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Comparison between Simbio, Organic and Chemical Fertilizers on the Yield and quantitate traits of Wheat *Triticum aestivum* L. on Nutrient Balance

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Abstract

The study involves a field experiment that will be conducted at the Ankawa field Directorate of Agricultural Research - Erbil in the growing season of 2021–2022, 10 km to the north of Erbil City (36.2463 N, 43.9931 E, and 420 m above mean sea level). To investigate the effect of three different types of fertilizers (simbio, organic, and chemical) with three different concentration levels (B0 B1 B2, O0 O1 O2, and C0 C1 C2) with three replications. The field experiment consists of 81 plots (27 * 3) using factorial split plot design. The wheat yield ranged from (3.02-5.56 *M*g ha^{-1}) the highest yield was in the plot (B2O2C2) and the lowest was in the plot (B0O0C0), moreover, the weight of 1000 gm ranged from (33.48-39.11), the highest and the lowest was the same as the yield plots. The concentration of NPK in the flag leaf of wheat ranged from (2.91-3.99 mg kg^{-1}), (0.11-0.14 mg kg^{-1}), and (1.62-1.82 mg kg^{-1}) respectively.

Key words: Simbio fertilizer; Organic fertilizer; Chemical fertilizer; Wheat yield.
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Introduction

The world's first commercial crop, wheat is crucial to most nations' economies and policies due to its nutritional value. This crop provides food for more than 35% of the world's population [1]. The wheat crop's ability to balance proteins and carbs in its grains is one of the key benefits that has made it of tremendous nutritional relevance to human life. About 65% of the world's total grain output and 50% of its protein production are made up of wheat and other grain crops (rice, maize and barley) [2]. While, according to FAO about 3.2 million ton of grain as produces during 2022 [15].

Because they damage beneficial soil flora and fauna, cause erosion, and pollute the environment, agrochemical fertilizers are no longer able to support crop yield. Therefore, organic and biofertilizers are crucial to boosting nutrient availability and consequently production in order to make agriculture sustainable. biofertilizers are a cost-effective, sustainable, and environmentally friendly source of plant nutrients. When used over the long term, bio fertilizers are more cost-effective, environmentally friendly, productive, and accessible to marginal and small farmers than chemical fertilizers. They may play a crucial part in preserving soil fertility and sustainability. Several writers have studied the function and significance of biofertilizers in the development of sustainable crops [3].

Foliar application of fertilizers is advised to be used in order to maximize the benefit of various fertilizers' use efficiency, particularly nitrogen, because of the significance of interrelatedness in the process of protein composition and grain filling and because a significant portion of this fertilizer as a soil fertilizer is exposed to losses in various ways or fixed in the soil by various factors [4].

Since the soil of the Kurdistan region is calcareous it causes a decrease in availability of nutrients. For this reason the application of biofertilizers is necessary for solving this problem and the objective of this study is the effect of three types of fertilizers on yield and nutrient availability for wheat plant and which type of fertilizer provide maximum yield of wheat.

Materials and methods

The research includes the field experiment which will be carried out at Ankawa field directorate of agricultural research - Erbil 10 km to the north of Erbil city (36.2463 N, 43.9931E and 420 m above the mean sea level), during the growing season of 2021-2022.

Fertilizers treatments consisted of three levels of each:

1-Simbio fertilizer (fulzyme plus) which is consist of: beneficial bacteria (bacillus subtilis and pseudomonas putida: $2*10^{10}gram^{-1}$), Enzyme systems (protease, amylase, chitinase and lipase) and biological stimulants (gibberellin and cytokinin activities: 0.3%) was mixed with wheat seeds in 3 level (B_0 = 0 kg ton^{-1} seeds, B_1 = 2 kg ton^{-1} seed it means 0.6 g for 30 gm seed, B_2 = 4 kg ton^{-1} seeds it means 1.2 gm for 30 gm seeds).

2-Organic fertilizer (power wheat 15-45-30 humic TE+EC) foliar application which is consist of: composite " total (N) 15% , humic acid 2.5%, (P_2O_5) 45%, (K_2O) 30%, (B) 0.010%, (Fe) EDTA 0.020%, (Mn) EDTA 0.010%, (Mo) 0.010%, (Zn) EDTA 0.020%, (Cu) EDTA 0.0020%, alpha naphthyl acetic acid 11mg/L, alpha naphthyl acetamide 0.031mg/L and sticking dispersing agents 35gm L^{-1}" were applied in three level O0 = 0 litre ha^{-1}, O1 = 2 litres ha^{-1} it means 0.6 ml for $3m^2$ for each treatment and O2 = 4 litre ha^{-1} it means 1.2 ml for $3m^2$ for each treatment at Stem extension level at 15th of March 2022.

