Affecting mechanical on some growth properties for corn ,MAHA cultivar

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Abstract

The effect of chisel plow on corn /Maha cultivar was observed based on some technical indicators, under three plowing depth (14,16 and 18 cm). The experiments were conducted in a factorial experiment under randomized complete block design with three replications. The 11-13% soil humidity was meaningfully best than 13-15% soil humidity in all studied parameters. For 11-13% soil humidity and 14cm plowing depth .the fuel consumption, machine efficiency, germination percentage, plant height, 1000 - weight grain, number of grains per ear and the corn productivity were 12.336 and 11.913l.ha -1 79.425 and 79.972 %; 89.527 and 92.346 %; 148.85 and 153.70 cm; 218.85 and 226.58 g; 474.308 and 499.354 grain;4.163 and 4.286t.ha -1 .

Keywords: corn , soil physical properties , chisel plow, plowing depth , soil humidity.

1. Introduction

Corn, is one of the most important crops in the world. About 700 million metric tons of this nutritious and valuable plant are harvested annually worldwide. Corn is a summer annual crop. It is mainly used for livestock feed, not to mention its rapidly increasing production for ethanol, a renewable fuel and is being used in hundreds of other products worldwide [1] . The maximum force was observed at 90° angle, which decreased with the decreasing angles. It was also observed that varying angles have considerable effect on the width of cut, while minimum force was observed on the curvature of plow . It was also conclude that soil forces has inverse relationship with soil humidity content and direct relationship with plowing depth[2]. Soil type and condition, humidity content and plowing depth were affecting on all mechanical conditions for machine[3]. Plowing is the process of creating an favorable environment for growth of seed , through eliminating all the competing weeds for plant growth during its lifetime ,this is done by determining the plowing depth and angle of plow penetration of the soil , as concluded appropriate the crop type and irrigation method [4]. [5] Soil physical properties improve using moldboard plow when tillage process , as compared with soil physical properties before tillage process and all soil physical properties affected with speed and soil humidity, Fuel is the basis of ability of the machine , fuel consumption is unstable and differs from one to another condition depending on machine size and type ,humidity of soil as well as tillage methods that impact the fuel consumption of a machine . According for the factors mentioned above [6]. Tilling plays a key role, to create a suitable places for plant growth by creating good soil for the roots to spread, and this reflects positively on increasing the plants productivity to be cultivated [7]. 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, [8].

2. Materials and methods

This study was conducted in 2019 , to evaluate for Massy Ferguson , Mf 265s machine with chisel plow . Two levels of soil humidity 11-13% and 13-15% and three levels of plowing depth 14,16,18 cm for corn cultivar Maha (MA) . The chisel plow using in this experiments of the plow organized on certain 18 cm depth and practical speed 2.678 km.hr-1. The field humidity was determined 13-15% using the pipette methods . Fuel consumption, machine efficiency, germination percentage, plant height, 1000 – weight grain, number of grains per ear and the corn crop productivity, were calculated for each running test.
2.1. **Mechanical characteristics**

2.1.1. **Fuel consumption**

The fuel consumption was determined as [9].

\[
Q_F = \frac{Q_D \times 10000}{W_F \times D \times 1000}
\]  

(1)

Where: \(Q_F\) fuel consumed amount L/ha, \(Q_D\) fuel consumed amount for treatment length (60 m), \(W_F\) machine width (m), \(D\) treatment length (60 m).

2.1.2. **Machine efficiency**: Machine efficiency was determined as [5].

2.1.3. **Theoretical machine capacity**: Theoretical machine capacity was calculated as follow:

\[
T_{FC} = \frac{S \times W}{C}
\]

(2)

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).

2.1.4. **Effective machine capacity**: Effective machine capacity was calculated as follow:

\[
E_{FC} = \frac{A}{T}
\]

(3)

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

was used for calculation of machine efficiency [8]

\[
F_E = \frac{E_{FC}}{T_{FC}} \times 100
\]

(4)

2.2. **The crop and its components**

2.2.1. **Germination percentage**: it is taken for 10 plants growing in one square meter in three replications.

2.2.2. **Plant height**: Corn height are measured by bar or ruler from soil surface till the plant end, in three replications.

2.2.3. **1000 – grain weight**: The samples random were taken for ten plant for calculated 1000- grain weight in one square meter in three replications [10]. Number of grains per ear was calculated as 10 ear in one square meter in three replications.

