

Response of three Wheat Cultivars *Triticum aestivum* L. to Chemical and Bio-Fertilization and Nano-NPK on yield traits and its Components.

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Abstract

A field experiment was carried out in the fields of the Department of Field Crops - College of Agriculture - Al-Qasim Green University during the agricultural season 2022-2023 to investigate the response of three bread wheat cultivars to chemical and biofertilization as well as nano-NPK and its impact on yield traits and its constituent parts by arranging split-plots in Sectoral. Three replicates of the Randomized Complete Block Design(RCBD). The main plots of wheat were planted with three different varieties, while the sub plots were fertilized with various combinations. The results showed that the cultivars differed among themselves in most of the studied traits, where the Baghdad cultivar excelled by giving it the highest mean for the number of spikes, weight of 1000 grains, grain yield, biological yield, and harvest index, which amounted to 339.1 m⁻², 41.42 g, 4.60 ton.ha⁻¹, and 13.55 ton.ha⁻¹ and 33.69% respectively, while the cultivar IPA 99 gave the highest average number of grains per spike with 55.61 grains.spike⁻¹. The results also demonstrated a significant distinction between the fertilizer combinations, with the highest averages for the studied traits being produced by the fertilizer combination of 50% compound fertilizer + 50% biofertilizer + 50% nano fertilizer, which also produced the highest average number of spikes (428.4 m²), highest average weight of 1000 grains (41.66 g), highest average yield of seeds (5.15 tons ha⁻¹), and highest biological yield (15.89 tons ha⁻¹). While the Baghdad variety's interaction with the fertilizer combination produced the highest average yield characteristics for 50% compound fertilizer + 50% biofertilizer + 50% nanofertilizer.

Keywords: wheat cultivars, chemical fertilizer, biological fertilizer, nano fertilizer.

Introduction

The wheat crop (*Triticum aestivum* L.) is one of Iraq most significant grain crops, and it leads the globe in both cultivated area and production. It is the main food for more than 60 countries in the world, as it contributes to providing more than 20% of the human need for food. Global wheat production for the year 2021 is estimated at about 761.6 million tons. As for wheat production in Iraq, it reached 4234 thousand tons for an area of 9464 thousand dunums, the Directorate of Agricultural Statistics[9]. Fertilizers are

natural or manufactured materials that are amended the soil with, added directly to the plant in order to provide the nutrients necessary for plant growth and development. Crop service operations. It has great importance in increasing production and improving quality, and it has a great impact in providing nutrients important for plant growth, increasing its availability against pests and pathogens, and stimulating plant growth and development, which the plant needs in large quantities such as nitrogen, phosphorus and

potassium. Biofertilizers are fertilizers that contain a similar group of beneficial microorganisms, bacterial and fungal, and when pollinated in the soil, they are active and effective, and make it more resistant to environmental conditions, in addition to improving the characteristics of the physical and soil [13]. The use of nanotechnology has great potential to increase the efficiency of fertilizer use, which is more effective and soluble, and accelerates penetration and representation within plant tissues. Nanotechnology is the art of processing materials within the nanoscale whose size is less than 100 nm [17]. This study aims at the response of bread wheat cultivars to different fertilizers, as well as studying the effect of bio- and nano-fertilizers on wheat yield, and the effect of combinations of chemical fertilizer NPK, bio-fertilizer, and nano-fertilizer npk on wheat yield.

