



Testing Two Varieties of Maize (*Zea mays* L.) Under Surface and Conventional Farming Systems at Different Speeds, Based on Some Mechanization and Yield Indicators

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ABSTRACT

The experiment was conducted in a field in Al-Abbasi sub-district, Al-Hawija district, approximately 72.6 km from the center of Kirkuk Governorate (latitude N35.270768, longitude E43.630299) during the spring season of 2025. The study aimed to investigate the effect of three factors on maize (*Zea mays* L.) traits, including mechanization indicators, yield, and some of its components. The factors included: tillage system (no-tillage and conventional tillage), three forward speeds (6.42, 7.23, and 8.15 km·h⁻¹), and two maize varieties (American Toro and American Royal). The experiment comprised 12 treatments arranged in a randomized complete block design (RCBD) using a split-split plot arrangement with three replications. Duncan's Multiple Range Test (DMRT) at 0.05 probability was used to compare the means. Studied traits included: number of ears per plant, number of rows per ear, number of kernels per row, number of kernels per ear, 300-kernel weight, and emergence percentage. Results indicated that mechanization traits were significantly influenced by the first two factors, while other traits were affected by all factors. The interaction between conventional tillage and 8.15 km·h⁻¹ speed achieved the highest significant values for field emergence percentage, number of rows per ear, 300-kernel weight, and ear weight. The speed of 8.15 km·h⁻¹ excelled in the number of rows per ear, whereas the speed of 6.42 km·h⁻¹ produced the highest number of kernels per row. The Toro variety showed significant superiority in most yield traits, except for 300-kernel weight, which was higher in the Royal variety. The interaction between conventional tillage and Toro produced the best values for number of ears per plant, kernels per row, and kernels per ear, while the interaction with Royal resulted in the highest 300-kernel weight. Additionally, no-tillage × Toro gave the highest number of rows per ear, and 6.42 km·h⁻¹ × Toro achieved the best number of kernels per row and per ear.

Keywords: Tillage, Varieties, Forward Speed, Maize, Surface Farming, Conventional Farming.

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INTRODUCTION

Maize (*Zea mays* L.) is considered one of the most important strategic crops worldwide, ranking third after wheat and rice due to its high economic, industrial, and nutritional value. It is widely used for human food, animal feed, and as a raw material in various industries, including pharmaceuticals, chemicals, fertilizers, and biofuel production. Maize is cultivated in most countries due to its adaptability to different soil types and climatic conditions. However, in recent years, a decline in maize yield has been observed in some regions, including Iraq, coinciding with climate changes such as reduced rainfall, increased temperatures, drought, and the intensification of global warming. Consequently, finding cultivation methods that provide favorable conditions for plant growth and yield, along with selecting suitable varieties for these conditions, has become essential. No-tillage systems offer multiple agronomic, economic, and environmental benefits by reducing the number of passes of agricultural machinery, saving time and labor, preserving crop residues on the soil surface, reducing water evaporation, maintaining soil moisture for longer periods, preventing water and wind erosion, preserving soil structure, and increasing soil carbon and organic matter content [1]. In contrast, conventional tillage helps break up compacted soil layers, improves soil aeration, facilitates root penetration, enhances water and nutrient availability, incorporates crop residues into the soil, and increases nutrient availability for plants.

It also reduces competition among plants, improves water infiltration and utilization, and provides a level seedbed for uniform and rapid seed germination. Repeated passage of agricultural machinery during tillage operations generates mechanical pressure on the soil, increasing bulk density and reducing porosity and permeability, which negatively affects water and nutrient movement and overall soil physical properties[2]. Such effects can reduce the soil's water retention capacity and nutrient availability, which are critical for achieving optimal maize productivity. Therefore, it is essential to study these effects carefully to understand how mechanical pressure influences the agricultural environment, improve cultivation techniques, and mitigate adverse soil impacts [3]including water scarcity, a major challenge in enhancing crop productivity[4].Surface farming reduces fuel consumption by relying on fewer operations compared to conventional farming, decreases slippage during field operations, improves operational efficiency, and protects the soil [5].Choosing suitable crop varieties adapted to the soil type and climatic conditions, along with an appropriate forward speed during planting, is crucial for determining growth traits and yield performance. Varieties well adapted to their environment exhibit better nutrient uptake efficiency, root development, and kernel formation. This study aims to

- Study the efficiency of two farming systems (no-till and conventional) to evaluate the mechanization traits and yield characteristics, along with some yield components, of two maize varieties.
- Determine the optimal seeding machine speed by examining the effect of different forward speeds on the yield traits and mechanization characteristics of the two maize varieties.
- Enhance the study results economically, in addition to assessing the impact of these factors on certain mechanization and yield traits, such as planting accuracy and the uniformity of seed distribution horizontally and vertically along the planting line.
- Identify the best and most suitable maize variety for these two farming systems.

Materials and Methods

Experimental Site:To determine soil characteristics, random soil samples were collected from various locations across the field at depths of 0–30 cm before planting. The samples were analyzed at the laboratories of the College of Agriculture and Forestry, University of Mosul, to determine selected physical soil properties, as presented in Table 1.