2.2.4. **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 [11].

2.3. **Physical properties**: Soil physical properties determined via were taken soil samples for ten site randomly selected for speed 2.978km.hr\(^{-1}\), three plowing depth 14, 16 and 18 cm, by [9]. And then the first part was executed from experiment. per running test

2.3.1. **Soil humidity**: Was determined as [6]

\[
W = \frac{W_{w}}{W_{w} + W_{s}} \times 100
\]

(5)

Where: \(W\): percentage of soil humidity, \(W_w\): Is weight wet soil, \(W_s\): Is weight dry soil.

2.3.2. **Soil bulk density**: Soil bulk density was determined by Eq. [6] [12]

\[
P_b = \frac{M_S}{V_T}
\]

(6)

Where: \(P_b\): Dry bulk density (mg. m\(^{-3}\)), \(M_S\): weight of the dried soil sample (mg), \(V_T\): total volume of the soil sample (m\(^3\)).

2.3.3. **Total soil porosity**: The Eq (7) was used for calculation of the total porosity of soil [13]
Where: $T_{SP}$ : total soil porosity (%) , $P_b$ : 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 humidity% | Speed km.hr$^{-1}$ | Plowing depth cm | Soil bulk density Mg.m$^{-3}$ | Total soil porosity % |
|----------------|--------------------|------------------|-----------------------------|-----------------------|
| 11-13%         | 2.678              | 14               | 1.34**                      | 49.43**               |
|                |                    | 16               | 1.38                        | 47.92                 |
|                |                    | 18               | 1.41                        | 46.79                 |
|                |                    | 14               | 1.36**                      | 48.67**               |
| 13-15%         | 2.678              | 16               | 1.41                        | 46.79                 |
|                |                    | 18               | 1.44                        | 45.66                 |

The influence of soil humidity and plowing depth on soil bulk density and total soil porosity was shown in Table 1. All the interactions are significantly different and the greatest evaluations (1.34Mg.m$^{-3}$ and 49.43% ) have come from the overlap among 11-13% soil humidity, 2.678 km.hr$^{-1}$ and 14cm plowing depth, while gives the interactions between, 13-15% soil humidity, 2.678 km.hr$^{-1}$ and 18cm plowing depth, the greatest evaluations (1.44 Mg.m$^{-3}$ and 45.66% ).

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

| Soil humidity% | Plowing depth Cm | silt | Clay | Sand | Soil tissue          |
|----------------|------------------|------|------|------|----------------------|
| 11-13%         | 14               | 470  | 370  | 160  |                      |
|                | 16               | 490  | 360  | 150  |                      |
|                | 18               | 470  | 360  | 170  |                      |
|                | Av               | 476.67 | 363.33 | 160 | Silt Clay loam      |
| 13-15%         | 14               | 480  | 380  | 140  |                      |
|                | 16               | 480  | 360  | 160  |                      |
|                | 18               | 490  | 370  | 140  |                      |
|                | Av               | 483.33 | 370  | 146.67 | Silt Clay loam |

In this experiment using the randomized complete block design RCBD according to the least significant difference L.S.D test [14].

### 3. Evaluations and discussion

#### 3.1. Fuel consumption

The plowing depth of 14 cm has the lowest fuel consumption which required of 11.913 L.ha$^{-1}$, and the plowing depth of 18cm has the highest fuel consumption which required of 13.581 L.ha$^{-1}$. Increase the load on the plow during tillage process when increased depth. From Table 3. The soil humidity of 11-13% was meaningfully well than 13-15% soil humidity, the evaluations were 12.336 and 13.231 L.ha$^{-1}$ respectively. The consumption a result of increasing soil humidity and also high soil resistance on the plow movement. This is consistent with [7]. The greatest evaluations (11.346 L.ha$^{-1}$) have come from the overlap among the plowing depth of 14 cm and 11-13% soil humidity. The fuel consumption at dissimilar circumstances is shown in Figure 1 for the plowing depth and soil humidity.
3.2. Machine efficiency

