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The performance and effect of two types of tillage systems on the growth and yield of hard wheat: A comparative study

[1] Murad Abdullah Abdul Qadir, [2] Ra'ed Mujbil Abdullah, [3] Susan Tahseen Muhammad Amen
[1, 2] Health and Medical Technical College, Kirkuk, Northern Technical University, Iraq
[3] College of Agriculture, University of Kirkuk, Hawija, Iraq

Corresponding Author: **Murad Abdullah Abdul Qadir**

Abstract
The experiment was carried out in one of the farmers' fields of Kirkuk irrigation project for the year 2021-2022 in order to study the performance of two types of tillage systems (tillage and non-tillage). Three levels of speed gear shifter were used, which were randomly distributed over the main sectors (5-5.5, 6-6.5, 7-7.5) km/h. The crop used in farming was Triticum durum wheat. The results showed a clear superiority of the factor (non-tillage) over (tillage) in all the studied properties, which were the density of spikes / m2, number of grains / spike, weight of 1000 grains (g), grain yield (kg/hectare), slide rate %, and the actual field productivity of the machine (acres/hour).). As for the tillage system, it reached (322.55 m2, 49.78, 43.73 g, 3579.26 kg/ha and 6.71 acres/hour) respectively, except for the sliding rate, which was higher in the tillage system by (2.48%)%. As for the speed gear shifter, the speed gear of seeding was affected by all the studied properties, which reached (379.29) m2, (53.50), (44.47) g, (4462.8) kg/acres, (1.15)% and (6.98) acres/hour. As for the interactions between the system with tillage, non-tillage, and tillage with the speed gears used in the sowing process, they were superior in all the studied properties by (447.96) m2, (65.15), (55.56) g, (4700.1) kg/hectare, (0.53)% and (9.43) acres\hour.

Keywords: Tillage System, Seeding Speed, Wheat

1. Introduction
Conducting primary tillage, smoothing, adjusting, leveling, and carrying out the process of seeding and planting, are all attempts to change the conventional farming pattern. Applying the non-till farming system is a modern scientific view and method, despite the emergence of this method in agriculture recently. There are many requirements that follow the conventional tillage system. If compared to the non-till farming system, it would provide many of these requirements to shorten the traditional agricultural processes with the direct cultivation and non-tillage system. This system is an expensive and consumptive. These operations would require fuel and labor consumption as a result of the treading the field several times by the tug vehicle [1]. Non-tillage farming reduces environmental damage, lowers runoff, and better water consumption. This type of tillage contributes to controlling the soil erosion and improving non-tillage farming in terms of soil biology, composition and organic matters, the stability of its aggregates and soil micro-pores, and an increase in soil resistance to pests, as indicated by Hargrove [2]. It became urgent to conduct an economic feasibility study of the agricultural operation. It is a key factor before carrying out agricultural activities, especially in areas with rainy weather, because of the aforementioned technical and financial problems. Farming in these areas is critical in terms of seasonal time and time of planting and sowing. Resorting to short period farming is a key factor in the on-rain farming in order to be able to plant the widest possible area in a short time, due to the short time available to prepare the land for cultivation and the capacity of the areas planted with cereal crops [3]. These mechanical seeders are required to be in direct contact between the seeds and the soil, and to carry out the fertilization process with the seed and with powerful digging equipment so that their harrows can penetrate the soil and place the seeds at the appropriate depth. Due to the diversity of crop seeds in their sizes and densities, and the different quantity of seeds to be planted, the necessary regulations for seeding and planting equipment may be made to produce positive results. There are various advantages of automatic mechanical seeder after carrying out the necessary regulation procedures, such as ensuring that the seeds are placed at a constant depth in the soil and covered well and ensuring the setting of the specified rate of seeds per acre. This leads to a significant saving in seeds of up to 50% or more, and ensuring a regular distribution of plants, which greatly helps in the degree of crop growth and production [4]. The type of soil, the degree of moisture, and the location are the factors on which the planting system is adopted. Research indicated that the use of a digging plow or a rolling plow