Table (1) the physical properties of soil and soil contents

Physical properties		
Soil contents	Clay	35.95
	Silt	18
	Sand	46.05
Soil texture		Sandy clay
PH		8.0

The field was divided into two sections according to the tillage system: the first section followed a no-tillage system, while the second section used conventional tillage with a moldboard disc plow at a depth of 20–30 cm, performing cross plowing to loosen the soil, incorporate previous crop residues, level the field, and prepare the seedbed before planting. Triple superphosphate fertilizer (P_2O_5 46%) was applied at a rate of $200 \text{ kg} \cdot \text{ha}^{-1}$ in a single dose, and urea fertilizer (N 46%) was applied at $200 \text{ kg} \cdot \text{ha}^{-1}$ in two splits: half at soil preparation and half at flowering[6]. The studied factors were distributed at different levels in a randomized complete block design, including tillage systems and forward speeds. A pneumatic precision planter was used, relying on an air suction system to accurately place seeds in the soil. Planting was carried out on March 21, 2025, with compound fertilizer applied directly during sowing. Two days after planting, the field was irrigated using a sprinkler system to provide adequate moisture for seed germination. Two tractors were used: the first, a Massey Ferguson 470 with a four-cylinder, 120-hp 4WD engine; the second, a Massey Ferguson 285 (ITMCO) with a four-cylinder diesel engine, 75 hp. The study included three factors: the first was the tillage system (no-tillage and conventional tillage), the second was forward planting speeds (6.42, 7.23, and $8.15 \text{ km} \cdot \text{h}^{-1}$), and the third was the use of two maize varieties. The study comprised 36 treatments ($2 \times 3 \times 2 \times 3$ replications = 36 treatments), designed in the field using a split-split plot arrangement within a randomized complete block design (RCBD) with three replications. Tillage systems were assigned to main plots, planting speeds to subplots, and maize varieties to sub-subplots. The following traits were studied:

1. **Number of ears per plant (Ear_Plant_1):** The number of ears was counted from five plants harvested from each experimental unit, and the average was calculated.
2. **Number of rows per ear (Rows_Ear_1):** The number of rows in the ear was counted for five ears from each experimental unit. [7].

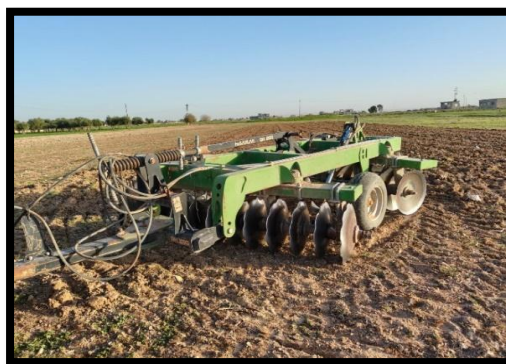
3. **Number of kernels per row (Kernels_Row_1):** The number of kernels in each row was counted for each ear and five ears from each experimental unit. [8].
4. **Number of kernels per ear (Kernels_Ear_1):** The number of kernels per ear was counted for five representative plants from each experimental unit at harvest. [9].
5. **300-kernel weight (g):** One hundred kernels were manually counted from each ear, multiplied by three, and weighed using a sensitive electronic balance for five ears from each experimental unit.
6. **Emergence percentage:** This trait was measured 12 days after sowing by dividing the number of emerged seedlings in each row by the total number of seeds in the same row. The results were then converted to a percentage using the following equation:

$$\text{Emergence Percentage} = \left(\frac{\text{Number of emerged seedlings after 12 days}}{\text{Total number of seeds}} \right) \times 100$$
 [10].

Equipment used



(pneumatic precision planter(sakalak))



(The disk plow used in the experiment)



no-tillage system

Results and Discussion

Number of ears per plant (Ear_Plant⁻¹):

Table 2 shows the effect of tillage systems, planting speeds, varieties, and their interactions on the number of ears per plant. It is evident that the tillage system had a significant effect on this trait, with the highest value of 1.49 ears per plant observed under conventional tillage, while the lowest value of 1.03 ears per plant was recorded under the no-tillage system. The increase in the number of ears under conventional tillage can be attributed to the improvement of soil physical properties, including increased porosity, reduced bulk density, and better root aeration. These conditions reduce water stress, enhance root growth and spread, and improve water and nutrient uptake, positively influencing physiological processes responsible for floral differentiation and ear formation, resulting in more ears per plant. Regarding the effect of planting speed, the averages indicate a non-significant variation between the tested speeds. The highest value of 1.29 ears per plant was recorded at 7.23 km·h⁻¹, while the lowest value of 1.23 ears per plant was observed at 6.42 km·h⁻¹. For the maize varieties, a significant difference was observed: the highest mean of 1.32 ears per plant was recorded for the Toro variety, whereas the lowest mean of 1.21 ears per plant was recorded for

