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The Effect Of Tillage Depths And Different Fertilizer Combinations On The Growth And Production Of The Wheat Crop (Triticum Aestivum L.)

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Abstract

A field experiment was conducted during the agricultural season 2020-2021, at the agricultural extension station in Al-Najmi district, 43 km northeast of the Samawa, the center of Al-Muthanna Governorate, to determine the effect of tillage depths and different fertilizer combinations (P-K) on the growth and production of the wheat crop. The experiment was applied according to the arrangement of the split block by two factors using the (RCBD) design and with three replicates, the study included two factors: The first factor; has four treatments of the tillage systems (0, 10, 20 and 30 cm). The second factor; four fertilizer combinations with the control treatment (30, 50, 75 and 120 kg ha^{-1}). Wheat seeds were sown on November 19, 2020. The results showed that the treatment of tillage systems had a significant effect on the studied traits, T2 excelled in giving the highest mean of the area of the flag leaf trait, the treatment of no-till farming systems (T0) gave the highest mean of the number of spikes, T3 tillage system treatment gave the highest mean of grain yield, T1 tillage treatment gave the highest mean for grain protein. As for the different fertilizer combinations (P-K), they had a significant effect on the studied traits, F2 fertilizer combination was significantly superior in achieving the highest average area of the flag leaf and grain yield, while the F4 fertilizer combination gave the highest average for grain protein. As for the interaction between the study factors, it had a significant effect on most of the studied traits, the treatment (F2×T3) was significantly superior in giving it the highest average for the trait of the area of the flag leaf and the number of spikes, whereas, treatment (F0×T3) gave the highest mean for grain yield.

Keywords: tillage depths and, fertilizer combinations, growth, production, wheat (Triticum aestivum L.).

Introduction

The wheat crop (Triticum aestivum L.), is the most important strategic and food crop for most of the world's population, it ranks first in terms of cultivated area and production, wheat is an essential source of human nutrition, because it contains of protein, carbohydrates, amino acids, vitamins and dietary fiber (Shewry et al., 2009). Wheat occupied the first place in the list of consumer food commodities, it provides more than 50% of calories, that enter the human diet, the cultivated area in Iraq in 2020 was about 8574 thousand dunums, with a productivity of 6238 thousand tons (Directorate of Agricultural Statistics, 2020).

The productive capacity of any crop, regardless of its specifications, related to the service operations applied according to the correct principles, one of these operations is tillage systems, affecting the physical and chemical properties of the soil, tillage is an important field practice, because of its role in improving soil management during soil disintegration and mixing, to change some physical properties, maintaining a fertile content suitable for plant growth and raising agricultural production. Frequent tillage is also a major cause of agricultural land degradation, and the occurrence of some negative changes in the surface layers of the soil, because of its effect on soil properties, such as soil compaction, stability and porosity of soil pools, lack of suitable cradle for seeds, as well as the spread of salts in the root zone, in addition to the problem of jungles that compete with the crop and exploit nutrients and moisture from the soil, it causes a decrease in productivity, many countries of the world have adopted the technology of no-till farming, because of its benefits, maintaining soil moisture, improving seedling growth, and facilitating agricultural operations, the increase in production during the seasons of scarce rain (Antar, 2013).

The no-till farming system is important in improving the productivity of the wheat crop, conserving resources and increasing the farmer's income, the no-till farming system achieves good productivity in dry seasons and reduces traditional tillage operations, which leads to the breaking of solid soil layers and the penetration of water into the depths of the soil and the plants not benefiting from it, the use of the no-till farming technique preserves the characteristics of the soil and its moisture content and reduces the density of the bushes with a negative impact, contributes to reducing the productivity of the crop through competition for the necessary requirements for the growth of the crop (Qatni, 2009).

Adding different fertilizer combinations, such as potassium and phosphorous fertilizers, one of the urgent agricultural inputs in the cultivation of grain crops, for the purpose of increasing agricultural production in terms of quantity and quality, the inaccurate addition of these fertilizers to the soil is accompanied by some problems that cause an imbalance in the ecological balance (Hammad, 1998).

The addition of potassium plays an important role in the growth and completion of the plant's life cycle, despite the fact that it does not form any organic compound, found in free ionic form in plant tissues, activates more than 80 enzymes directly and indirectly, such as proteinases, kinases, redox enzymes, and reductases (Ali and Shaker, 2014). Adding phosphorous to plants has an important role in cell division and regulation of vital activities, during the formation of energy-rich compounds, chloroplasts, mitochondrial membranes and cell protein, where phosphorous is concentrated in the cells of the highly effective active parts, such as the ends of the roots and the developing tops of the plant (Al-Muaini and Al-Obaidi, 2018).

