A study some growth characteristics for maize, Bohooth 106 variety under affecting mechanical for machine (moldboard plow type)

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Abstract

The effect of the practical speed and tillage distances on maize Bohooth 106 variety and soil physical properties, under impact some mechanical properties for type tillage machine (moldboard plow), were tested two practical speed levels of 2.409 and 3.543 km.hr⁻¹ and three levels tillage distances of 60, 65 and 70 cm. The experiments were conducted in a factorial experiment under randomized complete block design with three replications. The results showed that the practical speed 2.409 km.hr⁻¹ was significantly better than the practical speed 3.543 km.hr⁻¹ as while tillage distances at range 60 cm was significantly superior to the other two levels 65 and 70 cm in all studied conditions. For practical speed 2.409 km.hr⁻¹ and tillage distance 60cm, the fuel consumption, slippage percentage, machine efficiency, germination percentage, plant height, 1000-grain weight and the maize crop productivity were 11.301, 10.153 L.ha⁻¹, 10.240, 9.684%, 80.685, 82.002%, 90.803, 91.135% 167.682, 169.163 cm², 223.341, 239.130 g, and 4.149, 4.258 t.ha⁻¹. The best results have come from the overlap among the practical speed 2.409 km.hr⁻¹ and tillage distance of 60 cm, in all studied parameter.

Keywords: maize, soil physical properties, speed, tillage distances, moldboard plow.

1. Introduction

Maize is one of the most important cereal crops of the world and contributes to food security in most of the developing countries. In Iraq, maize is emerging as third most important crop after rice and wheat. Its importance lies in the fact that it is not only used for human food and animal feed but at the same time it is also widely used for corn starch industry, corn oil production, etc. The increasing use of maize as feed, increasing interest of the consumers in nutritionally enriched products and rising demand for maize seed are the core driving forces behind emerging importance of maize crop in Iraq. However, despite the production strength, Iraqi maize yields are significantly below the yields in major maize producing countries. There is immense scope for an increase in Iraqi corn production by increasing area under hybrids, adoption of better genetics and improved agronomic practices. Maize is bound to hold its share as an important cereal crop in future [1]. The aim of soil tillage is to prepare a suitable seedbed for the seed. The choices relating to tillage methods strongly affected the other components of the cropping system [2].

Growth of the maize crop is least affected while, the effect of tillage practice on root growth and development under zero tillage is related to depth of tillage implement. The roots under no tillage system accumulate to a greater extent in the top 5 cm depth as compared under conventional tillage system where roots move toward deeper depth [4]. Reported greater rate of infiltration with greater tillage intensity and depth [3]. That different methods of tillage have significant effect on yield and field of product yield, under impacted soil physical properties [5].

Soil tillage is the quality that enables a soil to provide the proper nutrients, in the proper amounts and in the proper balance, for the growth of specified plants when other growth factors such as light, temperature, moisture and the soil physical condition. High fertility soil tillage depend on plow type and this further implies an increase in the range of crops that can be grown [6]. The basic technique of tillage plowing and tillage operation is consists in returning the soil so that the lower part of soil is brought to the surface. Soil tillage, where it serves as the primary nutrient base for plants, [7]. Was greater effect when using the mouldboard plow on physical soil properties cultivator. [8] That the mouldboard plow was significantly better than
the disk plow in all some growth characteristics under impact soil moisture and tillage depth [9]. Mentioned that there is a significant moral effect of machine type, soil moisture and practical speed on field efficiency and some soil physical properties [10]. The main goal of this research is to study the effect of practical speed, and tillage distances, on some mechanical properties for moldboard plow type, soil physical properties and maize growth.

2. Materials and methods

This study was conducted in 2019, to evaluate for New Holland-TD80 machine with moldboard plow, the experiments were done at two levels of speed 2.409 km.hr⁻¹ and 3.543 km.hr⁻¹, and three distance between the point of share and the point of share other 60, 65 and 70 cm. The moldboard plow was selected for the experiments of the plow organized on certain 20 cm depth by hydraulic device for tractor and soil moisture 15-17% using the pipette methods. The tillage machine (moldboard plow type) has Working width 120 cm, Length 3010 mm, Height 1130 mm and Weight 320 kg. The tractor (New Holland-TD80 type) has engine power 80 PH, engine speed 2500 rpm, engine type Perkins (diesel), cylinders number 4 cylinders, firing order 1-3-4-2, P.T.O 540 rpm and Weight 3080 kg. Fuel consumption, slippage percentage, machine efficiency, germination percentage, plant height, 1000 - weight grain, number of grains per ear and the maize crop productivity, were calculated for each running test.

