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THE EFFECT OF FERTILIZER COMBINATIONS ON BREAD WHEAT YIELD IN SEVERAL LOCATIONS IN IRAQ

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ABSTRACT

Four field experiments were carried out in four sites with an area of 5 dunums for each site, three of them (Latifiya, Abu Ghraib and Radwaniyah) belonging to Baghdad governorate and the fourth site (Dawr) belongs to Salah al-Din Governorate, under the influence of two factors of fertilizers, (conventional fertilizer and fertilizing combination), For the purpose of determining the optimal fertilizer combination of wheat yield through the productivity achieved compared to conventional fertilizer and reducing the application of chemical fertilizers. The growth traits were studied such as plant height (cm) at physiological maturity, number of branches (branch. M^{-2}), number of spikes per square meter, number of grains per spike, the weight of 1000 grains, grain yield (ton. hec-1), biological yield (ton. hec^{-1}), and the percentage of harvest index. Statistical analysis was conducted at the 0.05 level. The program (HWSD) Harmonized World Soil Database adopting by the Food and Agriculture Organization (FAO) was used to sense the general physical and chemical properties of the soil for the four sites shown in Table (2). Analysis of variance was performed for each site and fertilizers independently; also meta-analysis of the four sites data was performed at the 5% level. Significant differences were observed between all the growth and yield traits of different fertilizers added, the fertilizer combination in all sites outperformed to added conventional fertilizer by its giving the highest mean grain yield (5.230 ton. h^{-1}) and its components in dawr site. As well as the sites differed significantly in some of the studied traits. The effect of interaction between fertilizers and sites was significant in all the studied traits, where the site of the Dawr in Salah al-Din governorate outperformed by giving the highest mean grain yield (4.805 ton.h^{-1}) when adding the fertilizer combination. From the results of the experiments, we conclude all traits and sites responded to the effect of the added fertilizer combination which gave the highest grain yield compared to adding the fertilizer in conventional form.

Key words: wheat, fertilizers, various sites, meta-analysis .

تاثير توليفات سمادية في انتاجية حنطة الخبز في عدة مواقع من العراق

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الخلاصة:

نفذت اربع تجارب حقلية في اربعة مواقع وبمساحة 5 دونم لكل موقع ، ثلاثة منها (اللطيفية وابو غريب والرضوانية) تابعة لمحافظة بغداد والموقع الرابع (الدور) تابع لمحافظة صلاح الدين، تحت تاثير عاملين من السماد (تقليدي وتوليفة سمادية) لغرض تحديد التوليفة السمادية الأمثل لمحصول الحنطة من خلال الأنتاجية المتحققة مقارنةً بالسماد التقليدي والتقليل من تطبيق الأسمدة الكيمياوية . تم دراسة صفات النمو المتمثلة بارتفاع النبات (سم) عند النضج الفسلجي وعدد الافرع (فرع/ $م^2$) وعدد السنابل بالمتر المربع وعدد الحبوب بالسنبلة ووزن 1000 حبة وحاصل الحبوب (طن $هـ^{-1}$) والحاصل الحيوي (طن $هـ^{-1}$) والنسبة المئوية لدليل الحصاد. اجري التحليل الاحصائي على مستوى 0.05. واستخدم البرنامج Harmonized World Soil Database (HWSD) المعتمد من قبل منظمة الاغذية والزراعة (FAO) لاستشعار صفات التربة الفيزيائية والكيمائية العامة للمواقع الأربعة والمبينة في الجدول (2). تم إجراء تحليل التباين لكل موقع والاسمدة بشكل مستقل، ثم أجري التحليل التجميعي لبيانات المواقع الاربع على مستوى 5 ٪. لوحظت فروق معنوية بين جميع صفات النمو والحاصل بتاثير اختلاف الاسمدة المضافة. وتفوقت التوليفة السمادية في جميع المواقع على السماد التقليدي المضاف باعطائها أعلى متوسط حاصل حبوب (5.230 طن.$هـ^{-1}$) ومكوناته واختلفت المواقع معنويا فيما بينها في بعض الصفات المدروسة لكن تفوق موقع الدور باعطائه اعلى متوسط حاصل حبوب. اثر التداخل بين الاسمدة والمواقع معنويا في جميع الصفات المدروسة، اذ تفوق موقع الدور في محافظة صلاح الدين باعطائه اعلى حاصل حبوب عند اضافة التوليفة السمادية (4.805 طن.$هـ^{-1}$). من نتائج التجارب نستنتج أن جميع الصفات وفي جميع المواقع استجابة لتاثير التوليفة السمادية المضافة بإعطائها أعلى حاصل حبوب مقارنة بأضافة السمادة بصورته التقليدية.