The area of the flag leaf is one of the most important parts of the plant in determining the productivity of the crop, be responsible for food production, it contributes greatly to the fullness of the bean from the stage of fertilization to physiological maturity, as a result of its active role in photosynthesis (Hadi et al., 2015). Al-Douri and Mohammed (2014) indicated through the results of their experiment to the superiority of the treatment of no-till agriculture compared to the treatment of tillage for most of the studied traits, including leaf area.

Al-Daami (2015) also found a significant effect of potassium levels (0, 150 and 200) kg ha^{-1} on the leaf area characteristic of wheat crop with averages of 29.62 and 31.57 cm^{-1} compared to the comparison treatment, which recorded the lowest average of 26.93 cm^2. Daoud (2011) indicated that there was an effect of tillage treatment on the number of spikes m^2 as it recorded (536) spikes m^2 compared to the control treatment without tillage, with an average of (460) spikes m^2. Zaboun et al. (2015) showed through an experiment to see the effect of three potassium levels (0, 120 and 180) kg k. ha^{-1}, and there was a significant difference between the levels of addition, and the level 120 kg k. ha^{-1} recorded the highest averages for the number of spikes m^2 amounted to 625. 6 spikes m^2. Majeed and Jabbar (2015) indicated that when adding levels of phosphate fertilizer (0, 40, 80 and 120) kg P_2O_5 ha^{-1}, the level of 120 kg P_2O_5 ha^{-1} significantly outperformed the rest of the levels for the number of spikes m2 with an average of 656.59 spikes m^2 compared to treatment The comparison gave the lowest average of 511.31 spikes m^2.

Grain yield is one of the important characteristics that is affected by different tillage systems and the level of fertilizer added, and it has an encouraging role in increasing the total yield of grain, as it represents the final product of its three components, were number of spikes m^2, number of spike grains, weight of 1000 grains (Ali, 2012). Daoud (2011) indicated that there was a significant increase in the grain yield for the tillage treatment compared to the no-till farming system. This is due to the role of tillage in improving the physical properties of the soil, including the decrease in the bulk density, the increase in the water availability in the soil and the improvement of soil aeration, and this is reflected positively on the growth of the crop and the result To increase the ability of expansion and spread of plant roots in the soil. Hamada (2016) showed through the results of his experiment that he conducted in gypsum soil that there is a significant increase of light tillage system over traditional tillage system in growth parameters of wheat plant yield. Muhaimid (2017) indicated that the traditional tillage with vertical disc tillage was significantly superior in increasing wheat yield by 1.406 tons ha^{-1} when compared to light tillage with disc harrow, which recorded the lowest yield of 1.370 tons ha^{-1}. Abdul Karim (2016) noticed a significant superiority of the level of the ground fertilizer 150 kg K ha^{-1}, as it gave the highest average grain yield of 3.45 and 3.43 tons ha^{-1} for the two seasons respectively. Majeed and Jabbar (2015) indicated that the addition of phosphate fertilizer at a level of 120 kg P2 o5 ha^{-1} gave a significant superiority to the grain yield with an average of 6.68 tons ha^{-1} compared to the comparison treatment, which gave the lowest average of 5.14 tons ha^{-1}.

The percentage of protein is one of the important qualitative characteristics that are affected by environmental conditions and agricultural processes, as the quality of wheat depends on the percentage of protein in the grain, there were significant differences between potassium levels (0, 2000 and 4000) mg K L^{-1} in most of the studied traits, including the percentage of protein in grains, which averaged 23.77%, the addition of half of the NPK fertilizer recommendation gave a significant superiority to the protein content in grains, with an average of 15.26% (Al-Yasiri, 2015).

Therefore, this study aims to indicate the selection of the appropriate tillage depth for the expansion of roots and absorption of nutrients and to find the best combination of potassium and phosphorous elements that achieve the best growth and production of wheat crop.

Materials and Mthods:

The experiment location:

A field experiment was carried out during the winter season (2020-2021) at the Agricultural Extension Station, belongs to the Directorate of Al-Muthanna Agriculture in Al-Najmi District, northeast of the city of Samawah, the center of Al-Muthanna Governorate, at silty loam texture soil.

Physical and chemical properties of the soil used in the experiment:

Soil analyzes before planting:

The degree of soil reaction: The soil pH was measured in a 1:1 water-soil suspension, using a PH-meter, as described in (Page et al., 1982).

Electrical conductivity (ECe): The electrical conductivity (EC) was measured in the saturated soil pulp extract, using an electrical conductivity device (EC-meter) as described in Richards (1954).