the Royal variety. The two-way interaction between tillage systems and planting speeds showed significant differences, with the highest value of 1.52 ears per plant occurring under conventional tillage combined with a speed of $7.23 \text{ km}\cdot\text{h}^{-1}$, and the lowest value of 1.00 ears per plant under no-tillage combined with $6.42 \text{ km}\cdot\text{h}^{-1}$. The two-way interaction between tillage systems and varieties also significantly affected ear number, with the highest value of 1.60 ears per plant observed under conventional tillage $\times$ Toro, and the lowest value of 1.02 ears per plant under no-tillage $\times$ Royal. Similarly, the two-way interaction between planting speed and varieties showed significant differences across most treatments. The highest value of 1.33 ears per plant was recorded for $8.15 \text{ km}\cdot\text{h}^{-1} \times$ Toro, while the lowest value of 1.16 ears per plant occurred under $6.42 \text{ km}\cdot\text{h}^{-1} \times$ Royal. The three-way interaction indicated that the studied factors significantly affected the number of ears per plant. The highest value of 1.61 ears per plant was achieved under conventional tillage $\times$ $6.42 \text{ km}\cdot\text{h}^{-1} \times$ Toro, whereas the lowest value of 1.00 ears per plant was recorded under no-tillage $\times$ $6.42 \text{ km}\cdot\text{h}^{-1}$ for both varieties and at $8.15 \text{ km}\cdot\text{h}^{-1}$ for the Royal variety.

Table 2: Effect of tillage systems, forward speed, varieties, and their interactions on the number of ears per plant (Ear per Plant⁻¹)

Tillage systems	Forward speed (km·h ⁻¹)	Varieties		Tillage systems × Planting speeds	Tillage means	system
		toro	royal			
Conventional tillage	6.42	1.61 a	1.33 b	1.47 a	1.49 a	
	7.23	1.58 a	1.46 ab	1.52 a		
	8.15	1.60 a	1.39 b	1.49 a		
No-tillage	6.42	1.00 g	1.00 g	1.00 b	1.03 b	
	7.23	1.06 g	1.06 g	1.06 b		
	8.15	1.06 g	1.00 g	1.03 b		
Tillage systems × Varieties	Conventional tillage	1.60	1.39 b	Forward means speed		
	No-tillage	1.04 g	1.02 g			
Planting speeds × Varieties	6.42	1.30 a b	1.16 g	1.23 a		
	7.23	1.32 a	1.26 a b g	1.29 a		
	8.15	1.33 a	1.19 b g	1.26 a		
Variety means		1.32 a	1.21 b			

Means with different letters within the same factor or interaction indicate significant differences according to Duncan's Multiple Range Test at 5% probability level.

Number of rows per ear (Rows_Ear⁻¹):

Table 3 shows the effect of the studied factors and their interactions on the number of rows per ear. The results indicate that tillage systems significantly affected this trait. The highest value of 15.63 rows per ear was recorded under no-tillage, while the lowest value of 15.58 rows per ear occurred under conventional tillage. The increase in row number under no-tillage can be attributed to the shallower seed depth and the relatively greater distance between seeds in the planting line, which provided better conditions for root growth by reducing competition for nutrients. This allows each plant to acquire more nutrients for photosynthesis and carbohydrate production, thereby enhancing floral differentiation responsible for determining the number of rows per ear. Additionally, the shallower seed placement in no-tillage facilitates nutrient uptake from the surface soil layer enriched with residues of previous crops, along with early vegetative growth, giving the plant a longer period to form more rows per ear. Regarding forward speeds, a significant difference was observed. The highest value of 15.85 rows per ear was recorded at $8.15 \text{ km}\cdot\text{h}^{-1}$, while the lowest value of 15.40 rows per ear occurred at $6.42 \text{ km}\cdot\text{h}^{-1}$. This is attributed to the greater spacing between seeds

and shallower planting at higher speeds, as previously explained. For varieties, a significant difference was found: the Toro variety had the highest mean of 16.38 rows per ear, while the Royal variety had the lowest mean of 14.83 rows per ear. This is due to genetic differences between varieties in their ability to form rows per ear, as well as their capacity to absorb water and nutrients from the soil and convert them into plant dry matter. The two-way interaction between tillage systems and forward speeds showed significant differences among most treatments. The highest value of 15.90 rows per ear occurred under no-tillage $\times$ 8.15 km·h⁻¹, while the lowest value of 15.40 rows per ear was recorded under both tillage systems $\times$ 6.42 km·h⁻¹. The two-way interaction between forward speeds and varieties also revealed significant differences. All speeds combined with the Toro variety produced higher values compared to the Royal variety. The highest mean of 16.40 rows per ear was observed under 6.42 and 8.15 km·h⁻¹ $\times$ Toro, while the lowest value of 14.40 rows per ear occurred under 6.42 km·h⁻¹ $\times$ Royal. The three-way interaction among the studied factors showed that the highest significant value of 17.20 rows per ear was recorded under no-tillage $\times$ 7.23 km·h⁻¹ $\times$ Toro, while the lowest value of 14.00 rows per ear was observed under both tillage systems $\times$ 6.42 km·h⁻¹ $\times$ Royal, with the same low value also recorded for no-tillage $\times$ 7.23 km·h⁻¹ $\times$ Royal.