كلمات مفتاحية: حنطة، أسمدة ، مواقع مختلفة، تحليل تجميعي .

INTRODUCTION

The wheat crop is one of the most important food crops in the world, it covers parts of the globe's surface considered the largest area than any other food crop. 4.5 Billion people in 94 countries depend on processed foods from their cereals. Feeding agricultural crops with chemical fertilizers and micro-elements is one of the most important foundations of agricultural production (7). Providing a balanced fertilizing combination of different elements is one of the challenges of the agricultural process due to the high costs of fertilizer and environmental pollution resulting from the use of large quantities of added fertilizers (4)(26) and the problems of the holding elements in the soil by plant roots, despite the addition of high levels of fertilizer thereof (2)(5)(27). Iraqi soils suffer from a lack of basic and important elements that ready for absorption, so addressing these problems has become necessary and also requires resorting to either reducing levels of fertilizers and adding them in multiple shots (24)(21) or by using cheap alternatives in the manufacture of fertilizer mixtures (24). And that can be only be achieved by using modern fertilizer blends with a highly specialized capacity in preparing plants with the necessary nutrients that have high dissolution, processing, and absorption capacity (3)(8)(10). In order to increase the efficiency of chemical fertilizers in such soils within the amounts adopted for them, it is necessary to work on improving their properties and maintaining their fertility by analyzing them (25), using appropriate quantities of treated fertilizer combinations according to each plant species in addition to the possibility of adopting changes in the ratios of concentrations of macro, micro, and organic fertilizer elements in sites or special cases that require them (15)(19). The use of fertilizer combinations would affect the improvement of growth and yield of wheat yield in quantity and quality (16)(20)(22). As activate its vegetative and reproductive growth, enhances its resistance, and improves its health status (6, 25, and 28). Fertilizer doses may contain, in whole or in part, soil nutrients in the form of a plant, animal, or mineral organic linkages (4) (18) that have a significant effect on improving agricultural soil properties, as it relates to its complete supplying with the important necessary elements in plant nutrition and its strengthening of the readiness of chemical fertilizers added to it (14)(11), which provides the appropriate and ideal condition for the consumption of nutrients and mineral fertilizers by plants (17)(23). It also significantly helps in reducing the consumption of nitrogenous fertilizers and soil nitrogen, in addition to its contribution to encouraging the process of biological nitrogen fixation. The integrated fertilizer combinations of soft, liquid, semi-liquid, semi-metamorphic, metamorphic, and decomposing fertilizers can increase their effectiveness depending on their preparation mechanism (6)(20). Which positively affects the growth of plants, especially in the early stages of his life (1)(13) the amounts or criteria for using fertilizer combinations are determined according to the type and composition of the soil texture, and soil organic matter content, and the date of addition depends on its type and the privacy of the site of cultivation and the cultivar (9)(12).The study aims determining the optimal fertilizer combination of wheat yield through the productivity achieved compared to conventional fertilizer and reduc-

ing the application of chemical fertilizers.