Soil texture: Soil texture was estimated by the pipette method mentioned in (Black, 1965).

Bulk density: It was estimated by (Core method) by taking a known volume of soil (100) cm^3, drying it and calculating the dry weight using a sensitive scale.

The true density: It was estimated by the pycnometer, according to what was mentioned in (Blake and Hartge, 1986).

Soil porosity: its values were estimated, after knowing the values of both the apparent density and the real density, according to what was mentioned in (Hassan et al., 1990).

Organic matter: It was estimated according to (Walkely and Black) method, and according to what was stated in (Black, 1965).

Available Nitrogen: (aluminum and nitrate) extracted with potassium chloride solution, and estimated using a (microcondole) according to the method described in (Blak, 1965).

Available phosphorous: The prepared phosphorous was extracted by a solution of 5.0 molar sodium bicarbonate and PH 8.5, and the color was developed by a solution of ammonium molybdate and ascorbic acid according to the Olsen method, it was estimated using a spectrophotometer at a wavelength of 882 nm as mentioned in (Page et al., 1982).

Available potassium: Potassium was measured with ammonium acetate (N1) solution, and then measured with a flame-photometer, according to what was mentioned in (Black, 1965).

Table (1): Some physical and chemical properties of the study soil before planting.

Properties	Unit	Volume
EC	dsm^{-1}	4.60
PH	-	7.70

Sant	g kg^{-1}	11.00
Silt		67.00
Clay		22.00
Soil texture	Silty loam	
Bulk density	mg m^{-3}	1.14
The true density		2.30
Porosity	%	52.00
Organic matter	g kg^{-1}	1.01
Available Nitrogen	mg kg^{-1}	17.90
Available phosphorous		169.70
Available potassium		11.03

Experiment factors

The experiment included a study of two factors:

The first factor: It included four treatments which are the different tillage systems and they were placed in the main plots: were 0, 10, 20 and 30 cm.

The second factor: adding a fertilizer mixture of mineral fertilizer (P-k) and it included four treatments and was placed in the secondary plots.

First: Phosphate fertilizer batches and five levels, were 0, 30, 50, 75 and 120 kg k.ha^{-1}**,** were symbol P0, P1, P2, P3 and P4.

Second: batches of potassium fertilizer in five levels, were 0, 30, 50, 75 and 120 kg k.ha^{-1}**,** were symbol K0, K1, K2, K3 and K4.

Experiment design

The experiment was applied in a split block method, Randomized Complete Block Design (R.C.B.D) with three replicates. The tillage parameters were placed in the main plates, while the fertilizer parameters were placed in the secondary plates, the area of the experimental unit was 2 × 2 m^2, it contains 8 lines, the distance between one plot and another was 1 m and between the main plot was 2 m^2, to avoid treatments interaction, a total of 60 experimental units were used in the experiment.

Soil preparation and field operations:

Soil preparation and servicing were carried out before planting, the soil was tillage using the parameters of the tillage systems using the turntable disc tillage, for three depths including tillage, the first depth is 10 cm, the second is 20 cm, and the third is 30 cm, leaving a no-till treatment. The land was divided according to the design used, and the area of the experimental unit was 2 × 2 m^2 for the experimental unit, by three blocks, the first block included 20 experimental units. The planting was on lines, the distance between one line and another was 20 cm. The planting was done with a planting depth of 4 cm. The grain of wheat (Triticum aestivum L.) Bohuth22 cultivar, was planted on 19/11/2020 with a seeding rate of 120 kg/ha (Brochure. 2012). The nitrogen fertilizer was added in three batches at the branching stage, elongation stage and flowering stage, at a rate of 200 kg. Phosphate fertilizer was added at different levels at once before planting. Potassium fertilizer was added at the specified levels and in two batches at the branching stage and flowering stage (Jadoua, 1995). The irrigation process was carried out using the tourist irrigation method, and the irrigation water was determined for all the experimental units, depending on the mechanical irrigation meter, the experiment was harvested on 9/4/ 2021 when the plant reached the stage of full maturity.

Studied traits

1. The area of the flag leaf (cm^2): It was calculated for the average of ten plants randomly selected from each experimental unit in the stage of completion of flowering according to the following equation:
The area of the flag leaf= length of the flag leaf × its width from the widest area × correction factor (95.0) (Thomas, 1975)

2. Number of spikes (m^2): The number of spikes after reaching full maturity was calculated from two middle lines from each experimental unit, and then converted to m^2.

3. Grain yield (tons ha^{-1}): It was estimated that two middle lines were harvested from each experimental unit and after manual threshing of the harvested plants, isolating straw and cleaning grains, then weighed with a sensitive scale and then transformed the weight on the basis of ton ha^{-1}.