Table 3: Effect of tillage systems, forward speed, varieties, and their interactions on the number of rows per ear (Rows per Ear⁻¹)

(rows per ha)					
Tillage systems	Forward speed (km·h ⁻¹)	Varieties		Tillage systems × Planting speeds	Tillage system means
		toro	royal		
Conventional tillage	6.42	16.40 c	14.40 h	15.40 c	15.58 b
	7.23	15.50 f	15.60 e	15.55 b	
	8.15	16.00 d	15.60 e	15.80 a	
No-tillage	6.42	16.40 c	14.40 h	15.40 c	15.63 a
	7.23	17.20 a	14.00 i	15.60 b	
	8.15	16.80 b	15.00 g	15.90 c	
Tillage systems × Varieties	Conventional tillage	15.96 b	15.20 c	Forward speed means	
	No-tillage	16.80 a	14.46 d		
Planting speeds × Varieties	6.42	16.40 a	14.40 d	15.40 c	
	7.23	16.35 a	14.80 c	15.57 b	
	8.15	16.40 a	15.30 b	15.85 a	
Variety means		16.38 a	14.83 b		

Means with different letters within the same factor or interaction indicate significant differences according to Duncan's Multiple Range Test at 5% probability level.

Number of Kernels per Row (Kernels·Row⁻¹):

The results in Table (4) indicate the effects of the studied factors and their interactions on the number of kernels per row. Significant differences were observed among tillage systems, with the highest value (38.33 kernels·row⁻¹) recorded under conventional tillage, and the lowest (31.3 kernels·row⁻¹) under no-tillage. The superiority of conventional tillage is attributed to its role in improving soil physical properties by increasing soil loosening and porosity and reducing bulk density, which enhances root growth and the efficiency of water and nutrient uptake (N, P, K, Zn) during flowering, while reducing water stress during the critical period (10 days before and after pollination), positively affecting pollination, kernel formation, and reducing kernel abortion, thus increasing the number of kernels per row. Regarding forward speed, significant differences were observed, with the highest value (36.95 kernels·row⁻¹) at 6.42 km·h⁻¹ and the lowest (33.35 kernels·row⁻¹) at 7.23 km·h⁻¹. The superiority at 6.42 km·h⁻¹ is due to optimal seed placement in terms of depth and uniform spacing, reducing mechanical damage at higher speeds, improving germination and uniform plant growth, which positively influences physiological processes responsible for pollination

and kernel formation. For varieties, the highest number of kernels per row ($35.23 \text{ kernels} \cdot \text{row}^{-1}$) was recorded for the Toro variety, while the lowest ($34.40 \text{ kernels} \cdot \text{row}^{-1}$) was for Royal. This advantage is attributed to the physiological and genetic traits of Toro, its ability to achieve balanced vegetative growth, dry matter accumulation, and higher kernel number per row compared to Royal. In the two-way interaction between tillage systems and speeds, conventional tillage $\times 6.42 \text{ km} \cdot \text{h}^{-1}$ significantly exceeded all other treatments, producing $42.0 \text{ kernels} \cdot \text{row}^{-1}$, while no-tillage $\times 8.15 \text{ km} \cdot \text{h}^{-1}$ recorded the lowest value ($29.5 \text{ kernels} \cdot \text{row}^{-1}$). For the tillage $\times$ variety interaction, the highest number of kernels per row (38.4) was observed for conventional tillage $\times$ Toro, while the lowest (30.53) occurred with no-tillage $\times$ Royal. In the forward speed $\times$ variety interaction, significant differences were observed among all treatments, with the highest value ($37.40 \text{ kernels} \cdot \text{row}^{-1}$) at $6.42 \text{ km} \cdot \text{h}^{-1} \times$ Toro, and the lowest ($32.30 \text{ kernels} \cdot \text{row}^{-1}$) at $8.15 \text{ km} \cdot \text{h}^{-1} \times$ Royal. In the three-way interaction, all treatments differed significantly, with the highest number of kernels per row (43.6) observed for conventional tillage $\times 6.42 \text{ km} \cdot \text{h}^{-1} \times$ Royal, and the lowest (28.20) for no-tillage $\times 8.15 \text{ km} \cdot \text{h}^{-1} \times$ Royal.

Table (4) Effect of cropping systems, forward speed, cultivars, and their interactions on the number of grains per row (grain . row⁻¹)

Tillage systems	Forward speed (km·h ⁻¹)	Varieties		Tillage systems $\times$ Planting speeds	Tillage system means
		toro	royal		
Conventional tillage	6.42	40.40 c	43.60 a	42.00 a	38.33 a
	7.23	33.60 f	34.80 k	34.20 c	
	8.15	41.20 b	36.40 d	38.80 b	
	6.42	34.40 f	29.40 k	31.90 e	
No-tillage	7.23	31.00 i	34.00 g	32.50 d	31.3 b
	8.15	30.80 i	28.20 l	29.50 f	
Tillage systems $\times$ Varieties	Conventional tillage	38.40 a	38.26 b	Forward speed means	
	No-tillage	32.06 c	30.53 d		
Planting speeds $\times$ Varieties	6.42	37.40 a	36.50 b		
	7.23	32.30 e	34.40 d		
	8.15	36.00 c	32.30 e	34.15 b	
Variety means	35.23 a	34.40 b			

Means with different letters within the levels of a single factor or interaction indicate significant differences according to Duncan's Multiple Range Test at a 5% probability level.