MATERIALS AND METHODS

During the wintertime 2022-2023 agricultural season, a field experiment in the fields of the Department of Field Crops - College of Agriculture - Al-Qasim Green University, with the aim of studying the response of three cultivars of wheat to combinations of chemical and bio-fertilizers and nanopk and its impact on yield traits and its components. The test area was leveled by hand operated equipment, smoothed with disc harrows, and plowed with reversible Moldboard plows. The experiment was carried out using the Randomized Complete Block Design (RCBD) and in a split-plot arrangement with three replicates. While the sub plot occupied the fertilizer combinations (completely recommended compound fertilizer, symbolized by F1, fully recommended compound fertilizer + biofertilizer, symbolized by F2, fully recommended complex fertilizer + nanofertilizer, symbolized by F3, 50% compound fertilizer only, symbolized by F4, 50% compound fertilizer + 50% fertilizer Bio-fertilizer, denoted by F5, 50% compound fertilizer + 50% nano-fertilizer, denoted by F6,

50% compound fertilizer + 50% bio-fertilizer, +50% nano-fertilizer, denoted by F7) The replicates were divided into secondary experimental units of 21 experimental units for one replicate. The sectors plots were allocated at random, so the total number of experimental units was ($3 \times 7 \times 3 = 63$ experimental units). On November 15, 2022, cultivation was carried out on 10 line, with a 20 cm spacing between each line and the last one, at a seeding rate of 120 kg per batch before planting, DAP fertilizer (18N-46P-0) containing 100 kg ha⁻¹ one average of phosphorus and nitrogen was added and urea fertilizer (N 46%) [1]. was used to supply nitrogen at a rate of 200 kg N ha⁻¹ on average. at planting, elongation, and the midpoint of booting, it was added in three batches. when sowing, potassium was provided as potassium sulfate (K 41.50) at a rate of 100 kg ha⁻¹, BioHealth applied the bio stimulant, which was added during emergence and came with a fertilizer recommendation of 4 kg per hectare. according to the Iranian Khazra company fertilizer suggestion of 8-10 kg ha⁻¹, the nano fertilizer booting stages at a ratio of 20:20:20.

Field Traits

Number of spikes (m²)

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

The number of grains in the spike (spike .grain⁻¹)

The average for ten, the number of grains was calculated cobs per experimental unit after they were drained and cleaned manually.

The weight of 1000 grains (g)

1000 grains were counted randomly for each experimental unit from the yield of one square

meter harvested, then weighed by a sensitive balance, and then returned to the yield.

Grain Yield (ton.ha⁻¹)

It was estimated in terms the square meter area of each unit under study of grain yield for the harvested plants after separating the straw from the seeds, after which the grain was weighed and the weight was converted into tons. ha⁻¹

Biological yield (tons. ha⁻¹)

It was determined from the sum of the gathered plant weights (straw plus grain) from an area of one square meter of each experimental unit and converted to tons. ha⁻¹

Harvest Index %

The Harvest index was calculated According to the equation (Donald ,Hamblin, 1976) .

Harvest index (%) = (grain yield / biological yield) x 100

Statistical Analysis

The data were gathered ,tabulated, and statistical analysis was performed using the Genstat statistical analysis system program at the 5% probability level. the averages were compared using the least significant difference (L.S.D) [4].

Table 1. the effect of cultivars and combinations of fertilizers and the interaction between them on a trait of the number of spikes m⁻²

Cultivars	Fertilizer combinations							
	F1	F2	F3	F4	F5	F6	F7	average
IPA 99	273.7	299.7	351	249.3	283.7	316.3	397.7	310.2
bohuth 22	342	374	397.7	298.3	310	353.7	416.7	356.0
Baghdad	392	396.3	431.3	331.7	368.3	403	471	399.1
average	335.9	356.7	393.1	293.1	320.7	357.7	428.4	
L.S.D (0.05)								
Cultivars			Fertilizer combinations			Interaction		
7.65			13.22			21.86		