4. Percentage of protein in grain (%): A sample of the same grains used to calculate the yield was taken and the protein percentage was estimated by means of the 2000 LB scan Crop device.

Results and discussion

The area of the flag leaf (cm^2):
Table (2) indicates the significant difference between the tillage systems and fertilizer combinations (P-K)) and the interaction between them in the trait of the area ofthe flag leaf (cm^2), as it is noted that there are significant differences in the area of the flag leaf according to the different coefficients of the cultivation systems used, whereas, the T2 tillage system treatment achieved the highest average area of the flag leaf (cm^2), as it reached 30.20 cm^2, while the treatments of the two tillage systems (T3 and T1) gave averages for the trait, which amounted to 29.09 and 28.22 cm^2 sequentially, compared to the treatment of T0, which gave the lowest mean of 25.91 cm^2. The reason for this may be attributed to the role of medium tillage in improving the physical and chemical properties of the soil, which improves the growth and spread of roots and increases their ability to absorb water and nutrients, reflected in an increase in the leaf area of the plant, did not agree with the conclusion reached by Al-Douri and Mohammed (2014).

As for the fertilizer combinations, the F2 combination was significantly superior in achieving the highest average area of the flag leaf as it reached 32.88 cm^2, compared to the fertilizer combination F3, which gave the lowest average for this trait, it was 25.49 cm^2. This is due to the abundance of nutrients in the quantities needed by the plant, led to the development of vegetative growth, which led to an increase in cell division and an increase in the expansion of leaf cells and an increase in the concentration of chlorophyll pigment in the leaf, reflected positively in increasing the efficiency of photosynthesis.

It is noted from the results of the interaction between the two factors, the tillage systems and fertilizer combinations, that the two interaction coefficients (F2×T3) and (F4×T2) outperformed, as they gave the highest averages of 37.02 and 35.47 cm^2 respectively, while the interference coefficients (F4×T0) and (F3×T0) gave the lowest averages for this trait, reaching 22.18 and 22.51 cm^2 respectively.

Table (2): The effect of tillage systems and fertilizer combinations (P-K) and the interaction between them on the trait of area of the flag leaf (cm^2).

Fertilizer / Tillage system	F0	F1	F2	F3	F4	Mean
T0	26.03	29.84	28.99	22.51	22.18	25.91
T1	24.37	32.66	32.75	28.07	23.27	28.22
T3	27.81	27.12	32.75	27.85	35.47	30.20
T4	29.30	24.18	37.02	23.53	31.43	29.09
Mean	26.88	28.45	32.88	25.49	28.09	
L.S.D$_{0.05}$	**F**		**T**		**F×T**	
	1.917		2.734		4.113	

Number of spikes (m^2):

Table (3) showed the significant effect of the plowing systems' coefficients on the characteristic of the number of spikes (m^2), it was significantly superior to the treatment of plowing systems T0, which gave the highest average of 269.4 seeds m^2 and without significant difference from treatment 3T, which averaged 264.7 seeds m^2, T1 treatment recorded a significant difference, which gave an average of 4.251 m^2 spikes, compared to the treatment of tillage systems T2, which gave the lowest average for this trait, it was 248.9 m^2 spike. The increase in the number of spikes can be explained by the role of no-till agriculture in improving the vegetative growth of the plant, especially the increase in the number of spikes due to the small number of bushes and their competition for the wheat crop, this result was don't agree with Daoud (2011).

The fertilizer combinations did not show any significant effect for this trait.

The interaction treatment between the two factors of the study (T3×F2) gave the highest mean of 303.3, while the interaction treatment (T2×F2) gave the lowest average for this trait, which amounted to 227.3 m^2 spike.

Table (3): The effect of tillage systems and fertilizer combinations (P-K) and the interaction between them on the number of spikes (m^2).

Fertilizer / Tillage system	F0	F1	F2	F3	F4	Mean
T0	270.3	275.3	245.3	267.0	289.0	269.4
T1	233.3	248.0	265.3	240.3	270.0	251.4
T3	251.3	263.3	227.3	247.3	255.0	248.9
T4	268.3	239.0	303.3	275.0	238.0	264.7
Mean	255.8	256.4	260.3	257.4	263.0	
L.S.D$_{0.05}$	**F**		**T**		**F×T**	
	N.S		10.04		26.79	

Grain yield (ton ha^{-1}):