Materials and work method

Four field experiments were conducted in four sites with an area of 5 dunums for each site, three of them (Latifiya, Abu Ghraib and Radwaniyah) belonging to Baghdad governorate and the fourth site (Dawr) belongs to Salah al-Din governorate, under the influence of two factors of fertilizer (traditional fertilizer and fertilizing combination). The Bura variety was cultivated on November 17-20, 2018, after preparing and the ground from the plowing, pulverizing, and laser level soil. The field was divided into blocks with dimensions of 100X25 meters, leaving a distance of 2 meters between one block and another. The traditional fertilization operations (comparison treatment) were performed according to the recommended (50 kg of nitrogen per dunum and 50 kg of P2O5) by adding them in urea form in two shots and DAP when planting, while the fertilizer combination (second treatment) was added as mentioned in Table 1. A surface irrigation method was pursued as needed. The four sites were harvested on 30 /5 -15/6/2019 according to the date of maturity. The growth characteristics such as plant height (cm) at physiological maturity, number of branches (branch.m^{-2}), number of spikes per square meter, number of seeds per spike, the weight of 1000 grains, grain yield (ton.h-1),biological yield (ton.h^{-1}), and the percentage of harvest index. Statistical analysis was conducted at the 0.05 level. The program Harmonized World Soil Database (HWSD) approved by the Food and Agriculture Organization (FAO) was used to sense the general physical and chemical properties of the soil for the four sites shown in Table (2).

Results and discussion

Plant height

The results of Table 3 indicate there are significant differences in the height of wheat plants between fertilizers, sites, and their interactions, as the fertilizing combination outperformed by giving it the highest average plant height (84.55 cm) compared to the traditional fertilization added, which recorded the lowest mean for this characteristic (73.88 cm) and the reason was due to the richness of the fertilizing combination in necessary elements for growth and which undoubtedly affected the increase in plant height (6). Al-Dawr site outperformed the highest mean plant height (83.12 cm), while the rest of the sites decreased from these two rates, but they did not differ significantly from each other. As the Abu Ghraib site recorded the lowest average for this trait, which was 76.23 cm, the main reason may be due to the environmental difference, especially the weather conditions (the climate of agriculture) between the studied sites, Especially the site of Al-Dawr, which locates in Tikrit governorate and which differed from the rest of the sites in soil and climate conditions, while the values of the rest of the sites converged in their mean height, perhaps due to the similar environmental conditions between them, especially the physical and chemical characteristics of the Latifiya, Abu Ghraib and Radwaniyah soil, which are all located in the Baghdad governorate. The interaction between fertilizers and the sites affected significantly the plant height mean, as the Dawr site recorded the highest plant height mean (88.75 cm) due to the effect of the fertilizing combination compared to the Latifiya site, which recorded the lowest mean to this trait (68.00 cm) due

to the effect of traditional fertilizers, and this means that the Bura cultivar greatly responded to the added fertilizing combination in terms of height, which increased when the conditions of the cultivated environment changed.

The number of branches.m^{-2}

The result in Table 4 showed significant differences in the number of total branches of wheat plants between fertilizers and sites and their interactions. As the fertilizing combination surpassed by giving the highest mean number of total branches per unit area (1750 branch.m^{-2}) compared to the traditional fertilizers added that recorded the lowest mean for this trait (1077 branch.m^{-2}), this confirms the content importance of the fertilizing combination of the necessary elements that encourage the growth of branches and increase their number per unit area compared to conventional fertilizers. Abu Ghraib site achieved the highest mean number of branches (1790 branch.m^{-2}), while the rest of the sites decreased significantly from this average, and Latifiya site achieved the lowest mean for this trait, reaching 1124 branch.m^{-2}. The interaction between fertilizers and the sites affected significantly the average number of branches per unit area. The Abu Ghraib site achieved the highest mean for this trait (2469 branch.m^{-2}) by the effect of fertilizing combination, compared to the Latifiya site, which achieved the lowest mean for this trait (967 branch.m^{-2}) due to the effect of the traditional addition of chemical fertilizer.

The number of spikes/m^2

Table 5 shows there are significant differences in the mean number of spikes of wheat crop as a result of the difference in the addition of chemical fertilizers at the different sites and their interaction, as it outperformed at a level higher than twice the number of spikes per unit area when adding the fertilizing combination (431.2 spike/m^2) compared to the conventional added fertilizer that achieved the lowest mean for this trait (201.2 spike/m2) This confirms the importance of the content and components of the fertilizing combination from the necessary elements to the emergence of the active branches, which can carry the largest number of spikes affected by increase in number of branches per unit area as in Table 4, Which has reflected positively in increase the branches number bearing spikes. The sites (Abu Ghraib, Al-Radwaniyah and Al-Dawr) did not differ significantly with each other in mean of this trait (334.9, 327.5 and 305.0 spike/m^2), respectively, but it significantly outperformed the Latifiya site, which recorded lowest mean for this trait (297.5 spike/m^2). The interaction of the added fertilizers and the sites had a significant effect on the mean spikes number per unit area, so the two sites of Latifiya and Abu Ghraib were similar in mean of this trait, and they achieved the highest mean of them (435.0 spike.m^{-2}) for each of them due to the effect of the added fertilizing combination compared to the Latifiya site, which achieved the lowest mean to this trait (105.0 spike/m^2) As a result of using conventionally added fertilizers, the number of effective branches per unit area did not get an increase.