Number of kernels per ear (kernels·ear⁻¹):

The results in Table (5) indicate the effect of the studied factors and their interactions on the number of kernels per ear. Tillage systems significantly affected this trait, with the highest value of $596.81 \text{ kernels} \cdot \text{ear}^{-1}$ recorded under conventional tillage, while the lowest value of $489.5 \text{ kernels} \cdot \text{ear}^{-1}$ was observed under no-tillage. The superiority in kernel number per ear under conventional tillage is attributed to the higher number of rows per ear and kernels per row in this system. Regarding the effect of forward speed, the table shows that the lowest value of $518.20 \text{ kernels} \cdot \text{ear}^{-1}$ occurred at $7.23 \text{ km} \cdot \text{h}^{-1}$, while the highest value of $569.43 \text{ kernels} \cdot \text{ear}^{-1}$ was recorded at $6.42 \text{ km} \cdot \text{h}^{-1}$. This difference is linked to the influence of speed on the number of rows per ear and kernels per row, with the $8.15 \text{ km} \cdot \text{h}^{-1}$ speed showing high values in these components. The maize varieties also significantly influenced this trait, with the Toro variety producing the highest number of kernels per ear ($576.20 \text{ kernels} \cdot \text{ear}^{-1}$) compared to the Royal variety ($510.11 \text{ kernels} \cdot \text{ear}^{-1}$). The superiority of Toro is due to its ability to form more rows per ear and more kernels per row, resulting in a higher total kernel count per ear. For the two-way interaction between tillage systems and forward speeds, significant differences were observed. The highest value ($645.15 \text{ kernels} \cdot \text{ear}^{-1}$) occurred under conventional tillage combined with $6.42 \text{ km} \cdot \text{h}^{-1}$, while the lowest value ($470.20 \text{ kernels} \cdot \text{ear}^{-1}$) was recorded under no-tillage with $8.15 \text{ km} \cdot \text{h}^{-1}$. The interaction between tillage systems and varieties showed that conventional tillage $\times$ Toro produced the highest number of kernels per ear ($614.16 \text{ kernels} \cdot \text{ear}^{-1}$), significantly higher than all other combinations, while no-tillage $\times$ Royal had the lowest value ($440.76 \text{ kernels} \cdot \text{ear}^{-1}$). Similarly, the interaction between forward speed and varieties indicated significant differences. The highest value ($613.32 \text{ kernels} \cdot \text{ear}^{-1}$) was observed for $6.42 \text{ km} \cdot \text{h}^{-1} \times$ Toro, while the lowest value ($495.40 \text{ kernels} \cdot \text{ear}^{-1}$) occurred with $8.15 \text{ km} \cdot \text{h}^{-1} \times$ Royal. The three-way interaction of

all studied factors showed the highest kernel number per ear ($662.50 \text{ kernels} \cdot \text{ear}^{-1}$) under conventional tillage $\times$ $6.42 \text{ km} \cdot \text{h}^{-1}$ $\times$ Toro, significantly higher than all other treatments, whereas the lowest value ($423.30 \text{ kernels} \cdot \text{ear}^{-1}$) was recorded for no-tillage $\times$ $8.15 \text{ km} \cdot \text{h}^{-1}$ $\times$ Royal.

Table (5) Effect of tillage systems, forward speed, varieties, and their interactions on the number of kernels per ear ($\text{kernels} \cdot \text{ear}^{-1}$)

Tillage systems	Forward speed ($\text{km} \cdot \text{h}^{-1}$)	Varieties		Tillage systems $\times$ Planting speeds	Tillage system means
		toro	royal		
Conventional tillage	6.42	662.50 a	627.80 c	645.15 a	596.81 a
	7.23	520.80 f	542.80 f	531.80 c	
	8.15	659.20 b	567.80 d	613.50 b	
No-tillage	6.42	564.15 e	423.30 k	493.72 e	489.50 b
	7.23	533.20 g	476.00 i	504.60 d	
	8.15	517.40 i	423.00 l	470.20 f	
Tillage systems $\times$ Varieties	Conventional tillage	614.16 a	579.46 b	Forward speed means	
	No-tillage	538.25 c	440.76 d		
Planting speeds $\times$ Varieties	6.42	613.32 a	525.55 d		
	7.23	527.00 c	509.40 e	541.85 a	
	8.15	588.30 b	495.40 f	518.20 c	
Variety means		576.20 a	510.11 b		

Means with different letters within a single factor or interaction indicate significant differences according to Duncan's Multiple Range Test at a 5% probability level.

