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EFFECT OF TILLAGE SYSTEMS ON GROWTH AND YIELD OF BREAD WHEAT *TRITICUM AESTIVUM* L. AND ASSOCIATED WEEDS

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ABSTRACT

A factorial field experiment was implemented during the agricultural season 2023-2024 in two mid-rainfall area locations, Sahleg and Kahreez villages. The factorial experiment included two factors. The 1st. was the locations, and the second factor was the Tillage systems, which were Conventional Tillage (CT) and Zero Tillage (ZT). Wheat grains (Ipaa 99 var.) were sown at a sowing rate of 100 kg hectare^{-1}. Fertilizer was added (DAP) and Urea by 100 kg hectare^{-1}. The experiment was designed according to the factorial experiment system using a Randomized complete Block Design with three replications, the results showed that Sahleg location was superior in all traits of yield and its components due to the difference in rainfall precipitation in it compared to Kahreez location ZT treatment was also superior to CT in all traits of yield and its components with highly a significant difference. The highest value of grain yield was achieved ZT at the Sahleg location by 281g.m^{-2}.

INTRODUCTION

Wheat crop (*Triticum aestivum* L.) takes the first share in the group of cereal crops that are grown in the country as well as the world, given the importance of this crop in achieving food security for all the world's population in addition to its role in economic and social development (Alrijabo, 2022 and Akol *et al.,* 2021). The cultivation of the crop is spread in a wide area of arable land in the world, and this plant occupies the first place in world agricultural production. The area planted with this crop in the Arab world is estimated at approximately 30.46% of the total cultivation of other cereal crops and a production rate of up to 48.02% of the production of these crops (Aula *et al.,* 2025; Antar and Ahmad, 2020; Al-joborri and Alabar, 2021). This percentage reaches approximately 3.07% of the world's production of this crop, which was estimated at 749.46 million tons. Iraq contributes 12.92% of the Arab countries' production. Many problems face the agricultural sector, especially wheat cultivation, including weeds, which are present in high density (Gandia et al., 2021; Hussain et al., 2025; Al-Hanoush et al., 2023). In Iraq, there are more than 16 types of broadleaf weeds and 12 types of narrow-leaved weeds. These weeds cause losses of up to 50% of the product, in addition to the deterioration of the quality of the crop. Researchers are resorting to investigating new scientific methods to increase crop productivity and improve its quality, such as the use of the conservation agriculture system, which is one of the modern

scientific methods of agriculture, which was introduced to Iraq through cooperation with the International Center for Research, ICARDA, in 2005. This system has achieved positive results in Nineveh Governorate compared to traditional agriculture (Aljuburi and Antar 2021; Wozink and Racher, 2020). Also, keeping the remains of the previous crop in the ground and not disturbing the soil in this type of plowing led to obtaining better results compared to other systems. The research aims to spread this application of plowing in the rain-fed areas in northern Iraq in order to reduce the effects of climate change that is currently affecting the world (ElSadek *et al.,* 2020; Gandia *et al.,* 2021). The study aims to spread the technology of no-till farming and abandon traditional tillage to obtain the best production at the lowest costs and to fully utilize rainwater, as well as to optimize the amount of fuel used in agricultural operations, in addition to abandoning the use of chemical pesticides by eliminating weeds and not allowing them to grow in subsequent seasons.

MATERIALS AND METHODS

A field experiment was implemented during the agricultural season 2023-2024 in two Mid Rainfall Area locations; the first was in the Sahleg village, 22 km from the center of Mosul, and the second in the Kahreez village, 54 km from the city center of Mosul, near Zummar district. The amount of rainfall precipitation was 419 mm in the Sahleg location and 303 mm in the Kahreez location. The factorial experiment included two factors. The 1st. was the locations, and the second factor was the Tillage systems, which were Conventional tillage (CT) and Zero tillage (ZT). Wheat grains (Ipaa 99 var.) were sown at a sowing rate of 100 kg hectare^{-1}. The seeds were planted in the first week of January. Fertilizer was added (DAP) and Urea by 100 kg hectare^{-1}. The experiment was designed according to the factorial experiment system using a Randomized Complete Block Design (R. C. B. D) with three replications. The studied traits were: Weeds No. m^{-2}. Biological Yield g.m^{-2}. Plant height (cm). Spike length (cm). Tillers No.m^{-2}. Spikes.m^{-2}. Grains No. spike^{-1}. Weight of 1000 grains gm and Grains weight gm.m^{-2}. The data were analyzed according to the factorial experiment system and the design of the randomized complete blocks. The means were compared using the Duncan range test, as the different coefficients were taken to be significant with different letters of the alphabet at a probability level of 5%