3-Chemical fertilizer which is consist of diammonium phosphate DAP 18.46.0 and Urea $(NH_2)_2CO$ 46% nitrogen during sowing time, (while Urea fertilizer was applied as two dosage 50% of the amount at sowing time and the other 50% at tillering stage on 2nd of march 2022), both of fertilizers are evenly mixed with the soil and applied in three levels C0 = 0 kg ha^{-1}, C1 = 120 kg ha^{-1} DAP and 80 kg ha^{-1} Urea it means 36 gm for $3m^2$ DAP and 24 gm for $3m^2$ (12+12) Urea for each plot and C2 = 240 kg ha^{-1} DAP and 160 kg ha^{-1} Urea it means 72 g for $3m^2$ DAP and 48 gm for $3m^2$ (24+24)

Urea for each plot. Number of treatments: 3B*3O*3C = 27, number of experiment units = 27*3 = 81, the area of each plots (length * width) = 2*1.5= 3 m^2, the distance between plots = 0.5 m, the distance between blocks = 1 m using factorial split plot design and the rate of planting was 100 kg ha^{-1}. Each plot consist of eight rows, the entire plot received 30 gm of seeds, the distance between them 18.75cm , it means each row received 3.75 gm of seeds, wheat sowing took place on 14th December 2021.

Table (1) physicochemical properties of soil studied area

Physical properties	
Particle size distribution	Sand 16.3 % Silt 55.4 % Clay 28.3 %
Textural name	Silt Clay L
Chemical properties	
Total $CaCO_3$	30.58 %
EC dSm^{-1}	0.2
pH	7.82
O.M	0.72 %
N	900 mg kg^{-1}
P	9.5 mg kg^{-1}
K	162 mg kg^{-1}

Results

Effect of simbio, Organic, chemical fertilizers and their interaction on wheat yield

Table (2) shows the single factors of (simbio, organic, and chemical) fertilizers affected significantly at level of significant ≥0.05 on wheat yield, the highest value (4.87, 4.69 and 5.27) *Mg* ha^{-1} were recorded rom application of (B2= 4 kg ton^{-1} seed, O2 = 4 liters ha^{-1}, C2 = 240 kg ha-1 DAP and 160 kg ha^{-1} Urea) fertilizers respectively. While the lowest value (4.26, 4.48, and 3.82) *Mg* ha^{-1} were recorded from (B0= zero kg ton^{-1} seed, O0 = zero liter ha^{-1}, and C0 = zero kg ha-1 DAP and zero kg ha^{-1} Urea) (control) treatment.

The two factor combination treatments significantly affected wheat yield, the highest values (4.94, 5.49 and 5.34) Mg ha^{-1} were recorded from combination treatments of (B2= 4 kg ton^{-1} seed, O2 = 4 liters hec^{-1}), (B2= 4 kg ton^{-1} seed C2 = 240 kg ha^{-1} DAP and 160 kg ha^{-1} Urea) and (O2 = 4 liters ha^{-1}, C2 = 240 kg ha^{-1} DAP and 160 kg ha^{-1} Urea), while the lowest values (4.14, 3.28, and 3.66) *Mg* ha^{-1} were recorded from (B0= zero kg ton^{-1} seed, O0 = zero liter ha^{-1}, B0= zero kg ton^{-1} seed, C0 = zero kg ha^{-1} DAP and zero kg ha^{-1} Urea, O0 = zero liter ha-1, and C0 = zero kg ha^{-1} DAP and zero kg ha^{-1} Urea) (control) treatment.

The triple combination treatments also affected significantly wheat yield, the highest value (5.56) *M*g ha^{-1} was recorded from combination treatment of (B2= 4 kg ton^{-1} seed, O2 = 4 liters ha^{-1} and C2 = 240 kg ha^{-1} DAP and 160 kg ha^{-1} Urea), while the lowest value (3.02) *Mg* ha^{-1} was recorded from (B0= zero kg ton^{-1} seed, O0 = zero liter ha^{-1}, C0 = zero kg ha^{-1} DAP and zero kg ha^{-1} Urea) this results agree with [6].