may be suitable for some areas without others, as it showed positive results in increasing the number of crop plants and increasing the components of the total yield compared to conventional or no-tillage farming [5] carried out a study on the performance of the four-unit fertigator mechanical seeder for growing maize, where they showed that the best homogeneity of seed distribution was achieved at a speed gear of 6 km/h with a depth of 10 cm. The distance between the seeds within the single line was the best it could be, where the number of plants per unit area increased, and the productivity of maize crop increased by such treatment. The mechanical seeding process is affected by various factors, such as the speed gear of the seeding process in the field (3, 6, 9, 11.2) km/h with the two depths (10,5) cm. They concluded that the speed gear shifter of the seeder machine has an effect on the accuracy of the distance between corn seeds in one [6] showed that when increasing the forward speed gear shifter of the tug machine during the sowing process, it would lead to reducing fuel consumption and increasing both the slide rate and the actual field productivity of the machine. Rajbo and Hassan (2011) conducted a study that included a comparison of the effect of non-tillage farming with conventional farming on the phenotypic and productive properties of hard wheat. The results showed that the treatment of non-tillage farming did not differ significantly from the conventional farming in the properties of the number of straws, the number of spikes per square meter, the weight of a thousand grains, and the height of the plant. Non-tillage farming achieved significant superiority over conventional farming in the properties of the number of spike grains, grain yield, and hay weight [7] studied the effect of various tillage systems on barley yield, where they did not notice an obvious superiority of the non-tillage farming system over other systems that included (digger plow, vertical disc plow, rotary plow and tipper plow). Tilling had a positive and significant effect on the physical properties of the soil. The research aims at determining the priority of the farming system used represented by tillage and non-tillage, as well as the appropriate speed of the sowing process and their impact on the cultivation of the wheat crop.

2. Research materials and methods

This study was carried out in one of the farmers' fields (Soil texture, mixture, clay, alluvial, and its apparent density of 1.35 g/cm³) alongside Kirkuk irrigation project for the year 2021-2022 on the crop used in cultivating the class of wheat "Triticum durum" with a quantity of seeds (27) kg/acres. Sowing was carried out on 25/11/2021, by using a tugged seeder machine (Atchison) that is Australian origin. The harrows in the seeder are (15), where the distance between each harrow is (17) cm. The seeder machine also contains two boxes: one is for seeds and the other for fertilizer. There is a feeding mechanism for each box (seeds and compost) below the two boxes, which is a spiral auger. After feeding, special tubes deliver the seeds to the cavities and then put them into the soil. After that, the process of covering the seeds with soil and then compressing by means of covering and pressure wheels that go behind the harrows at the back of the mechanical seeder. This mechanical seeder was pulled by a CASE (2004) 120 HP agricultural tractor with 8 forward slow and 8 fast speed gear shifter, as well as two reverse speed gears. A randomized complete block design (RCBD) was used for a two-factor and three-replication experiment. The tillage systems were placed in the main sectors and included two tillage systems: non-tillage and conventional tillage. Three levels of speed gears were used, which were randomly distributed over the main sectors (5-5.5, 6-6.5, 7-7.5) km/h. Replications were taken for the experimental units for a distance of (50) meters and a width of (2.5) meters, which is the width of the seed. The studied properties were (slide rate, actual field productivity of the machine, and acres/hour) (spikes density/m2, number of grains/spike, weight of 1000 grains g, and grain yield kg/hectare), and the total branches (the rims) and the effective branches (the holder of wheat spikes). A stopwatch was used in the experiment to read the time to get the appropriate speed gear. That speed gear was measured for each treatment with and without load to calculate the percentage of sliding.

$$slide\ rate = \frac{speed\ without\ load - speed\ with\ load}{speed\ without\ load} \times 100\%$$

The actual field productivity of the machine (acres/hour)= Actual speed (m/h) x actual width x efficiency=2500m^2
The data were statistically analyzed by using the ready-made statistical program (SAS) Statistical Analysis System (2005) to find out the effect of the tillage system, forward speed gear, and the interactions among them on the studied properties. Duncan's multiple range test was also used to compare means by using the same program (SAS).

3. Results and discussion

Table 1 shows the effect of the tillage system, non-tillage, and tillage, on the studied properties, which are the density of spikes / m2, number of grains/spikes, weight of 1000 grains (g), grain yield (kg / hectare), slide percentage %, and the actual field productivity of the machine (acres\hour). The results of the table indicated the superiority of the no-till system in all the studied properties, which reached to (322.55 m 2, 49.78, 43.73 g, 3579.26 kg / hectare and 6.71 acres / h), respectively, except for the property of sliding, which was higher in the tillage system by (2.48).) %. It is known that the property of the sliding percentage, which is the lowest value, is the best.