3. Mechanical characteristics

3.1. Fuel consumption

Fuel consumption is measured by the fuel consumption device in mL for treatment length (45 m) was calculated using Eq 1 [4].

\[ Q_F = \frac{Q_D \times 10000}{W_p \times D \times 1000} \] (1)

Where: \( Q_F \) fuel consumed amount L/ha, \( Q_D \) fuel consumed amount for treatment length (45 m), \( W_p \) machine width (m), \( D \) treatment length (45 m).

3.2. Slippage percentage

Measured by the practical and theoretical speed [4].

Practical speed: After tillage depth determination in the experiment the plow hacked in the soil with practical speed 3.543 km/hr⁻¹, within treatment length (45 m) for both speed and tillage distances in three replication. The Eq (2) was used for calculation of practical speed.

\[ V_p = \frac{3.6 \times D}{T_p} \] (2)

Where: \( V_p \) practical speed Km.hr⁻¹, \( T_p \) practical time (hr).

Theoretical speed: Without plowing the soil, only the weapon touches the soil, with speed 3.543 km.hr⁻¹ within treatment length (45 m) for both speed and tillage distances in three replication. The Eq (3) was used for calculation of theoretical speed.

\[ V_T = \frac{3.6 \times D}{T_t} \] (3)

Where: \( V_T \) theoretical speed Km.hr⁻¹, \( T_t \) theoretical time (hr).

Eq (4) was used for calculation of slippage percentage using two speeds the practical and theoretical.

\[ S = \frac{V_p \times V_T}{V_T - V_T} \times 100 \] (4)

Power losses due to slippage is calculated from the following Eq (5) [4].

\[ P_s = \frac{f(V_p - V_T)}{270} \] (5)
Where: $P_s$: Power losses due to slippage (kw)

### 3.3. Machine efficiency:

Machine efficiency is the ratio of effective machine capacity to theoretical machine capacity, and it can be affected by time lost in the machine and the full width of the machine [6].

### 3.4. Theoretical machine capacity

Theoretical machine capacity is the rate of work when the implement uses its full width and time and it was calculated as follow:

$$T_{FC} = \frac{S \times W}{C} \quad (6)$$

Where: $T_{FC}$: theoretical machine capacity ha h$^{-1}$, $S$: working speed (Km hr$^{-1}$), $W$: cutting width of implement (M), and $C$: Conversion factor (10).

### 3.5. Effective machine capacity

Effective machine capacity is the actual rate of work and it was calculated as follow:

$$E_{FC} = \frac{A}{T} \quad (7)$$

Where $E_{FC}$: effective machine capacity (ha h$^{-1}$), $A$: distance (ha), $T$: time (hour).

was used for calculation of machine efficiency [11].

$$F_E = \frac{E_{FC}}{T_{FC}} \times 100 \quad (8)$$

### 3.6. The crop and its components

#### 3.6.1. Germination percentage

Percentage of germination is found for number plants growing in one square meter in three replications.

#### 3.6.2. plant height

Maize height are measured by bar or ruler from soil surface till the plant end, in three replications.

#### 3.6.3. 1000 - weight grain

The samples random were taken for ten plant for calculated1000- grain weight in one square meter in three replications [12].

#### 3.6.4. The maize crop productivity

The samples random were taken for 25 plants in ten rows and calculate productivity of the crop in three replications. According of the method used by [9].

### 4. Physical properties

Physical properties of the soils determined, were taken soil samples for six site randomly selected for two speed 2.409 km.hr$^{-1}$ and 3.543 km.hr$^{-1}$, three tillage distances 60, 65 and 70 cm for 20 cm tillage depth determined by hydraulic device for tractor according to the method used by [9].we were taken of the soil samples for different speeds and tillage distances, when 15-17% moisture soil, And then the first part was executed from experiment. [8]. each running test.

#### 4.1. Soil moisture

Samples were taken to measure soil moisture in the surface layer, 20cm. Soil samples were weighted and drying in oven with 105°C. The moisture content of soil samples, was calculated by using Eq. 9 [10].
Where : \( W \) :Is soil moisture percentage , \( W_{w} \) : Is weight wet soil , \( W_{d} \) : Is weight dry soil . 