Weight of 300 Kernels (g):

The results presented in Table (6) indicate that the weight of 300 kernels was significantly influenced by the study factors. Regarding tillage systems, the highest weight (85.37 g) was recorded under conventional tillage, while the lowest (77.74 g) occurred under no-tillage. The superiority of conventional tillage is attributed to its role in improving soil aeration and increasing porosity, which facilitates root growth and expansion, enhances water and nutrient uptake (e.g., nitrogen, which boosts chlorophyll activity and photosynthetic efficiency, and phosphorus, which accelerates sugar translocation from leaves to kernels), and promotes carbohydrate accumulation. Additionally, the water stored in large soil pores acts as a medium for transporting carbohydrates and nutrients, maintains turgor pressure within kernel cells, allows natural expansion, supports enzymatic activity, and drives the metabolic processes necessary for material deposition in the kernels. Regarding the effect of planting speed, significant differences were observed. The highest weight (84.85 g) was obtained at a speed of $7.23 \text{ km} \cdot \text{h}^{-1}$, while the lowest (76.30 g) occurred at $8.15 \text{ km} \cdot \text{h}^{-1}$. The optimal weight at $7.23 \text{ km} \cdot \text{h}^{-1}$ is attributed to proper seed depth and uniform distribution along the planting line, which ensured adequate water and nutrient supply during kernel development. This speed also promoted uniform plant growth, enhanced pollination, and improved kernel filling. Deviations in speed, whether higher or lower, disrupted this balance due to improper seed depth or irregular spacing, leading to reduced kernel weight. Regarding variety means, significant differences were observed. The Royal variety recorded the highest weight (83.95 g), while Toro had the lowest (79.16 g). The superior performance of Royal is attributed to its physiological and genetic traits, which promote more uniform rows and kernels, higher kernel filling efficiency, extended photosynthetic duration, and better nutrient translocation from leaves and stems to the kernels during the filling stage, ultimately increasing kernel weight. Concerning interactions:

- The two-way interaction between tillage and planting speed showed that conventional tillage $\times$ $8.15 \text{ km} \cdot \text{h}^{-1}$ produced the highest weight (86.48 g), while no-tillage $\times$ $8.15 \text{ km} \cdot \text{h}^{-1}$ recorded the lowest (66.12 g).
- The two-way interaction between speed and variety indicated that $7.23 \text{ km} \cdot \text{h}^{-1}$ $\times$ Toro achieved the highest weight (84.85 g), whereas $8.15 \text{ km} \cdot \text{h}^{-1}$ $\times$ Toro produced the lowest (68.05 g).
- The two-way interaction between tillage and variety revealed that conventional tillage $\times$ Royal achieved the highest weight (85.58 g), while no-tillage $\times$ Toro had the lowest (73.16 g).
- The three-way interaction among all experimental factors showed that conventional tillage $\times$ $7.23 \text{ km} \cdot \text{h}^{-1}$ $\times$

Royal produced the highest weight (87.30 g), whereas no-tillage $\times$ 8.15 km·h⁻¹ $\times$ Toro recorded the lowest (50.05 g).

Table (6) Effect of Tillage Systems, Planting Speed, Varieties, and Their Interactions on the Weight of 300 Kernels (g)

Tillage systems	Forward speed (km·h ⁻¹)	Varieties		Tillage systems × Planting speeds	Tillage system means	
		toro	royal			
Conventional tillage	6.42	84.65 d	82.55 d	83.60 c	85.37 a	
	7.23	84.80 e	87.30 a	86.05 b		
	8.15	86.06 c	86.90 b	86.48 a		
No-tillage	6.42	84.54 c	82.39 e	83.47 d	77.74 b	
	7.23	84.90 d	82.40 e	83.65 c		
	8.15	50.05 f	82.19 g	66.12 e		
Tillage systems × Varieties	Conventional tillage	85.17 b	85.58 a	Forward speed means		
	No-tillage	73.16 d	82.33 c			
Planting speeds × Varieties	6.42	84.60 b	82.47 d			83.53 b
	7.23	84.85 a	84.85 a			84.85 a
	8.15	68.05 e	84.54 c			76.30 C
Variety means		79.16 b	83.95 a			

Means with different letters at the levels of any factor or interaction indicate significant differences according to Duncan's multiple range test at a 5% probability level.

Field Germination Percentage (%):

The results presented in Table (7) indicate the effects of tillage systems, forward speed, and maize cultivars on field germination percentage. It was observed that the no-tillage system resulted in a higher germination rate, reaching 98.83%, compared to 97.83% under the conventional tillage system, although this difference was not statistically significant. Nevertheless, a clear distinction between the means was noted, which can be attributed to the role of tillage in loosening and aerating the soil, enhancing its water-holding capacity, and creating favorable conditions for seedling growth. Such conditions facilitate root penetration, deeper growth, and more efficient nutrient uptake, unlike in untilled soil where a compacted surface layer, residue from previous crops, or increased bulk density may hinder seedling emergence. Regarding the effect of forward speed, significant differences were observed. The highest germination percentage (100%) was recorded at a speed of 8.15 km·h⁻¹, while the lowest (88.156%) occurred at 6.42 km·h⁻¹. This can be explained by the fact that higher forward speeds reduce the depth at which seeds are planted due to increased soil reaction to the seed furrow openers and press wheels, positioning seeds closer to the soil surface and promoting faster and more uniform emergence compared to seeds sown at greater depths. This finding differs from the observations reported by [11]. and [12]. In the two-way interaction between tillage system and forward speed, significant differences were observed in half of the treatments. The highest germination percentage (100%) was recorded for the interaction of the no-tillage system with a speed of 7.23 km·h⁻¹ and for both tillage systems at 8.15 km·h⁻¹. The lowest value (85.66%) occurred with the interaction of conventional tillage and a speed of 6.42 km·h⁻¹. For the interaction between tillage system and cultivars, the results indicated no significant differences, with the highest germination (99.11%) observed for conventional tillage $\times$ Royal cultivar and the lowest (97.66%) for no-tillage $\times$ Toro cultivar. In the interaction between forward speed and cultivars, significant differences were observed in half of the treatments. The highest germination (100%) occurred for Royal cultivar at 7.23 km·h⁻¹ and for both