Effect of simbio, organic, and chemical fertilizers and their interaction on weight of 1000 seeds gm of wheat

Table (3) refers to the single factors of (simbio, organic, and chemical) fertilizers affected significantly at level of significant ≥0.05 on wheat yield, the highest value (36.83, 36.40 and 37.69) 1000 seeds gm were recorded rom application of (B2= 4 kg ton^{-1} seed, O2 = 4 liter ha^{-1}, C2 = 240 kg ha^{-1} DAP and 160 kg ha^{-1} Urea) fertilizers respectively. While the lowest value (35.46, 35.94 and 34.79) 1000 seeds gm were recorded from (B0= zero kg ton^{-1} seed, O0 = zero liter ha^{-1}, and C0 = zero kg ha^{-1} DAP and zero kg ha^{-1} Urea) (control) treatment.

The two factor combination treatments significantly affected on wheat yield, the highest values (37.05, 38.66 and 37.98) 1000 seeds gm were recorded from combination treatments of (B2= 4 kg ton^{-1} seed, O2 = 4 liter ha^{-1}), (B2= 4 kg ton^{-1} seed C2 = 240 kg ha^{-1} DAP and 160 kg ha^{-1} Urea) and (O2 = 4 liters ha^{-1}, C2 = 240 kg ha^{-1} DAP and 160 kg ha^{-1} Urea), while the lowest values (34.53, 35.22 and 33.95) 1000 seeds gm^{-1} were recorded from (B0= zero kg ton^{-1} seed, O0 = zero liter ha^{-1}, B0= zero kg ton^{-1} seed, C0 = zero kg ha^{-1} DAP and zero kg ha^{-1} Urea, O0 = zero liter ha^{-1}

Table (2) interaction effect of Sim bio, Organic and Chemical fertilizers on wheat yield *M*g ha^{-1}

Sim bio fertilizer Levels	Organic fertilizer Levels	Chemical fertilizer Levels			Average				
		C0	C1	C2	BO	BC	OC	B	O
B0	O0	3.02	4.44	4.97	4.14	3.28	3.66 O0C0	4.26	4.48
	O1	3.24	4.46	5.04	4.25	4.48	3.81		
	O2	3.59	4.54	5.09	4.40	5.03	3.99		
B1	O0	3.73	4.57	5.21	4.50	3.91	4.60	4.62	4.58
	O1	3.94	4.64	5.29	4.62	4.65	4.65		
	O2	4.05	4.75	5.37	4.72	5.29	5.28		
B2	O0	4.23	4.79	5.40	4.81	4.26	3.99	4.87	4.69
	O1	4.25	4.85	5.51	4.87	4.86	4.74		
	O2	4.32	4.93	5.56	4.94	5.49	5.34 O2C2		
Average C		3.82	4.66	5.27					

LSD	B	O	C	BO	BC	OC	BOC
0.05	0.14	0.24	0.14	0.42	0.24	0.24	0.42

^{1}, and C0 = zero kg ha^{-1} DAP and zero kg ha^{-1} Urea) (control) treatment.

The triple combination treatments also affected significantly on wheat yield, the highest value (39.11) 1000 seeds gm^{-1} was recorded from combination treatment of (B2= 4 kg ton^{-1} seed, O2 = 4 liter ha^{-1} and C2 = 240 kg ha^{-1} DAP and 160 kg ha^{-1} Urea), while the lowest value (33.48) 1000 seeds gm^{-1} was recorded from (B0= zero kg ton^{-1} seed, O0 = zero liter ha^{-1}, C0 = zero kg ha^{-1} DAP and zero kg ha^{-1} Urea) this results agree with [7].

Table (3) Effect of Sim bio, Organic, Chemical fertilizers and their interaction on weight of 1000 seeds gm of wheat

Sim bio fertilizer Levels	Organic fertilizer Levels	Chemical fertilizer Levels			Average				
		C0	C1	C2	BO	BC	OC	B	O
B0	O0	33.48	35.55	36.64	35.22	33.95	34.53	35.46	35.94
	O1	33.94	35.56	36.87	35.46	35.59	35.95		
	O2	34.44	35.67	36.99	35.70	36.83	37.34		
B1	O0	34.79	35.96	37.23	35.99	35.03	34.80	36.24	36.19
	O1	35.05	36.16	37.63	36.28	36.13	36.04		
	O2	35.24	36.27	37.85	36.45	37.57	37.77		
B2	O0	35.31	36.34	38.16	36.60	35.40	35.05	36.83	36.40
	O1	35.41	36.40	38.71	36.84	36.44	36.70		
	O2	35.49	36.57	39.11	37.05	38.66	37.98		
Average C		34.79	36.05	37.69					