RESULTS AND DISCUSSION

Table (1) indicates that geographical locations have a significant effect on the number of weeds and the phenotypic and quantitative traits of the bread wheat crop, as the Sahleg location was weedier compared to the Kahreez location, with the number of weeds m^{-2} for the two locations reaching 8.17, 3.00 weeds. m^{-2}, respectively. The Sahleg location also outperformed the Kahreez location in terms of biological yield, with a value of (641.83 g.m-2), which achieved a biological yield of (510.00 g.m^{-2}). There were no significant differences between the two locations in terms of plant height and spike length. In contrast, the number of tillers m^{-2} in the Sahleg location was significantly lower than the Kahreez location, with values of (299.17, 329.17 tillers m-2) respectively , these results are identical to (Minhas et al. 2023; Abdulatef 2023) results .

Table (1): The effect of locations on weeds and the growth and yield of bread wheat.

Location	Weeds No. m^{-2}	BiologicalYield $g.m^{-2}$	Plant heights cm.	Spike lengths cm.	Tillers. No m^{-2}
Sahleg	8.17 a	641.83 a	64.00 a	8.17 a	299.17 b
Kahreez	3.00 b	510.00 b	62.17 a	9.02 a	329.17 a

Table (2) indicates that geographical locations also have a significant effect on the traits of the yield and its components. Although there was no significant difference in the traits of the number of spikes.m^{-2} between the two locations, the Sahleg location outperformed the Kahreez location significantly in the traits of the number of grains per spike (grains. $spike^{-1}$), the weight of 1000 grains gm., and consequently the grain yield $gm.m^{-2}$, with values of (28.25, 31.83, 265.83) respectively , these results are consistent with the results of (Jabar *et al.,* 2024).
The reason for the superiority of the Sahleg location in grain yield is due to the abundance of rainfall in this location during the season, which reached more than 419 mm, compared to the Kahreez location, which received a total of only 303 mm of rainfall during the season. The physiological reason for the superiority of the Sahleg location in grain yield is due to its superiority in the traits of the components of the yield, which are the number of grains per spike, and the weight of 1000 grains, in addition to the non-significant difference in the trait of the number of spikes.m^{-2}, which achieved a significant difference in the traits of the grain yield in the Sahleg location compared to the grain yield of the Kahreez location , these results are consistent with the results of (Jalli *et al.,* 2021; Al-Sehahi *et al.,* 2015).

Table (2): The effect of locations on the yield and its components traits of bread wheat

Location	Spikes No. m^{-2}	Grains No. $spike^{-1}$	Weight of 1000 grains $g.m^{-2}$	Grains weight $g.m^{-2}$
Sahleg	285.00 a	28.25 a	31.83 a	265.83 a
Kahreez	288.00 a	24.89 b	25.75 b	191.00 b

Table (3) indicates that the Till-system had a significant effect on the number of weeds, phenotypic and quantitative traits of bread wheat crop, as the Conventional Tillage (CT) field was weedier compared to the Zero Tillage (ZT) field, as the number of weeds.m^{-2} for the two sowing systems reached (9.50, 1.67 weeds. m^{-2}), respectively. ZT outperformed in the biological yield with a value of (636.83 $g.m^{-2}$) on CT which achieved a biological yield of (515.00 $g.m^{-2}$) these results are identical to (Amar *et al.,* 2025; Baktash and Naes 2016) results.

In plant height, ZT outperformed CT with a significant difference, as plant height in ZT reached 68.82 cm, and in CT, 57.35 cm. ZT also outperformed CT in the number of tillers, which reached 342.33 tillers m^{-2} in ZT, compared to CT,

which reached 266.00 tillers m-^{2}. While there were no significant differences between the two sowing systems in the spike length these results are consistent with the results of (Abdulla *et al.,* 2024; Al- Hachmi and Frhan, 2017).

Table (3): The effect of Till-systems on weeds and the growth and yield of bread wheat

Till system	Weeds No. m^{-2}	Biological Yield g.m^{-2}	Plant height cm.	Spike length cm.	Tillers.m^{-2}
CT	9.50 a	515.00 b	57.35 b	8.62 a	266.00 b
ZT	1.67 b	636.83 a	68.82 a	8.57 a	342.33 a

Table (4) indicates that the Till-system has a significant effect on the traits of the yield and its components. Although there is no significant difference in the weight of 1000 grains between the two Till-systems, ZT outperformed CT significantly in the traits of the number of spikes.m^{-2}, the number of grains per spike, and grains. Spike^{-1}, and consequently the grain yield gm.m^{-2}, with values of (313.0, 27.96, 253.33) respectively. The reason for the superiority of ZT in grain yield is due to its superiority in the two most important traits of the yield components, which are the number of spikes. m^{-2} and the number of grains per spike, which achieved a significant difference in the grain yield trait in ZT compared to the grain yield of CT these results are consistent with the results of (Minhas et al. 2023).