Table 1: shows the effect of the farming system

Factors	Actual field productivity of the machine (acres/hour)	Slide rate %	Grain yield kg/hectare)	grain weight (g)	Number of grains / spike	Density of spikes/m2
Non-tillage	6.71 a	1.45 b	3579.26 a	43.73 a	49.78 a	322.55 a
Tillage	3.34 b	2.48 a	3192.73 b	28.69 b	32.55 b	260.66 b

Table 2 shows the effect of speed gears for seeding process significantly on all studied properties. The seeding speed gear was affected by the density of spikes in indicating the best values which was (379.29) m^2 at the 3rd speed gear. The lowest value at the 2nd speed was (225.69) m2. The property of the number of grains/spike achieved the best values at the 3rd speed gear shifter, which reached (53.50). As for the lowest value, it was at the 2nd speed gear, which was (28.91). For the 1000-grain weight property, it showed the best values at the 3rd speed gear, which was (44.47). As for the lowest value, it was at the 2nd speed gear at (29.88). As for the property of the total yield, the best value of the yield at the 3rd speed gear shifter was (4462.8) kg / acres, whereas the lowest value was at the 2nd speed gear at (2480.3) kg / acres. Regarding the properties of sliding rate, the effect of the speed gear shifter of the seeding process at the 2nd speed gear indicated the highest slide percentage (2.86%), while the 3rd speed gear showed the lowest value of the slide rate (1.15)%. As for the actual field productivity of the machine, the 3rd speed gear showed the highest value (6.98) acres/acres per hr/hour, while the 2nd speed showed the lowest value of (2.86) acres/hours.

Table 2: shows the effect of the seeding process speed (km/h) on the studied properties

Speed factor (km/h)	Actual field productivity of the machine (acres/hour)	Slide rate *%*	Grain yield (kg/hectare)	grain weight (g)	Number of grains / spike	Density of spikes/m2
1st gear shifter	5.23 b	1.90 b	3215.0 b	34.28 b	41.09 b	269.83 b
2nd gear shifter	2.86 c	2.86 a	2480.3 c	29.88 b	28.91 c	225.69 b
3rd gear shifter	6.98 a	1.15 c	4462.8 a	44.47 a	53.50 a	379.29 a

Table 3 shows the interactions among the tillage system, non-tillage, and tillage with the speed gears used in the sowing process in the following properties: spike density / m^2, number of grains / spike, weight of 1000 grains (g), grain yield (kg/ha), slide rate %, and actual field productivity of the machine (acres/hour).

Table 3: Shows the effect of the interaction between the planting system and the gear speed of the seeding process on the studied properties

Tillage system	Gear Speed used (km/h)	Actual field productivity of the machine (acres/hour)	Slide ratio *%*	Grain yield (kg/hectare)	grain weight (g)	Number of grains / spike	Density of spikes/m2
Non-tillage	1st gear	7.26 b	1.53 c	3577.4 c	40.37 b	50.85 b	296.83 b
	2nd gear	3.43 cd	2.30 b	2460.3 d	35.26 bc	33.33 cd	222.85 b
	3rd gear	9.43 a	0.53 d	4700.1 a	55.56 a	65.15 a	447.96 a
Tillage	1st gear	3.20 bc	2.26 b	2852.6 d	28.19 cd	31.33 d	242.83 b
	2nd gear	2.30 d	3.43 a	2500.2 d	24.50 d	24.49 d	228.52 b
	3rd gear	4.53 c	1.76 bc	4225.4 b	33.39 bc	41.84 bc	310.63 b

The significant effect of the interaction among the previously mentioned studied factors was on the density of spikes. The highest value for this property was in the no-till system with the 3rd speed gear at (447.96) m^2, whereas the lowest value for this property was with the same system at the 2nd speed gear at (222.85)m^2. The property of the number of grains/spike showed the best combination of factors which was for the third speed gear at (65.15). The lowest value for this property was (24.49) for the tillage system with second speed gear. It also showed significant differences for the weight of 1000 grains, in which the best value for this property was for the no-till system with the 3rd speed gear at (55.56)g, whereas the lowest value was at the 2nd speed gear of the tilled land system at (24.50) g. As for the total grain yield, it was significantly affected as a result of the interactions of the studied factors. The best value for the total grain yield at the third speed gear of the no-tillage was (4700.1) kg/hectare, while the lowest value for the grain yield at the second speed gear and for no-tillage was (2460.3) kg/hectare. As for the percentage of slipping, the highest value of this property was at the second speed gear of tillage by (3.43%). The lowest value was at the 3rd speed gear of no-tillage by (0.53)%. As for the actual field productivity of the machine, the 3rd speed gear achieved the highest value for this property, when no-tillage was (9.43) acres/hour. The lowest value was at the 2nd speed gear of the tillage (2.30) acres / hour.

4. Conclusions

1. There is a quantitative and moral superiority of the non-tillage farming system over the conventional farming system in all the studied properties. Subsequently, this would be a key indicator
2. The third speed gear showed significant superiority in all the studied properties.
3. As for the interactions between the planting system and the speed of the seeding process, there were significant differences in all the studied properties.

5. Recommendations

1. No-till farming should be adopted as a means to increase the productivity of agricultural crops.
2. Experiments should be conducted for other crops and knowing the extent of their response to that system.
3. Other studies and other different speed gears should be conducted to find out the extent to which these crops

are affected.

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