LSD	B	O	C	BO	BC	OC	BOC
0.05	0.14	0.24	0.14	0.42	0.24	0.24	0.42

Effect of level of bio, organic, and chemical fertilizer and their interaction of concentration of nitrogen in the flag leaf of wheat

Table (4) specify the single factors of (simbio and chemical) fertilizers affected significantly at level of significant ≥ 0.05 on the concentration of nitrogen in the flag leaf of wheat, the highest value (3.61 and 3.61) mg kg^{-1} were recorded rom application of (B2= 4 kg ton^{-1} seed and C2 = 240 kg ha^{-1} DAP and 160 kg ha-1 Urea) fertilizers respectively. While the lowest value (3.23 and 3.22) mg kg^{-1} were recorded from (B0= zero kg ton^{-1} seed, O0 =

zero and C0 = zero kg ha^{-1} DAP and zero kg ha^{-1} Urea) (control) treatment.

The two factor combination treatments significantly affected on the concentration of Nitrogen in the flag leaf of wheat, the highest values (3.75, 3.83 and 3.76) mg kg^{-1} were recorded from combination treatments of (B2= 4 kg ton^{-1} seed, O1 = 2 liters ha^{-1}), (B2= 4 kg ton^{-1} seed C2 = 240 kg ha^{-1} DAP and 160 kg ha^{-1} Urea) and (O1 = 2 liters ha^{-1}, C2 = 240 kg ha^{-1} DAP and 160 kg ha^{-1} Urea), while the lowest values (3.10, 3.10 and 3.03) mg kg^{-1} were recorded from (B0= zero kg ton^{-1} seed, O0 = zero liter ha^{-1}, B1= 2 kg ton^{-1} seed, C0 = zero kg ha^{-1} DAP and zero kg ha^{-1} Urea, and O0 = zero liter ha^{-1} C0 = zero kg ha^{-1} DAP and zero kg ha^{-1} Urea) treatment.

The triple combination treatments also affected significantly on the concentration of Nitrogen in the flag leaf of wheat, the highest value (3.60) mg kg^{-1} was recorded from combination treatment of (B2= 4 kg ton^{-1} seed, O2 = 4 liter ha-1 and C2 = 240 kg ha^{-1} DAP and 160 kg ha-1 Urea), while the lowest value (3.22) mg kg^{-1} was recorded from (B0= zero kg ton^{-1} seed, O0 = zero liter ha^{-1}, C0 = zero kg ha^{-1} DAP and zero kg ha^{-1} Urea) this results agree with [9].

Table (4) Effect of level of Sim bio, organic, and chemical fertilizer and their interaction of concentration of Nitrogen in the flag leaf of wheat (mg kg^{-1})

Sim bio fertilizer Levels	Organic fertilizer Levels	Chemical fertilizer Levels			Average				
		C0	C1	C2	BO	BC	OC	B	O
B0	O0	3.12	3.08	3.10	3.10	3.20	3.03	3.23	3.33
	O1	2.91	2.93	3.55	3.13	3.11	3.45		
	O2	3.49	3.34	3.57	3.47	3.40	3.51		
B1	O0	2.93	3.51	3.70	3.38	3.10	3.34	3.39	3.46
	O1	3.30	3.49	3.75	3.52	3.49	3.28		
	O2	3.08	3.47	3.29	3.28	3.58	3.76		
B2	O0	3.04	3.75	3.73	3.51	3.38	3.29	3.61	3.44
	O1	3.81	3.43	3.99	3.75	3.63	3.50		
	O2	3.29	3.70	3.77	3.58	3.83	3.54		
Average C		3.22	3.41	3.60					

LSD	B	O	C	BO	BC	OC	BOC
0.05	0.19	0.33	0.19	0.57	0.33	0.33	0.57

Effect of level of bio, organic, chemical fertilizer and their interaction of concentration of Phosphorus in the flag leaf of wheat

Table (5) notice the single factors of (simbio and organic) fertilizers affected significantly at level of significant ≥0.05 on the concentration of Phosphorus in the flag leaf of wheat, the highest value (0.13 and 0.13) mg kg^{-1} were recorded from application of (B0= zero kg ton^{-1} seed and O2 = 4 liters ha^{-1}) fertilizers respectively. While the lowest value (0.12 and 0.11) mg kg^{-1} were recorded from (B1= 2 kg ton^{-1} seed, B2= 4 kg ton^{-1} seed, and O1= 2 liters ha^{-1}).