Table (4): The effect of Till-systems on the yield and its components traits of bread wheat

Till-system	Spikes. No. m^{-2}	Grains No. spike^{-1}	Weight of 1000 grains g.	Grains weight g.m^{-2}
CT	260.00 b	25.18 b	28.75 a	204.17 b
ZT	313.00 a	27.96 a	28.83 a	253.33 a

Table (5) indicates the achievement of significant differences in the interaction between the two factors of locations and Till-systems. In the trait of the number of weed plants, the highest number of weed plants (14.67 weeds.m^{-2}) was achieved in the interaction of the Sahleg location with CT compared to the rest of the treatments that were similar in significance.

The highest biological yield (703.67g.m^{-2}) was achieved in the interaction of Sahleg location with ZT, with a significant difference from the other treatments. The lowest biological yield was achieved in the interaction of Kahreez location with CT (450.00 gm.m^{-2}). Regarding plant height, the interaction of ZT with both locations achieved the highest plant height significantly compared to the interaction of CT with both locations.

For spike length, the highest values were achieved in the interaction of ZT with the Sahleg location and the interaction of CT with the Kahreez location, with

values of (9.33 and 10.23 cm), respectively. As for the number of tillers.m^{-2}, the ZT interaction at the Kahreez location achieved the highest number of tillers.m^{-2} (359 tillers.m^{-2}), followed by the interaction of ZT with the Sahleg location (325.00 tillers.m^{-2}).

Table (5): The effect of interaction between locations and Till-systems on weeds and the growth and yield of bread wheat

Location	Till-system	Weeds No. m^{-2}	Biological Yields g.m^{-2}	Plant heights cm.	Spike lengths cm.	Tillers No.m^{-2}
Sahleg	CT	14.67 a	580.00 b	56.33 b	7.00 b	273.33 c
	ZT	1.67 b	703.67 a	71.67 a	9.33 a	325.00 b
Kahreez	CT	4.33 b	450.00 c	58.37 b	10.23 a	258.67 c
	ZT	1.67 b	570.00 b	65.97 a	7.80 b	359.00 a

In the traits of the yield and its components, Table(6) indicates the achievement of significant differences in the interaction between the factors of locations and Till-systems. In the trait of the number of spikes.m^{-2}, the highest number of spikes (325.00 spikes.m^{-2}) was achieved in the interaction of the Kahreez location with ZT, followed by the interaction of ZT with the Sahleg location (301.00 spikes.m^{-2}), with a significant difference from the interaction of CT in the two locations.

The highest number of grains per spike (29.67 grains. spike^{-1}) was achieved in the interaction of Sahleg with ZT, with a significant difference from the other interactions. Regarding the 1000-grain weight, the interaction of Sahleg with the two Till-systems achieved the highest 1000-grain weight values (32.83 and 30.83 gm.), respectively. The lowest average of 1000-grain weight was achieved in the interaction of CT with Kahreez (24.67 gm.). In terms of grain yield, the interaction of ZT achieved a significant superiority over CT in the Sahleg location, with a value of (281.67 g.m^{-2}). The interaction of ZT also achieved a significant superiority over CT in the Kahreez location, with a value of (225.00 g.m^{-2}).

Table (6): The effect of interaction between locations and Till-systems on the yield and its components traits of bread wheat.

Location	Till system	Spikes No. m^{-2}	Grains No. spike^{-1}	Weight of 1000 grains g.	Grains weight g.m^{-2}
Sahleg	CT	269.00 c	26.83 b	32.83 a	250.00 b
	ZT	301.00 b	29.67 a	30.83 a	281.67 a
Kahreez	CT	251.00 c	23.53 c	24.67 c	158.33 d
	ZT	325.00 a	26.25 b	26.83 b	225.00 c

It is noted from the table that the highest value of the number of spikes (325.00 spikes.m^{-2}) was in the ZT treatment at the Kahreez location. However, this

treatment did not achieve the highest grain yield, as the highest grain yield (281.67 gm.m^{-2}) was achieved in the ZT treatment at the Sahleg location, even though the number of spikes in this treatment (301.00 spikes.m^{-2}) was significantly less than the number of spikes in the ZT treatment at the Kahreez location.