cultivars at $8.15 \text{ km}\cdot\text{h}^{-1}$, while the lowest (96%) was recorded for Toro cultivar at $7.23 \text{ km}\cdot\text{h}^{-1}$. The three-way interaction among the studied factors and field germination percentage showed that the combination of both tillage systems with a speed of $8.15 \text{ km}\cdot\text{h}^{-1}$ and both cultivars resulted in 100% germination. Similarly, the same percentage was recorded for both tillage systems at $7.23 \text{ km}\cdot\text{h}^{-1}$ with the Royal cultivar, whereas the lowest germination (94.66%) was observed for conventional tillage $\times$ speed $7.23 \text{ km}\cdot\text{h}^{-1} \times$ Toro cultivar.

Table (7) Effect of Tillage Systems, Forward Speed, Cultivars, and Their Interactions on Field Germination Percentage (%)

Tillage systems	Forward speed ($\text{km}\cdot\text{h}^{-1}$)	Varieties		Tillage systems $\times$ Planting speeds	Tillage system means
		Toro	royal		
Conventional tillage	6.42	96.00 a b	97.33 a b	bc 97.66	97.27 a
	7.23	94.66 b	100.00 a	abc 97.33	
	8.15	100.00 a	100.00 a	100.00 a	
No-tillage	6.42	95.66 b	95.66 b	95.66 c	98.83 a
	7.23	a b 97.33	100.00 a	a b 98.66	
	8.15	100.00 a	100.00 a	100.00 a	
Tillage systems $\times$ Varieties	Conventional tillage	96.88 a	99.11 a	Forward speed means	
	No-tillage	97.66 a	98.55 a		
Planting speeds $\times$ Varieties	6.42	95.83 b	96.50 b		
	7.23	96.00 b	100.00 a	98.00 b	
	8.15	100.00 a	100.00 a	100.00 a	
Variety means		98.11 a	98.00 a		

Means with different letters for any factor or interaction indicate significant differences according to Duncan's multiple range test at a 5% probability level.

Conclusions

1. The conventional tillage system (after plowing) produced the highest significant values for all yield traits, except for the number of rows per cob.
2. The two-way interaction between conventional tillage and the three forward speeds showed significant variations for most studied traits compared to the interaction between no-tillage and the three forward speeds.
3. The two-way interaction between tillage systems and varieties produced significant differences for several traits. Specifically, the interaction of no-tillage with the "Toro" variety showed significant differences for the number of rows per cob, while the interactions of conventional tillage with both "Toro" and "Royal" varied in the significance of most traits individually.
4. Increasing the forward speed of planting led to a significant increase in both the field emergence percentage and the number of rows per cob, while the 300-kernel weight was significantly higher at a forward speed of $7.23 \text{ km}\cdot\text{h}^{-1}$ compared to the other speeds used. However, most of the remaining traits showed a significant decrease.
5. The two-way interaction between forward speeds and the "Toro" variety produced the highest significant values for most vegetative and yield traits, except for the 300-kernel weight, which was highest in the interaction of the $7.23 \text{ km}\cdot\text{h}^{-1}$ speed with both varieties.
6. The "Toro" variety exhibited the highest significant values for the number of cobs per plant, number of rows per cob, number of kernels per row, number of kernels per cob, cob weight, and individual plant yield, whereas the "Royal" variety was superior only in 300-kernel weight.
7. In the three-way interaction, the highest results were generally obtained at the combination of conventional tillage, a forward speed of $6.42 \text{ km}\cdot\text{h}^{-1}$, and the "Toro" variety for most growth and yield traits. The exception was the field emergence percentage, which increased at the combination of both tillage systems with the second and third forward speeds and both varieties.