The two factor combination treatments significantly affected on the concentration of Phosphorus in the flag leaf of wheat, the highest values (0.14, 0.14 and 0.13) mg kg^{-1} were recorded from combination treatments of (B0 O2, B0 C0, O0 C0, O1 C2 and O2 C2), while the lowest values (0.11) mg kg^{-1} were recorded from (B1 O1, B1 O2 B2 O0, B2 O1, B1 C0, O1 C0, and O1 C1).

The triple combination treatments also affected significantly on the concentration of Phosphorus in the flag leaf of wheat, the highest value (0.14) mg kg^{-1} was recorded from combination the treatment of (B0 O0 C0, B0 O2 C0 and B0 O2 C2), while the lowest value (0.10) mg kg^{-1} was recorded from (B1 O2 C0) these results agree with [10].

Table (5) Effect of level of Sim bio, organic, and chemical fertilizer and their interaction of concentration of Phosphorus in the flag leaf of wheat (mg kg^{-1})

Sim bio fertilizer Levels	Organic fertilizer Levels	Chemical fertilizer Levels				Average			
		C0	C1	C2	BO	BC	OC	B	O
B0	O0	0.14	0.13	0.11	0.13	0.14	0.13	0.13	0.12
	O1	0.13	0.11	0.12	0.12	0.12	0.12		
	O2	0.14	0.13	0.14	0.14	0.12	0.12		
B1	O0	0.13	0.13	0.13	0.13	0.11	0.11	0.12	0.11
	O1	0.11	0.11	0.12	0.11	0.12	0.11		
	O2	0.10	0.12	0.12	0.11	0.12	0.12		
B2	O0	0.12	0.11	0.12	0.11	0.12	0.12	0.12	0.13
	O1	0.11	0.12	0.11	0.11	0.12	0.13		
	O2	0.12	0.13	0.13	0.12	0.12	0.13		
Average C		0.12	0.12	0.12					

LSD	B	O	C	BO	BC	OC	BOC
0.05	0.01	0.01	0.01	0.02	0.01	0.01	0.02

Effect of level of bio, organic, chemical fertilizer and their interaction of concentration of Potassium in the flag leaf of wheat

Table (6) indicate the single factors of (simbio) fertilizer affected significantly at level of significant ≥0.05 on the concentration of Potassium in the flag leaf of wheat, the highest value (1.75) mg kg^{-1} was recorded rom application of (B0= zero kg ton^{-1} seed) fertilizers respectively. While the lowest value (1.65) mg kg^{-1} was recorded from (B1= 4 kg ton^{-1} seed).

The two factor (organic and chemical) combination treatments significantly affected on the concentration of Potassium in the flag leaf of wheat, the highest values (1.81 and 1.79) mg kg^{-1} were recorded from combination treatments of (B0 C0, and O1 C2), while the lowest values (1.63 and 1.65) mg kg^{-1} were recorded from (B1 C0, B1 C1, and O2 C1).

The triple combination treatments also affected significantly on the concentration of Potassium in the flag leaf of wheat, the highest value (1.82) mg kg^{-1} was recorded from combination treatment of (B0 O0 C0, B0 O1 C2 and B0 O2 C0), while the lowest value (1.62) mg kg^{-1} was recorded from (B1 O2 C2) this results agree with [11].

Table (6) Effect of level of Sim bio, organic, chemical fertilizer and their interaction of concentration of Potassium in the flag leaf of wheat (mg kg^{-1})

Sim bio fertilizer Levels	Organic fertilizer Levels	Chemical fertilizer Levels				Average			
		C0	C1	C2	BO	BC	OC	B	O
B0	O0	1.82	1.67	1.70	1.73	1.81	1.69		
B0	O1	1.79	1.80	1.82	1.80	1.70	1.73	1.75	1.68
B0	O2	1.82	1.64	1.72	1.73	1.75	1.74		
B1	O0	1.58	1.68	1.69	1.65	1.63	1.67		
B1	O1	1.64	1.63	1.75	1.67	1.63	1.72	1.65	1.75
B1	O2	1.67	1.59	1.62	1.63	1.68	1.79		
B2	O0	1.69	1.67	1.66	1.67	1.73	1.74		
B2	O1	1.77	1.72	1.81	1.77	1.71	1.65	1.73	1.70
B2	O2	1.73	1.73	1.78	1.75	1.75	1.71		
Average C		1.72	1.68	1.73					

LSD	B	O	C	BO	BC	OC	BOC
0.05	0.06	0.11	0.06	0.19	0.11	0.11	0.19

Discussion

Wheat yield Mg

The results in Table 2 show that chemical fertilizer contributes greatly to grain yield compared to simbio and organic fertilizers. As shown in table (1), the highest value was related to chemical fertilizer, and the same result was observed by [7]. Moreover, chemical fertilizer mixed with simbio and organic also shows the highest yield of wheat. This may be due to chemical fertilizer; because of this, these refined, pure minerals produce near-immediate effects in a matter of days, if not weeks. The effects of different fertilizers are shown in the following order, from highest to least effective: chemical organic simbio.