The reason for the superiority of the yield of the ZT interaction in the Sahleg location is due to the significant superiority of this interaction in two important traits of the yield components, which are the trait of the number of grains in the spike (29.67 grains. spike^{-1}), and the trait of the weight of 1000 grains (30.83 gm.), which made this interaction achieve significant superiority in the trait of grain yield.

CONCLUSIONS

1. The agricultural land in Nineveh Province is approximately 1.6 million hectares, 95% of which depends on rainwater for irrigation. Therefore, this study is importance to decision-makers, as it provides clear evidence of climate variability in Nineveh.
2. Diagnosing climate change is like diagnosing a disease, but without an effective and curative treatment, the diagnosis becomes useless. Therefore, shifting from conventional agriculture to conservation agriculture is an effective treatment for combating climate change in Iraq, and in Nineveh Province in particular, because it's the breadbasket of Iraq and the fact that 95% of its agricultural area is irrigated by rain.
3. Many researchers have confirmed that conservation agriculture has provided and continues to provide successes in improving the growth of field crops and improving their qualitative and quantitative traits. It has been shown that:

   The results indicated that fields under ZT exhibited early emergence, higher soil moisture content, plant height (77.2 cm), better yield attributes (spike length, number of grains per spike, number of effective tillers, and 1000-grain weight), and grain and straw yield in comparison to the conventional tillage. The use of conventional tillage using a rotary plough resulted in the highest number of weeds, the lowest plant height, the lowest number of branches per square meter, the lowest number of spikes per square meter, and the lowest grain yield and biological yield. These results make us recommend the following to achieve sustainable development: Climate change in some regions, from the Mid Rainfall area and the Low Rainfall Area, makes us recommend the necessary and rapid transition to the Conservation Agriculture CA method (Zero Tillage) for all of Nineveh Province. This new technology guarantees the most efficient harvesting of rainwater. It achieves good yields that enable farmers to continue the agricultural process and population stability in their villages, in addition to the benefits of this technology in preserving the environment and preventing soil erosion and air dust pollution.

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CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest.

تأثير أنظمة الحراثة على نمو ومحصول قمح الخبز (*Triticum aestivum* L.) والادغال المرافقة لها

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الخلاصة

تم تنفيذ تجربة حقلية عاملية خلال الموسم الزراعي 2023–2024 في موقعين من مواقع المناطق شبة المضمونة الامطار والتي تستلم معدل امطار يتراوح من 400–500 ملم، قريتي سهليج وكهريز ضمن قضاء زمار الواقع شمال غرب مدينة الموصل. تضمنت التجربة العاملية عاملين. الأول هو المواقع والعامل الثاني هو أنظمة الحراثة وهي الحراثة التقليدية (CT) والحرث الصفري (Z.T) زرعت حبوب الحنطة صنف اباء 99 بمعدل بذر 100 كغم هكتار$^{-1}$.في الاسبوع الاول من شهر كانون الثاني وتمت إضافة السماد (DAP) واليوريا بمقدار 100 كغم هكتار$^{-1}$ عند بداية موسم الزراعة تم تصميم التجربة وفقًا لنظام التجارب العاملية باستخدام تصميم القطاعات العشوائية الكاملة وبثلاث 3 مكررات تم اختبار المعاملات حسب اختبار دنكن المتعدد المدى تحت مستوى احتمال 5 % وأظهرت النتائج أن موقع سهليج كان متفوقًا في جميع صفات المحصول ومكوناته معنويا مثل عدد الادغال والحاصل البايولوجي ووزن 1000 بذرة وحاصل الحبوب / م$^{-2}$ بسبب اختلاف هطول الأمطار فيه مقارنة بموقع كهريز. كما تفوقت معاملة الحرث الصفري على الزراعة التقليدية معنويا في صفات المحصول ومكوناته مثل الحاصل البيولوجي وعدد الاشطاء وعدد السنابل وعدد الحبوب بالسنبلة وحاصل الحبوب / م$^{-2}$ بفارق كبير. تم الحصول على أعلى قيمة لإنتاج الحبوب عند استخدام الحرث الصفري في موقع سهليج بمقدار (281 غم.م$^{-2}$).

الكلمات المفتاحية: الحرث الصفري، الحراثة التقليدية، مكافحة الادغال، موقع قرية سهليج، موقع قرية كهريز.

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