Results and discussion

Number of spikes m⁻²: The findings in Table1 show the importance of each of the cultivar and fertilizer combinations as well as their interactions in terms of characteristics. The cultivar IPA99 produced the lowest average of 310.2 m⁻², while the Baghdad cultivar excelled and attained an average of 310.2 m². These findings are in line with what [19,22]. discovered, who said that the cultivars varied among themselves in terms of the wheat crop's number of spikes .The same table also reveals that the fertilizer combinations varied significantly from one another .By providing the highest average of 428.4 m-2, the fertilizing combination of 50% compound fertilizer + 50% bio-fertilizer + 50% nano-fertilizer was superior to the 50% compound fertilizer, which only provided the lowest average of 293.1 m-2. Table1. demonstrates the stark contrasts between the cultivars and fertilizer mixtures . The treatment of the interaction between the Baghdad cultivar and the fertilizer combination of 50% compound fertilizer + 50% biological fertilizer + 50% nano-fertilizer excelled by giving it the highest mean for this trait amounting to 471 m⁻², while the interaction treatment between the cultivar IPA 99 and the fertilizer combination of 50% compound fertilizer only gave less averaged 249.3 m⁻².

Number of grains per spike (spike .grain⁻¹):

The findings in Table 2 make it evident that fertilizer and cultivar combinations have a considerable impact on this feature as well as their interactions. The cultivar IPA-99 produced the greatest average of 55.61 grains and excelled in terms of grains produced per spike. Spike⁻¹, The cultivar Bohuth 22 had the lowest average of 49.33 grains per spike⁻¹, The results showed that the number of grains in a spike varies according to the ability of varieties to compete between plants in their stages of growth, and this is reflected in this characteristic. This result agrees with what was reached by [2,15], who indicated that the cultivars differed among themselves in the number of grains per spike. The same table also shows that the fertilizer combination of a completely advised compound fertilizer plus nano-fertilizer greatly outperformed all others

by providing it the trait's highest mean value, which came to 56.88 grains of spike⁻¹. Although only 50% compound fertilizer was produced by the fertilizer mixture, the lowest average was 48.77 grains. Spike⁻¹. This could be as a result of an increase in grain production brought on by the availability of nutrients, particularly nitrogen, during the early stages of growth [5]. concurred with this conclusion. Table 2 demonstrates the stark contrasts between cultivars and fertilizer mixtures. In contrast to the interaction treatment between Bohuth 22 and the 50% compound fertilizer, which only produced the lowest average of 45.66 grains spike⁻¹, the interaction treatment between IPA 99 and the fertilizer combination was a complete recommended compound fertilizer + nano fertilizer.

Table2. Effect of cultivars and fertilizer combinations and the interaction between them on the trait of the number of grains per spike (spike grain⁻¹)

Cultivars	Fertilizer combinations							
	F1	F2	F3	F4	F5	F6	F7	average
IPA 99	54.66	56.66	59.66	51.66	53	55.66	58	55.61
bohuth 22	47.66	50.66	53	45.66	47.66	49.66	51	49.33
Baghdad	51.66	55	58	49	52	56.66	57.33	54.23
average	51.33	54.11	56.88	48.77	50.88	54	55.44	
L.S.D (0.05)								
Cultivars			Fertilizer combinations			Interaction		
0.38			0.54			0.90		

Weight of 1000 grains (g): The results in Table 3 demonstrated that there were considerable variations in this feature among wheat cultivars, with the Baghdad cultivar producing the highest average weight of 1000 grains, which was 41.42 g, and the IPA 99 cultivar producing the lowest average weight, 38.04 g. The difference between the cultivars in this characteristic is due to the difference in the duration of the grain filling for each of

them, and this result agrees with [11,12,20], who confirmed that the cultivars differ in the average weight of 1000 grains. From the same table, it can be seen that there is a significant difference between the fertilizer combinations for traits involving 1000 grain weights. For example, the fertilizer combination that produced the highest average for this trait was 50% compound fertilizer + 50% biological fertilizer + 50% nanofertilizer. The lowest

average was 35.22 g, despite the fertilizer combination producing just 50% compound fertilizer. The reason for this increase is that the biofertilization has led to the acceleration of emergence as a result of the increase in the manufactured metabolites, and this has an important role in preparing nutrients for the plant and thus increasing the weight of 1000 grains .This result agrees with [16,21] . The interaction between the two study factors

varied significantly for this trait, with the interaction treatment between the IPA 99 cultivar and the fertilizer combination giving 50% compound fertilizer only, while the interaction treatment between the Baghdad cultivar and the fertilizer combination gave 50% compound fertilizer + 50% biofertilizer + 50% nanofertilizer, the highest mean for the trait amounted to 44.66 g.