1000 grain yield

The results from table (3) show that the weight of 1000 grains increases with increasing the amount of fertilizer; the highest increase was observed from B2O2C2 treatments, and the same results were observed by [8], which reported that the weight of 1000 grains is attributed to the amount of applied fertilizer.

The concentration of nitrogen (NPK) in flag leaf

Table (4) shows that the concentration of N was significant in the flag leaf of wheat, and the same results were observed by [9]. Moreover, nitrogen shows the highest concentration in comparison with phosphorus and potassium. This may be due to the double application of nitrogen fertilizer from simbio, which contains *Azotobacter spp*. and *Azosperilum spp*., which encourage nitrogen fixation in plants and soil, furthermore, the application of Urea in chemical fertilizer also contributes mainly to the nitrogen concentration in soil and plant tissue [12].

The concentration of phosphors in table (5) shows the lowest concentration in comparison with nitrogen and potassium. This may be because that our Kurdistan soil contains a high amount of calcium carbonate, which causes P fixation in the soil and therefore leads to P deficiencies in plants [13].

In table (6), the concentration of potassium in flag leaf shows a significant difference between simbio and organic fertilizer this may be due to the bacteria solubilizing potassium (bacteria name), which is present in concentration in comparison with phosphorus and potassium. This may be due to the double application of nitrogen fertilizer from simbio, which contains *Azotobacter spp*. and *Azosperilum spp*., which encourage nitrogen fixation in plants and soil, furthermore, the application of Urea in chemical fertilizer also contributes mainly to the nitrogen concentration in soil and plant tissue [12].

The concentration of phosphors in table (5) shows the lowest concentration in comparison with nitrogen and potassium. This may be because that our Kurdistan soil contains a high amount of calcium carbonate, which causes P fixation in the soil and therefore leads to P deficiencies in plants [13].

In table (6), the concentration of potassium in flag leaf shows a significant difference between simbio and organic fertilizer this may be due to the bacteria solubilizing potassium (bacteria name), which is present in simbio fertilizer; moreover, organic fertilizer contains a high amount of K_2O (%) [14].

Conclusion

The result shows that the effect of Chemical fertilizer was higher than that of simbio and Organic fertilizer (chemical > organic > simbio). All three applied fertilizers do not have any effect on the distribution of NPK in soil or plant leaves.

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مقارنة بين الأسمدة السيمبيو والعضوية والكيميائية في الصفات الإنتاجية والكمية لنبات القمح *Triticum aestivum* L. على التوازن الغذائي

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الملخص

تتضمن الدراسة تجربة حقلية ستجرى في حقل مديرية البحوث الزراعية في عنكاوا – أربيل في الموسم الزراعي 2021–2022، على بعد 10 كم شمال مدينة أربيل (36.2463 شمالاً، 43.9931 شرقاً، و420 متراً فوق متوسط سطح البحر). مستوى). تم دراسة تأثير ثلاثة أنواع مختلفة من الأسمدة (سيمبيو، العضوية، والكيميائية) بثلاثة مستويات تركيز مختلفة (B0 B1 B2، O0 O1 O2، وC0 C1 C2) وبثلاثة مكررات. تتكون التجربة الحقلية من 81 قطعة (3*27) باستخدام تصميم القطع المنشقة العاملية. تراوح إنتاج القمح من (3.02–5.56 ملغ هكتار$^{-1}$) وكان أعلى إنتاج في القطعة (B2O2C2) وأقل إنتاجية في القطعة (B0O0C0)، كما تراوح وزن 1000 غم من (33.48–39.11). وكان أعلى وأدنى نفس قطع العائد. تراوح تركيز NPK في ورقة علم القمح من (2.91–3.99 ملجم كجم$^{-1}$) و(0.11–0.14 ملجم كجم$^{-1}$) و(1.62–1.82 ملجم كجم$^{-1}$) على التوالي.

الكلمات المفتاحية: سماد سيمبيو ، سماد عضوي ، سماد كيماوي ، محصول قمح.