Number of Grain.spike^{-1}

Table 6 showed significant differences between the added fertilizers, while the number of grains per spike did not differ significantly with different cultivation sites, but the interaction between them

was significant in the mean of this trait, as the fertilizing combination surpassed added conventional fertilizers with the highest number of grains per spike (52.22 and 39.345 Grain.spike^{-1}) respectively, this means the fertilizing combination had the largest in stimulating the emergence sites of the grains on the spike holder. The fertilizing combination at the Latifiya site outperformed by giving the highest mean for this trait (56.326 Grain.spik^{-1}), compared to the conventional fertilizers added at the same site, which achieved the lowest mean for this trait(26.95 Grain. spike^{-1}).

1000 grains weight (g)

The results of Table 7 indicate that there were no significant differences in the mean weight to 1000 grains of the wheat crop at different cultivation sites, but they differed significantly by the effect of added fertilizers and their interaction with the sites. As the added fertilizing combination superior by giving the highest mean weight of 1000 grains (58.19 g) compared to the conventional fertilizers added by the traditional method, which recorded a significant decrease in the mean for this trait (47.50 g) This indicates the importance of providing the necessary nutrients in the early stages of seed emergence to prepare the required amount of metabolites into the grains with the highest filling rate. A result of the interaction between added fertilizers and planting sites had a significant effect on the mean weight of 1000 grains. The effect of adding the fertilizing combination was superior to the Dawr site by giving it the highest mean to this trait (59.25 g) compared to the Radwaniyah site, which achieved the lowest mean to this trait (45.25 g) when fertilizers were added to its conventional form.

Grain yield, ton.h^{-1}

The results of Table 8 indicate that there is a significant difference between the added fertilizers, while the different sites had no significant effect on the mean grain yield, and the interaction between the added fertilizers with the study sites showed a significant effect on the mean of this trait. The added fertilizing combination superior in highest average for grains (4.805 tons.h^{-1}) compared to the conventional fertilizers added, which recorded the lowest mean to the trait (2.429 tons.h^{-1}). For yield components, the superiority of the fertilizing combination in a highest mean grain yield is due to its superiority with the highest growth characteristics and a highest mean yield components. The interaction between the cultivation sites and the added fertilizers was significant, and the fertilizer combination at the Al-Dawr site gave the highest mean grain yield (5.230 ton.h^{-1}) compared to conventional fertilizers at the same site, which decreased significantly and gave the lowest mean grain yield (2.429 ton.h^{-1}). This confirms poor of the soil Al-Dawr site with its necessary elements content for production, so the crop responded greatly by providing the necessary elements for growth and production, and vice versa.

Biological yield.h^{-1}

Table 9 shows presence significant differences in the mean biological yield of wheat crop as a result to the difference in the added fertilizers and as a result of the variation of cultivation sites and their interaction. As the biological yield per unit area was higher when adding the fertilizing combination (19.20 ton.h^{-1}) compared to the added conventional fertilizers

which achieved a lower average for these trait (20.12 $t.h^{-1}$) the reason is due to the superiority of the added fertilizing combination in height of the plant, the number of branches and the number of spikes per unit area as well as the increase in the weight of 1000 grains, which had a positive effect on increasing the biological yield. The cultivated sites in Baghdad outskirts (Latifiya, Abu Ghraib and Al-Radwaniyah) did not significantly differ among themselves in the mean of this trait (15.44, 16.57 and 16.96 $ton.h^{-1}$) respectively, But they decreased significantly from Al-Dawr site, which recorded the highest mean for this trait (20.76 $ton.h^{-1}$), and this is due to the great variation in environmental conditions between the sites at the level of the two governorates (Baghdad and Salah al-Din), Al-Dawr site outperformed the mean biological yield and achieved highest mean (23.56 $ton.h^{-1}$) due to the effect of the added fertilizing combination compared to Abu Ghraib site, which achieved the lowest mean to this trait (13.99 $ton.h^{-1}$) as a result of the effect of the fertilizers added in its conventional form.