References

- [1]. Yang, C., Zhao, Y., Long, B., Wang, F., Li, F., & Xie, D. (2023). Biodegradable mulch films improve yield of winter potatoes through effects on soil properties and nutrients. *Ecotoxicology and Environmental Safety*, 264, 115402.
- [2]. Imran, Amanullah, Ali khan, A., Mahmood, T., Al Tawaha, A. R., & Khanum, S. (2021). Adequate fertilization, application method and sowing techniques improve maize yield and related traits. *Communications in Soil Science and Plant Analysis*, 52(19), 2318-2330 .
- [3]. Loke, P. F., Kotzé, E., Du Preez, C. C., & Twigge, L. (2019). Dynamics of soil carbon concentrations and quality induced by agricultural land use in Central South Africa. *Soil Science Society of America Journal*, 83(2), 366-379.
- [4]. Su, Y., Lauerwald, R., Makowski, D., Viovy, N., Guilpart, N., Zhu, P., ... & Ciais, P. (2023). Global warming increases the chance of success of maize-wheat double cropping in Europe.
- [5]. Al-Kaisi, M. H. (2018). Effect of tillage systems on soil properties and crop yield. *Journal of Agricultural Science*, 10(2), 115-221.
- [6]. Al-Sahouki, M. M. (1990). *Maize: Its Production and Improvement*. Higher Education Press, Ministry of Higher Education and Scientific Research, University of Baghdad, Iraq.
- [7]. Al-Sahouki, M. M. (1990). *Maize: Its Production and Improvement*. Higher Education Press, Ministry of Higher Education and Scientific Research, University of Baghdad, Iraq.
- [8]. Al-Sahouki, M. M. (1990). *Maize: Its Production and Improvement*. Higher Education Press, Ministry of Higher Education and Scientific Research, University of Baghdad, Iraq.
- [9]. Al-Sahouki, M. M. (1990). *Maize: Its Production and Improvement*. Higher Education Press, Ministry of Higher Education and Scientific Research, University of Baghdad, Iraq.
- [10]. ISTA (International Seed Testing Association). 2013. International rules for seed Testing. Adopted at the ordinary meeting. 2012, budapest, hungary to become effective on January 2005. The International Seed Testing Association - (ISTA).
- [11]. Kuş, E. (2021). Optimization of Operational Parameters of a Vacuum Single-Seed Planter for Sowing of Maize. *Journal of Agricultural Sciences*, 27(3), 327–334. <https://doi.org/10.15832/ANKUTBD.678544>
- [12]. Jasim, A. R. A., & Zumam, K. A. (2017). Effect of the combined machine speed on some technical performance indicators of the mechanical unit and some growth traits of maize (*Zea mays* L.). *Iraqi Journal of Agricultural Research*, 22(6), 223–234.

تقييم صنفين من الذرة الصفراء (*Zea mays* L.) تحت نظامي الزراعة السطحية والتقليدية عند سرعات مختلفة، استناداً إلى بعض مؤشرات المكنة والمحصول

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الخلاصة

أجريت التجربة في أحد حقول ناحية العباسي التابعة لقضاء الحويجة والذي تبعد حوالي 72.6 كم عن مركز محافظة كركوك والذي تقع ضمن الاحداثيات خط العرض: **N35.270768** خط الطول: **E43.630299** للموسم الربيعي 2025 لدراسة تأثير ثلاثة عوامل في صفات الذرة الصفراء، وهي الصفات المكنية وصفات المحصول وبعض مكوناته. تضمنت العوامل: نظام الزراعة (بدون حرثة وبعد الحرثة)، ثلاث سرعات أمامية (6.42، 7.23، 8.15 كم/ساعة)، وصنفين من الذرة الصفراء (تورو الأمريكي، رويال الأمريكي)، وبذلك اشتملت التجربة على 12 معاملة ضمن تصميم القطاعات العشوائية الكاملة (**RCBD**) بنظام القطع المنشقة-المنشقة وبثلاث مكررات. تم إجراء اختبار دنكن متعدد المدى للمقارنة بين المتوسطات عند مستوى معنوي 0.05 شملت الصفات المدروسة عدد العرائيص لكل نبات. عدد الصفوف لكل عرنوص. عدد الحبوب لكل صف. عدد الحبوب لكل عرنوص. وزن 300 حبة/نسبة البزوغ. أظهرت النتائج أن الصفات المكنية تأثرت بالعاملين الأول والثاني، بينما بقيت الصفات تأثرت بجميع العوامل. حقق التداخل بين الزراعة بعد الحرثة والسرعة 8.15 كم/ساعة أفضل القيم المعنوية لنسبة البزوغ الحظلي، وعدد الصفوف لكل عرنوص، ووزن 300 حبة ووزن العرنوص. كما تفوقت السرعة 8.15 كم/ساعة في عدد الصفوف لكل عرنوص، بينما تفوقت السرعة 6.42 كم/ساعة في عدد الحبوب لكل صف. أظهر الصنف تورو تفوقاً معنوياً في معظم صفات المحصول باستثناء وزن 300 حبة الذي كان أعلى في الصنف رويال. حقق التداخل بين الزراعة بعد الحرثة والصنف تورو أفضل القيم في عدد العرائيص لكل نبات وعدد الحبوب لكل صف وعدد الحبوب لكل عرنوص، بينما تفوق التداخل مع الصنف رويال في وزن 300 حبة. كما أعطى تداخل الزراعة بدون حرثة مع الصنف تورو أفضل قيمة لعدد الصفوف لكل عرنوص، والسرعة 6.42 كم/ساعة مع الصنف تورو أفضل القيم لعدد الحبوب لكل صف وعدد الحبوب لكل عرنوص.

الكلمات المفتاحية: الحرثة، الأصناف، السرعة الأمامية، الذرة الصفراء، الزراعة السطحية، الزراعة التقليدية.