### 4.2. Soil bulk density

For measuring bulk density, three soil samples from different parts of the land were collected using the pipette method. The collected samples were immediately put in plastic bags to conserve moisture during transferring to the laboratory and weighed it, then dried at 105 °C for 48 hr. Mass of dried soils was weighted. Soil bulk density was determined by Eq. 10 [13] .

\[
P_{d} = \frac{M_{d}}{V_{t}}
\]

Where : \( P_{d} \) : Dry bulk density (mg.m\(^{-3}\)) , \( M_{d} \) :weight of the dried soil sample (mg) , \( V_{t} \): total volume of the soil sample (m\(^3\)).

### 4.3. Total soil porosity

The total porosity of soil samples collected for each treatment was calculated using following equation , an assumed particle density of 2.65 mg.m\(^{-3}\). The Eq (11) was used for calculation of the total porosity of soil [3].

\[
T_{sp} = \left(1 - \frac{P_{d}}{P_{s}}\right) \times 100
\]

Where : \( T_{sp} \) : total soil porosity (%) , \( P_{d} \) : dry bulk density (mg.m\(^{-3}\)) , \( P_{s} \) : partial density (mg.m\(^{-3}\)) , and shown in the table below .

### Table 1. Experiment machine properties

| Soil moisture% | Speed km.hr\(^{-1}\) | Distances tillage cm | Soil bulk density Mg.m\(^{-3}\) | Total soil porosity % |
|---------------|----------------------|----------------------|-------------------------------|----------------------|
| 15-17%        | 2.409                | 60                   | 1.31**                        | 50.56**              |
|               |                      | 65                   | 1.36                          | 48.67                |
|               |                      | 70                   | 1.40                          | 47.16                |
|               |                      | 60                   | 1.34**                        | 49.43**              |
| 15-17%        | 3.543                | 65                   | 1.38                          | 47.92                |
|               |                      | 70                   | 1.42                          | 46.41                |

The influence of soil moisture and tillage depth on soil bulk density and total soil porosity was shown in Table 1. All the interactions are significantly different and the best results (1.31 Mg.m\(^{-3}\) and 50.56%) have come from the overlap among 15-17% soil moisture, 2.409 km.hr\(^{-1}\) and 60cm tillage distances with using moldboard plow, while gives the interactions between , 15-17% soil moisture,3.543 km.hr\(^{-1}\) and 70cm tillage distances, the best results (1.42 Mg.m\(^{-3}\) and 46.41%).

### Table 2. Soil minutes volumes analysis in the experiment machine .

| Soil moisture% | Tillage depth Cm | Silt | Clay | Sand | Soil tissue |
|---------------|------------------|------|------|------|-------------|
| 15-17%        | 16               | 480  | 370  | 150  |
| 15-17 %       | 18               | 480  | 390  | 130  |
|               | 20               | 470  | 360  | 170  |
The results were analyzed statistically by using the randomized complete block design RCBD and the difference among treatments for each factor was tested according to the least significant difference L.S.D test [14].

5. Results and discussion

5.1. Fuel consumption

The influence of tillage distances on fuel consumption is shown in Table 1. The difference among practical speed for each factor was tested according to the least significant difference L.S.D test [14].

5.2. Slippage percentage

The influence of tillage distances on the slippage percentage is shown in Table 1. The increase in tillage distances led to an increase in slippage percentage, and the results were 9.68, 10.64, and 11.94% respectively, at different tillage distances. This is due to increased drag force when increase tillage distances led to increase slippage ratio. These results are consistent with the results of [3]. From Table 2, it is indicated that the slippage percentage of the 2.409 km.hr⁻¹ practical speed was significantly better than the 3.543 km.hr⁻¹ practical speed, the results were 10.491 and 11.301 L.ha⁻¹ respectively. Because high soil resistance of the plow movement and increase the force of the clouds and thus increasing fuel consumption. The interaction among moldboard plow, tillage distance 60 cm and practical speed 3.543 km.hr⁻¹ gave best result (9.815 L.ha⁻¹).

5.3. Machine efficiency

The influence of practical speed on machine efficiency is shown in Table 3. The practical speed 2.409 km.hr⁻¹ has the highest machine efficiency which required 80.685%, while the practical speed 3.543 km.hr⁻¹ has the lowest machine efficiency which required 80.011%. The machine efficiency reduction was due to the high pressure on the moldboard plow during the tillage process, there was an inverse relationship between practical speed and tillage distances. These findings are consistent with the findings of [6]. It is indicated that the machine efficiency of the level 60 cm distance tillage was significantly better than 70 cm tillage distance. The results were 82.002, 79.925, and 79.118% respectively. Because of high soil resistance of the plow movement and thus decreasing machine efficiency when distances of the tillage increased. The best result (82.513%) was obtained by moldboard plow at 2.409 km.hr⁻¹ practical speed and 60 cm tillage distance. The level of the fuel consumption at different conditions is shown in Figure 1. for tillage distance and practical speed for tractor.