Harvest index

The results of Table 10 indicate there are significant differences in the harvest index for bread wheat crop between the fertilizers and the sites and their interactions, as the fertilizing combination treatment was superior by giving it the highest average harvest index (26.53%) compared to the conventional fertilizers added, which recorded the lowest average for this trait (18.96%). The two sites Latifiya and Al-Radwaniyah outperformed the highest mean harvest index (25.% and 24.06%), and they did not differ significantly from each other, while the two sites Abu Ghraib and Al-Dawr were lower than these rates, but they did not significantly differ from each other. However, Abu Ghraib achieved the lowest average for this trait, which was 19.70%. The effect of the interaction between fertilizers and sites was significant in mean harvest index. Al-Latifiya site achieved the highest mean of harvest index (35.12%) due to the effect of fertilizing combination compared to the Dawr site, which recorded the lowest mean to this trait (14.91) when conventional fertilizers added.

It is possible to re-experiment if the same fertilizer combinations are available and the conclusion is adopted based on the multiplicity of sites that gave a good index to improve productivity through the added fertilizers combinations.

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Table (1), the content, quantity, and timing of adding the fertilizing combination and conventional fertilizer

First treatment (fertilizing combination)	Adding quantity	Adding time
Yara Mila 12–11–18	kg 25	At plowing
Orgevit	kg 25	
Appetizer	1L	After the completing germ – nation 15 days foliar spray
sol 10–52–10 Pro	kg 1	
Appetizer	1L	Before the emerge of the flag–leaf sprinkle foliar
sol 10–52–10 Pro	1L	
Urea 47–0–0	kg 20	adding to the ground before the flag–leaf appears
Second treatment (conventional fertilizer)		
DAP 18–48–0	kg 80	With plowing
Urea 47–0–0	kg 60	Two weeks after cultivation
Micro–Elements	kg 2	sprinkle foliar after 15 days completing germination
Potassium 0–0–50	kg 50	adding to the ground before the flag–leaf appears
Urea 47–0–0	kg 20	

Table (2), General Physical and Chemical Characterization of Soil Four Sites Using (HWSD) Program According to the Food and Agriculture Organization (FAO).

top soil 0–30 cm	Latifiya	Abu Ghraib	Radwaniyah	Dawr
Topsoil Sand Fraction (%)	35	35	35	35
Topsoil Silt Fraction (%)	47	47	47	45
Topsoil Clay Fraction (%)	18	18	18	20
Topsoil USDA Texture Classification	loam	loam	loam	loam
Topsoil Reference Bulk Density (kg /dm3)	1.41	1.41	1.41	1.4
Topsoil Bulk Density (kg /dm3)	1.39	1.39	1.39	1.5
Topsoil Gravel Content (%)	10	10	10	20
Topsoil Organic Carbon (% weight)	0.6	0.6	0.6	0.47
Topsoil pH (H_2O)	8	8	8	7.9
Topsoil CEC (clay) (cmol /kg)	65	65	65	51
Topsoil CEC (soil) (cmol /kg)	14	14	14	10
Topsoil TEB (cmol /kg)	19.8	19.8	19.8	10.4
Topsoil Calcium Carbonate (% weight)	11.7	11.7	11.7	31.6
Topsoil Gypsum (% weight)	0.2	0.2	0.2	15.1
Topsoil Sodicity (ESP) (%)	2	2	2	4
Topsoil Salinity (ECe) (dS /m)	0.7	0.7	0.7	2.9

Table 3: mean plant height (cm) of bread wheat due to the effect of fertilizers combinations with sites

