²)

Table 3 shows that there is a big difference in the trait of between the varieties and fertiliser combinations, as well as between the combinations and the varieties.

flag leaf area. The results of Table 2 show a significant difference between the varieties in the average tillers, as the variety A1 achieved the highest average of 41.9. The reason for the superiority of this variety in this trait is attributed to the interaction of the variety with environmental and genetic factors. The results of Table 2 show a significant Table 2. The effect of varieties and fertilizer combinations and their interaction on the

difference between the fertilizer combinations, as the B2 fertilizer combination gave the highest average. The reason for this superiority is attributed to the increase in the efficiency of the photosynthesis process, regulation of metabolism, and improvement of the water system during the vegetative growth stage, which reflects on the growth and development of the plant, and subsequently had a positive effect on increasing the area of the flag leaf (Al-Mousawi 2020). The results in Table 2 shows a significant difference in the interaction between the

trait of flag leaf area (cm²).

4-1-3 Number of Shoots (m²)

The results of Table 3 indicate a significant difference between the varieties and fertilizer combinations, as well as the interaction between them, in the trait of the number of tillers.

The results of Table 3 showed a significant

Varieties	Fertilizer formulations			
	B0	B1	B2	average
A1	36.43	41.9	38.9	39.21
A2	30.6	35.5	30.06	32.74
Average	35.78	38.7	35.78	
L.S.D (0. 05)				
Varieties	Fertilizer formulations		Interference	
0.21	0.54		0.87	

largest possible
 The results of Table 3 show a significant difference between the fertilizer combinations, with the B1 fertilizer combination giving the highest average. The superiority of the fertilizer combination is attributed to the role of NPK fertilizer in increasing nutrient availability, which helped in penetrating plant tissues and increasing their absorption rates. This fully performed its nutritional role within the plant tissues and subsequently stimulated the plants to increase the number of shoots. The results in Table 3 a significant difference in the interaction between the varieties and the fertilizer combinations A2B1. Table 3 - Effect of varieties and fertilizer combinations and their interaction on the trait of number of shoots (m²)

4-2 The effect of varieties and fertilizer

difference between the varieties in the average number of tillers, as the variety A2 achieved the highest average of 319.6. The reason for the differences between the varieties in the number of tillers may be attributed to the variety's ability to produce the largest possible number of tillers.

Varieties	Fertilizer formulations			
	B0	B1	B2	average
A1	270	342	306.7	306.23
A2	275	349	335	319.6
Average	272.5	345.5	320.85	
L.S.D (0.05)				
Varieties	Fertilizer formulations		Interference	
10.07	12.13		10.07	

the shoots to the cultivar's ability to produce the number of shoots combinations on yield traits and components of wheat crop.

4-2-1 Number of ears per m²

The trait of the number of spikes is one of the important components of wheat yield, which varies with different genetic compositions and their ability to produce spikes per unit area. The results indicate a significant difference between the varieties and fertilizer combinations, as well as the interaction between them, in the trait of the number of spikes.

The results of Table 4 show a significant difference between the varieties in the average number of ears, with the A2 variety achieving the highest average of 314.5. The reason for the superiority of this variety in the number of tillers and ears, as shown in Table 3, was reflected in the number of ears per unit area.

The results of Table 4 show a significant difference between the fertilizer combinations, as the B1 fertilizer

Varieties	Fertilizer formulations			
	B0	B1	B2	average
A1	266.7	299.7	273.7	280.33
A2	268.7	344	331	314.56
Average	267.7	321.85	302.35	
L.S.D (0.05)				
Varieties	Fertilizer formulations		Interference	
12.17	14.36		24.06	

combination gave the highest average. This is attributed to its contribution in preparing an active transport system for the phloem, which aids in the transfer of nutrients. The results in Table 4 showed a significant interaction between the varieties and the A2B1 fertilizer combinations. The effect of varieties and fertilizer combinations and their interaction on the trait of number of ears per m².