Table 3. The effect of practical speed and tillage distances on fuel consumption. L.ha⁻¹.

| practical speed Km.hr⁻¹ | Tillage distances cm | Means of practical speed Km.hr⁻¹ |
|-------------------------|----------------------|---------------------------------|
| 2.409                   | 10.491, 11.96, 12.316| 11.301                          |
| 3.543                   | 9.815, 10.001, 11.813| 10.343                          |
| LSD=0.05                |                      | 0.211                           |
| Means of tillage distances cm | 10.15, 10.54, 11.764 | 0.626                           |
Figure 1. Effect of practical speed and tillage distances on the fuel consumption.

Table 4. The effect of practical speed and tillage distances on slippage percentage %.

| practical speed Km.hr⁻¹ | Tillage distances cm | Means of practical speed Km.hr⁻¹ |
|-------------------------|----------------------|----------------------------------|
| 2.409                   | 9.322                | 10.240                           |
| 3.543                   | 10.046               | 11.267                           |
| LSD=0.05                |                      | 1.021                            |
| Means of tillage distances cm | 9.684               | 11.935                           |
| LSD=0.05                |                      | 1.401                            |

Figure 2. Effect of practical speed and tillage distances on the slippage percentage.

Table 5. The effect of practical speed and tillage distances on machine efficiency %.

| practical speed Km.hr⁻¹ | Tillage distances cm | Means of practical speed Km.hr⁻¹ |
|-------------------------|----------------------|----------------------------------|
| 2.409                   | 82.513               | 80.685                           |
| 3.543                   | 81.493               | 80.011                           |
| LSD=0.05                |                      | 0.320                            |
| Means of tillage distances cm | 82.002               | 79.118                           |
| LSD=0.05                |                      | 1.022                            |
5.4. Germination percentage

The germination percentage was affected by the influence of practical speed and tillage distances which is indicated that the practical speed 2.409 km.hr⁻¹ was significantly better than the practical speed 3.543 km.hr⁻¹ and were results 90.803 and 89.614 % respectively (Table 4). At tillage distance 60 cm, the germination percentage was highest of 91.135%. and at the tillage distance 70 cm indicated the lowest germination percentage 89.313%. Increased soil fragmentation with low tillage distances unlike increasing tillage distances which led to reduce the soil physical properties and reflected negatively on the germination percentage for maize crop. These results are consistent with the results of [2]. The best result (92.169%) was obtained by moldboard plow at 60 cm tillage distance and practical speed 2.409 km.hr⁻¹. The level of the germination percentage at different conditions is show in Figure 4 for tillage distance and practical speed for tractor.

5.5. Plant height

The decrease in tillage distances leads to increase plant height being 168.163, 165.865 and 163.813 cm respectively for different levels of tillage distances. Decreased physical properties of soil when increasing the tillage distances and this is reflected negatively on plant height. These results are consistent with the results of [5]. From Table 5. The practical speed 2.409 km.hr⁻¹ indicated in the highest plant height (167.682 cm) and at the practical speed 3.543 km.hr⁻¹ indicated the lowest plant height (164.879 cm). Because the decrease of practical speed for the mechanical unit (plow + tractor) led to the fragmentation of the soil blocks and thus led to a decrease in the soil physical properties and reflected positive on the plant height for maize crop. These results are consistent with the results of [1]. The best result (169.821%) was obtained by moldboard plow at 60 cm tillage distance and practical speed 2.409 km.hr⁻¹. The level of the plant height at different conditions is show in Figure 5 for tillage distance and practical speed for tractor.

5.6. 1000-weight grain

Table 6 shows the influence of tillage distances on 1000-weight grain. The increasing of the tillage distances led to the decrease of the 1000-weight grain and the results were 239.130, 210.599 and 201.776 g respectively at different tillage distances. The tillage leads to improve soil ventilation which it’s a significant impact in the absorption of food and water by the roots hence decreased tillage distances led to increasing 1000-weight grain. These results are consistent with the results that gained by [9]. It is indicated that the 1000-weight grain for the practical speed 2.409 km.hr⁻¹ was significantly better than the practical speed 3.543 km.hr⁻¹, the results were 223.341 and 210.994 g respectively. The best results (245.218 g) was achieved for moldboard plow at 2.409 km.hr⁻¹ practical speed and 60 cm tillage distance. The level of the 1000-weight grain at different conditions is show in Figure 6 for tillage distance and practical speed for tractor.