Sites	fertilizers		Sites mean
	Conventional fertilizers	Fertilizing combination	
Latifiya	68.00	87.00	77.50
Abu Ghraib	73.75	78.70	76.23
Radwaniyah	76.25	81.75	79.00
Dawr	77.50	88.75	83.12
mean	73.88	55.8٤	79.22
LSD 5٪	fertilizers	sites، interaction *fertilizer	sites
	2.404	4.807	3.399

Table 4: mean number of total branches of plants (branch.m^{-2} plant) of bread wheat by the effect of fertilizers combinations, and sites

Sites	fertilizers		Sites mean
	Conventional fertilizers	Fertilizing combination	
Latifiya	967	1282	1124
Abu Ghraib	1111	2469	1790
Radwaniyah	1006	1697	1352
Dawr	1225	1552	1388
mean	1077	1750	1414
LSD 5٪	fertilizers	sites، interaction *fertilizer	sites
	122.1	244.2	172.7

Table 5: mean number of spikes (spike.m^{-2}) of bread wheat by the effect of fertilizers combinations and sites

Sites	fertilizers		Sites mean
	Conventional fertilizers	Fertilizing combination	
Latifiya	160.0	435.0	297.5
Abu Ghraib	244.8	425.0	334.9
Radwaniyah	220.0	435.0	327.5
Dawr	180.0	430.0	305.0
mean	201.2	431.2	316.2
LSD 5٪	fertilizers	sites، interaction *fertilizer	sites
	25.61	51.21	36.21

Table 6: mean number of Grain.spike^{-1} of bread wheat by the effect of fertilizers combinations and sites

Sites	fertilizers		Sites mean
	Conventional fertilizers	Fertilizing combination	
Latifiya	26.950	56.326	4.301
Abu Ghraib	45.842	51.357	4.842
Radwaniyah	42.780	53.109	4.770
Dawr	44.605	48.714	4.563
mean	39.345	52.220	4.619
LSD 5٪	fertilizers	sites، interaction *fertilizer	sites
	1.497	2.970	1.485

Table 7: mean weight of 1000 grains (g) of bread wheat due to the effect of fertilizers combinations and sites.

Sites	Fertilizers		Sites mean
	Conventional fertilizers	Fertilizing combination	
Latifiya	47.50	57.75	52.62
Abu Ghraib	49.25	57.00	53.12
Radwaniyah	45.25	58.75	52.00
Dawr	48.00	59.25	53.62
mean	47.50	58.19	52.84
LSD 5٪	fertilizers	sites، interaction *fertilizer	sites
	1.504	3.009	2.127

Table 8: mean weight of grain yield (ton.h^{-1}) of bread wheat by the effect of fertilizers combinations and sites.

Sites	Fertilizers		Sites mean
	Conventional fertilizers	Fertilizing combination	
Latifiya	2.820	4.460	3.640
Abu Ghraib	2.630	4.717	3.674
Radwaniyah	2.327	4.812	3.570
Dawr	1.937	5.230	3.584
mean	2.429	4.805	3.617
LSD 5٪	fertilizers	sites interaction *fertilizer	Sites
	0.2594	0.5188	0.3669

Table 9: mean bio-yield (ton.h^{-1}) for bread wheat by the effect of fertilizers combinations and sites

Sites	fertilizers		Sites mean
	Conventional fertilizers	Fertilizing combination	
Latifiya	14.25	16.62	15.44
Abu Ghraib	13.99	19.15	16.57
Radwaniyah	16.46	17.46	16.96
Dawr	17.97	23.56	20.76
mean	15.67	19.20	17.43
LSD 5٪	fertilizers	sites، interaction *fertilizer	sites
	2.19	4.38	3.10

Table 10: mean yield index (%) of bread wheat by influence of fertilizers combinations and sites

Sites	fertilizers		Sites mean
	Conventional fertilizers	Fertilizing combination	
Latifiya	16.65	35.12	25.88
Abu Ghraib	22.22	17.19	19.70
Radwaniyah	22.06	26.07	24.06
Dawr	14.91	27.76	21.34
mean	18.96	26.53	22.75
LSD 5٪	fertilizers	sites، interaction *fertilizer	sites
	2.528	5.056	3.575