. Table 3. Effect of cultivars and combinations of fertilizers and the interaction between them on the weight of 1000 grains (g)

Cultivars	Fertilizer combinations							
	F1	F2	F3	F4	F5	F6	F7	average
IPA 99	34.66	36.66	38.66	33.33	35.00	37.66	39.66	36.52
bohuth 22	37.00	39.00	40.00	34.33	37.00	38.33	40.66	38.04
Baghdad	40.00	41.66	43.66	38.00	40.00	42.00	44.66	41.42
average	37.22	39.11	40.77	35.22	37.33	39.33	41.66	
L.S.D (0.05)								
Cultivars			Fertilizer combinations			Interaction		
0.26			0.61			1.00		

Grain yield (tons.ha⁻¹): It was observable from Table 4 out comes the significant effect of the cultivars on the trait of grain yield, where the Baghdad cultivar recorded the highest average of 4.60 tons ha⁻¹, compared to the cultivar IPA 99 with most minimal average of 3.45 tons ha⁻¹. The reason for the excelled of the Baghdad cultivar over the other two cultivars was To its excelled in terms of yield, including the number of spikes m⁻² and the weight of 1000 grains. The difference between wheat cultivars in terms of grain yield is due to the different adaptability of these cultivars to the prevailing environmental conditions during the growing season as a result of their different genetic makeup. These results agree with what was obtained by [7,18], who indicated that cultivars differed in the average grain yield of wheat. It is also noted from the same table that the plants that were fertilized

with the fertilizer combination 50% compound fertilizer + 50% biofertilizer + 50% nano-fertilizer gave the highest grain yield reaching 5.15 tons ha⁻¹, While the plants that were fertilized with the fertilizer combination of 50% compound fertilizer only gave the lowest grain yield, which amounted to 2.84 tons ha⁻¹ and the reason for this increase in grain yield is due to the positive effect of fertilizers and their ability to provide nutrients and increase the efficiency of the photosynthesis process. This result agreed with [3]. The results of Table 4. showed that the plants of the Baghdad cultivar, when fertilized with the fertilizer combination of 50% compound fertilizer + 50% biofertilizer + 50% nanofertilizer, gave the highest grain yield of 6.08 tons ha⁻¹, while the plants of the cultivar IPA99 when fertilized with the 50% fertilizer combination.

Compound fertilizer only, the lowest average amounted to 2.57 tons.ha⁻¹.

Table 4. Effect of cultivars and fertilizer combinations and the interaction between them on grain yield (tons. ha⁻¹)

Cultivars	Fertilizer combinations							
	F1	F2	F3	F4	F5	F6	F7	average
IPA 99	2.51	4.22	4.45	2.57	2.62	3.39	4.40	3.45
bohuth 22	2.94	4.38	4.09	2.58	4.44	4.70	4.98	4.01
Baghdad	3.86	4.84	5.97	3.38	3.25	4.83	6.08	4.60
average	3.10	4.48	4.84	2.84	3.44	4.31	5.15	
L.S.D (0.05)								
Cultivars			Fertilizer combinations			Interaction		
0.30			0.27			0.49		