5.7. Maize productivity

Table 7 shows the influence of tillage distances on the maize productivity t.ha⁻¹. The increasing of the tillage distances led to the decrease of the production of the maize crop and the results were 4.258, 3.957 and 3.724 t.ha⁻¹ respectively at different tillage distances. Soil resistance to penetration increasing is one of the factors influencing the productivity of maize yield through its effect on root extension and plant growth with tillage distance increased. This is consistent with [12]. It is indicated that the maize productivity with the practical speed 2.409 km.hr⁻¹ was significantly better than the practical speed 3.543 km.hr⁻¹, the results were 4.149 and 3.810 t.ha⁻¹ respectively. The best results (4.515 t.ha⁻¹) was achieved for moldboard
plow, at 2.409 km.h\(^{-1}\) practical speed and 60 cm tillage distance. The level of the maize productivity at different conditions is shown in Figure 7 for tillage distance and practical speed for tractor.

**Table 6.** The effect of practical speed and tillage distances on germination percentage %.

| practical speed Km.hr\(^{-1}\) | Tillage distances cm | Means of practical speed Km.hr\(^{-1}\) |
|-------------------------------|----------------------|-----------------------------------------|
| 2.409                         | 92.169               | 90.803                                  |
| 3.543                         | 90.101               | 89.614                                  |
| LSD=0.05                      |                      | 1.659                                   |
| Means of tillage distances cm | 91.135               | 89.313                                  |
| LSD=0.05                      |                      | 1.822                                   |

**Figure 4.** Effect of practical speed and tillage distances on the germination percentage.

**Table 7.** The effect of practical speed and tillage distances on plant height cm.

| practical speed Km.hr\(^{-1}\) | Tillage distances cm | Means of practical speed Km.hr\(^{-1}\) |
|-------------------------------|----------------------|-----------------------------------------|
| 2.409                         | 169.821              | 167.682                                  |
| 3.543                         | 168.506              | 164.879                                  |
| LSD=0.05                      |                      | 2.031                                    |
| Means of tillage distances cm | 169.163              | 163.813                                  |
| LSD=0.05                      |                      | 2.439                                    |

**Figure 5.** Effect of practical speed and tillage distances on the plant height.
Table 8. The effect of practical speed and tillage distances on 1000-weight grain g.

| practical speed Km.hr⁻¹ | Tillage distances cm | Means of practical speed Km.hr⁻¹ |
|-------------------------|----------------------|---------------------------------|
| 2.409                   | 245.218              | 223.341                         |
| 3.543                   | 233.041              | 210.994                         |
| LSD=0.05                |                      | 7.213                           |
| Means of tillage distances cm | 239.130          | 210.599                         |
| LSD=0.05                |                      | 9.044                           |

![Figure 6. Effect of practical speed and tillage distances on the 1000-weight grain.](image)

Table 9. The effect of practical speed and tillage distances on maize productivity t.ha⁻¹

| practical speed Km.hr⁻¹ | Tillage distances cm | Means of practical speed Km.hr⁻¹ |
|-------------------------|----------------------|---------------------------------|
| 2.409                   | 4.515                | 4.149                           |
| 3.543                   | 4.001                | 3.810                           |
| LSD=0.05                |                      | 0.144                           |
| Means of tillage distances cm | 4.258              | 3.957                           |
| LSD=0.05                |                      | 0.352                           |

![Figure 7. Effect of practical speed and tillage distances on the maize productivity.](image)

**Conclusions**

The practical speed 2.409 km.hr⁻¹ was significantly better than the practical speed 3.543 km.hr⁻¹ in all studied condition except fuel consumption, the tillage distance 60cm was significantly superior to other two levels 65 and 70cm in all studied
properties. The best results were obtained by moldboard plow at practical speed $2.409 \text{ km.h}^{-1}$ and 60 cm tillage distance for maize crop.

**Recommendation**

The present recommends to carry out future studies using other of machinery types and conduct other organizations on machine and the moisture content to know their effect on the physical characteristics of soil and machine.

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