Table (4) shows the significant effect of tillage systems and fertilizer combinations (P-K) and the interaction between them on the characteristic of grain yield. The results showed the significant superiority of the two tillage treatments (T3 and T1), which gave the highest average for this trait amounting to 5.449 and 5.376 tons ha^{-1}, with a significant difference from the T2 tillage system treatment, which gave an average of 4.933 tons ha^{-1}, compared to the T0 tillage system treatment, which recorded the lowest average for this trait amounting to 4.728 tons ha^{-1}. The reason for the increase in the grain yield is attributed to the use of deep tillage systems T3 which is an end result of the improvement of plant growth as a result of the role of tillage in improving the physical and chemical properties of the soil, including reducing the bulk density, increasing the porosity of the soil, and increasing the plant's supply of the necessary nutrients, by allowing the roots to spread, which leads to increased plant growth and production, agreed with the findings of Daoud (2011) and Ramadhan (2013).

As for the fertilizer combinations, the results showed the superiority of the F2 treatment in giving it the highest average of 5.484 tons ha^{-1}, whereas, the F1 treatment gave the lowest level for this trait, which was 4.853 tons ha^{-1}. The reason is attributed to the appropriate fertilizer combination in providing the plant with nutrients, its role in the activity of vital processes by increasing the growth of the vegetative and root system, thus, access to a high productivity of the grain yield.

The results showed a significant effect of the interaction between the two workers, as the interaction treatment (T3×F0) excelled in recording the highest average of 6.290 tons ha^{-1}, whereas, the comparative treatment of interference (T0×F0) gave the lowest average for this trait, which was 3.607 tons ha^{-1}.

Table (4): The effect of tillage systems and fertilizer combinations (P-K) and the interaction between them on the characteristic of grain yield (tons ha^{-1}).

Fertilizer / Tillage system	F0	F1	F2	F3	F4	Mean
T0	3.607	4.277	5.663	4.680	5.413	4.728
T1	6.273	5.297	5.363	4.243	5.703	5.376
T3	4.733	5.263	5.017	5.120	4.533	4.933
T4	6.290	4.573	5.893	5.650	4.837	5.449
Mean	5.226	4.853	5.484	4.923	5.122	
$L.S.D_{0.05}$	**F**		**T**		**F×T**	
	0.3165		0.2302		0.5944	

Grain protein (%):

Table (5) showed the significant effect of the study factors and the interaction between them on the character of grain protein (%), the results of the table showed the significant effect of tillage systems treatments, as the T1 treatment recorded the highest average for this trait, as it reached 1.4100%, without a significant difference from the T0 treatment, which gave an average of 1.3967% for the trait, while the T2 treatment recorded a significant difference, as it gave an average of 1.3813%, compared to the treatment of T3 tillage systems, which recorded the lowest average for this trait, it was 1.3773%. The reason for this is due to the role of light tillage and the lack of soil erosion and its retention of nutrients necessary for plant growth, which made it more flexible in the efficiency of the transfer of elements, positively reflected in the increase in grain protein, it was known that the percentage of protein in grains is one of the most important measures used in evaluating the quality of grains.

A significant effect of the fertilizer combinations was observed on the character of protein concentration in grains , the fertilizer combination (F4) outperformed, it recorded the highest average of 1.5267% compared to the comparison treatment, which gave the lowest average for this trait amounted to 1.2658%. The reason for the increase in the proportion of protein in grains is due to the increase in fertilizer combinations, because of its role in increasing the vegetative total, which led to an increase in the photosynthesis process of the plant, thus, adding these products to the downstream (biological), and increase the proportion of protein in it, this result agreed with the findings of Al-Halfi et al. (2014) and Al Yasiri (2015).

Table (5): The effect of tillage systems and fertilizer combinations (P-K) and the interaction between them on the protein concentration in grain (%).

Fertilizer / Tillage system	F0	F1	F2	F3	F4	Mean
T0	1.2733	1.3300	1.3867	1.4600	1.5333	1.3967
T1	1.2733	1.3367	1.4167	1.4833	1.5400	1.4100
T3	1.2600	1.3200	1.3733	1.4400	1.5133	1.3813
T4	1.2567	1.3167	1.3600	1.4333	1.5200	1.3773
Mean	1.2658	1.3258	1.3842	1.4542	1.5267	
$L.S.D_{0.05}$	**F**		**T**		**F×T**	
	0.01191		0.01174		N.S	

Conclusions

The significant effect of light tillage regimes on growth traits, yield and its components, including the area of the flag leaf, the number of spikes, the grain yield and the percentage of protein in the grains. There was a response of the wheat crop to the added fertilizer combinations, as it achieved a significant increase in the area of the flag leaf, the yield of grains and the percentage of protein in the grains.

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