Biological yield (tons. ha⁻¹) : According to Table 5 data, there was a substantial difference in this feature amongst wheat cultivars, with the Baghdad cultivar yielding the highest average of 13.55 tons ha⁻¹ and the IPA 99 cultivar providing the lowest average of 12.13 tons ha⁻¹. The same data shows that there are considerable differences between the fertilizer mixtures, with the greatest average of 15.89 tons.ha⁻¹ coming from the mixture of 50% compound fertilizer + 50% biofertilizer + 50% nanofertilizer. At the same fertilizer mixture, which was impacted by the increase in its components, the biological yield increased even though the fertilizer combination only

produced 50% compound fertilizer; the lowest average was 9.32 tons.ha⁻¹. This outcome was in line with [8]. The same table demonstrates that there are notable variations between the cultivars and the fertilizer mixtures for this trait, with the interaction treatment between the Baghdad cultivars and the fertilizer mixture excelling at 50% compound fertilizer + 50% biofertilizer + 50% nano fertilizer, which gave the highest average of 16.24 tons ha⁻¹ in comparison to the treatment. The lowest average of 9.29 tons ha⁻¹ was produced by the interaction between IPA 99 and the fertilizing combination of 50% compound fertilizer

Table 5. Effect of cultivars and fertilizer combinations and the interaction between them on biological yield (tons. ha⁻¹)

Cultivars	Fertilizer combinations							
	F1	F2	F3	F4	F5	F6	F7	average
IPA 99	11.30	12.82	15.04	9.29	12.09	13.17	16.10	12.83
bohuth 22	10.03	12.13	15.26	8.44	10.30	13.43	15.34	12.13
Baghdad	12.42	14.29	16.10	10.23	12.27	13.33	16.24	13.55
average	11.25	13.08	15.47	9.32	11.55	13.31	15.89	
L.S.D (0.05)								
Cultivars			Fertilizer combinations			Interaction		
0.40			0.24			0.50		

Harvest Index %: It is clear from the results of Table 6 the significant effect of the cultivars and fertilizer combinations and the interaction between the cultivars and the fertilizer combinations in this trait. The Baghdad cultivar performed exceptionally well in the harvest index and produced the greatest mean of 33.69%, which was comparable to the Bohuth 22 cultivar 33.425%, while the IPA 99 cultivar produced the lowest average of 26.96%. The reason for the superiority of the Baghdad cultivar over the other two cultivars in this characteristic may be attributed to its superiority in the weight of 1000 grains and the grain yield, as well as its high efficiency in converting photosynthetic products into an economic crop, and this result agrees with what was reached by [6,14], who indicated that the cultivars differ among themselves in the

characteristic of the harvest index. It is also noted from the same table that the fertilizer combination, a fully recommended compound fertilizer + biofertilizer, excelled significantly by giving it the highest average of this trait, which amounted to 34.51%, while the fertilizer combination of 50% only compound fertilizer gave the lowest average of 30.59%. Table 6. shows that there are significant differences between the varieties and the fertilizer combinations, as the interaction treatment between the Bohuth 22 cultivar and the fertilizer combination of 50% compound fertilizer + 50% biofertilizer was excelled by giving it the highest mean of the harvest index of 43.35%, while the treatment of the interaction between the IPA 99, and the fertilizer combination of 50% compound fertilizer + biofertilizer gave the lowest average of 21.93%.

Table 6. Effect of cultivars and fertilizer combinations and the interaction between them of harvest index %

Cultivars	Fertilizer combinations							
	F1	F2	F3	F4	F5	F6	F7	average
IPA 99	22.36	33.39	29.86	27.90	21.93	25.92	27.35	26.96
bohuth 22	29.48	36.18	26.57	30.71	43.35	35.10	32.55	33.42
Baghdad	31.15	33.95	37.21	33.17	26.55	36.32	37.50	33.69
average	27.66	34.51	31.21	30.59	30.61	32.44	32.47	
L.S.D (0.05)								
Cultivars			Fertilizer combinations			Interaction		
2.17			2.18			3.83		

Conclusion

This study showed that wheat cultivars varied among themselves in the qualities that were examined . As the Baghdad cultivar excelled in the majority of the yield qualities ,the fertilizer combinations that produced the best grain yield being 50% compound fertilizer + 50% biofertilizer + 50% nano fertilizer the best.

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