4-2-2 Number of grains per spike (grains per spike -1)
 The results of Table 5 showed a significant difference between the varieties in the average number of grains per spike (grain spike -1) and the interaction between them in the number of grains per spike (grain spike -1). The variety A2 achieved the highest average, reaching 54.46 grains per spike -1. The reason for the superiority of variety A2 may be attributed to its lower number of tillers in Table 3, which reduced competition among

the plants during their growth stages, reflecting positively on the number of grains per spike. This is consistent with what Al-Halfi (2017) found, who indicated significant differences between the varieties in the trait of the number of grains per spike. The results of Table 5 showed a significant difference between the fertilizer combinations in the average number of grains, as the fertilizer combination B1 gave the highest average. This increase is attributed to fertilization and pollination processes and the reduction in the abortion rate of florets, which positively reflects on the number of grains per spike (Jhanzad et al., 2015). In addition to the role of chemical fertilizers in providing nutrients during the crop growth stages, especially the provision of phosphorus, which regulates hormone activity and stimulates the photosynthesis process, this leads to an increase in the number of grains per ear (Al-Arqawazi, 2010). The results in Table 5 showed a significant difference in the interaction between the varieties and the A2B1 fertilizer combinations.

Table (5) Effect of varieties and fertilizer combinations and their interaction on the trait of number of grains per spike (grains per spike -1)

Varieties	Fertilizer formulations			
	B0	B1	B2	average
A1	49.77	50.79	49.28	49.94
A2	51.8	56.71	54.88	54.46
Average	50.78	53.75	52.08	
L.S.D (0. 05)				
Varieties	Fertilizer formulations		Interference	
0.71	0.96		1.62	

4-2-3 Weight of
 Table 6 indicated that there was a big variation between the varieties in the average significant difference between the varieties and fertiliser combinations, as well as the interaction between them in the attribute of 1000-grain weight (g). The variety A2 had the greatest average of 37.66, which could be because it had the most leaf area. Table 6's results showed that the fertiliser combinations were very different from each other. The B1 fertiliser combination had the highest average. This rise is due to the fact

1,000 grains (g)
 that fertilisers help metabolic reactions happen rapidly and efficiently, which helped supply the body's basic nutritional needs. This finding aligns with Sajadina et al. (2021), who demonstrated that grain weight increased with fertiliser application and its availability at various growth stages. The results in Table 5 also demonstrated that the interaction between the varieties and the fertiliser combinations A2B1 was very different.

Table 6: The effect of varieties and fertilizer combinations and their interaction on the 1000-grain weight (g)

Varieties	Fertilizer formulations			
	B0	B1	B2	average
A1	35	36.67	36	35.89
A2	36	39	38	37.66
Average	35.5	37.83	37	
L.S.D (0. 05)				
Varieties	Fertilizer formulations		Interference	
0.49	0.866		1.42	

4-2-4 Grain yield (tonne ha -1)

Table 7's results showed that there was a big variation between the varieties in the average significant difference between the varieties

and fertiliser combinations, as well as the interaction between them in the trait of grain yield (tonne ha-1). The average for variety A2 was the highest at 3.3. This could be because it

had the best number of spikes and weight of

1000 grains (Tables 4 and 6).

Table 7's results showed a big difference between the different fertiliser combinations. The B1 fertiliser combination had the highest average. This rise is due to the fact that it has better yield components, such as the number of spikes (Table 4) and the weight of 1000 grains (Table 6), which led to a higher yield.

The biofertilizer gave the wheat plants the nutrients they needed, which shows that the fertilisers can make up for some of the chemical fertilisers.

Table 5 revealed a notable interaction between the types and the A2B1 fertiliser combinations.

Table 7: The effect of varieties and fertilizer combinations and their interaction on grain yield (ton ha⁻¹)

Varieties	Fertilizer formulations			
	B0	B1	B2	average
A1	2.57	4.22	2.51	3.1
A2	2.58	4.38	2.94	3.3
Average	2.575	4.3	2.725	
L.S.D (0. 05)				
Varieties	Fertilizer formulations		Interference	
0.288	0.266		0.495	

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