The plowing depth of 14 cm has the highest machine efficiency which required of 79.972 %, and the plowing depth of 18 cm has the lowest machine efficiency which required of 77.415%. The machine efficiency reduction was due to the high pressure on the moldboard plow during the tillage process, there was an inverse relationship between plowing depth and soil humidity. This is consistent with [4]. From Table 4. That the machine efficiency of the level 11-13% soil humidity was meaningfully best than 13-15% soil humidity. The evaluations were 65.536 and 64.163 % respectively. Decreasing machine efficiency when distances of the tillage increased a result of high soil resistance of on plow with plowing process. The greatest evaluations (80.528%) have come from the overlap among the plowing depth of 14 cm and 11-13% soil humidity. The machine efficiency at dissimilar circumstances is shown in Figure 2 for the plowing depth and soil humidity.

| Soil humidity% | Plowing depth cm | Means of soil humidity % |
|----------------|------------------|--------------------------|
| 11-13          | 14               | 11.346                   |
|                | 16               | 12.622                   |
|                | 18               | 13.041                   |
| 13-15          | 14               | 12.481                   |
|                | 16               | 13.091                   |
|                | 18               | 14.121                   |
| LSD=0.05       |                  | 1.312                    |
| Means of plowing depth cm |                  | 11.913                   |
| LSD=0.05       |                  | 12.856                   |
|                |                  | 13.581                   |

Table 3. The effect of soil humidity and plowing depth on fuel consumption. L.ha⁻¹.

![Figure 1. Effect of soil humidity and plowing depth on the fuel consumption.](image)

![Table 4. The effect of soil humidity and plowing depth on machine efficiency %.

| Soil humidity% | Plowing depth cm | Means of soil humidity % |
|----------------|------------------|--------------------------|
| 11-13          | 14               | 80.528                   |
|                | 16               | 79.715                   |
|                | 18               | 78.033                   |
| 13-15          | 14               | 79.416                   |
|                | 16               | 78.223                   |
|                | 18               | 76.796                   |
| LSD=0.05       |                  | 1.618                    |
| Means of plowing depth cm |                  | 79.972                   |
| LSD=0.05       |                  | 78.969                   |
|                |                  | 77.415                   |

Table 4. The effect of soil humidity and plowing depth on machine efficiency %.
Figure 2. Effect of soil humidity and plowing depth on the machine efficiency.

Table 5. The effect of soil humidity and plowing depth on germination percentage %.

| Soil humidity % | Plowing depth cm 14 | Plowing depth cm 16 | Plowing depth cm 18 | Means of soil humidity % |
|-----------------|----------------------|----------------------|----------------------|--------------------------|
| 11-13           | 93.011               | 88.767               | 86.809               | 89.527                   |
| 13-15           | 91.682               | 86.913               | 85.551               | 88.048                   |
| LSD=0.05        |                      |                      |                      | 1.251                    |
| Means of plowing depth cm | 92.346               | 87.840               | 86.180               |                          |
| LSD=0.05        |                      |                      |                      | 1.533                    |

Figure 3. Effect of soil humidity and plowing depth on the germination percentage.

Table 6. The effect of soil humidity and plowing depth on length plant cm.

| Soil humidity % | Plowing depth cm 14 | Plowing depth cm 16 | Plowing depth cm 18 | Means of soil humidity % |
|-----------------|----------------------|----------------------|----------------------|--------------------------|
| 11-13           | 155.61               | 146.83               | 144.11               | 148.85                   |
| 13-15           | 151.79               | 140.22               | 139.58               | 143.86                   |
| LSD=0.05        |                      |                      |                      | 3.044                    |
| Means of plowing depth cm | 153.70               | 143.53               | 141.85               |                          |
| LSD=0.05        |                      |                      |                      | 2.821                    |
Figure 4. Effect of soil humidity and plowing depth on the length plant.

Table 7. The effect of soil humidity and plowing depth on 1000-weight grain g.

| Soil humidity %  | Plowing depth cm | Means of soil humidity % |
|------------------|------------------|-------------------------|
| 11-13            | 14               | 235.16                  |
| 13-15            | 16               | 222.21                  |
|                  | 18               | 201.17                  |
| LSD=0.05         |                  | 218.85                  |
| Means of plowing depth cm | 226.58 | 215.04 |
| LSD=0.05         |                  | 200.58                  |

Figure 5. Effect of soil humidity and plowing depth on the 1000-weight grain.

Table 8. The effect of soil humidity and plowing depth on number of grain per ear g/ear.

| Soil humidity %  | Plowing depth cm | Means of soil humidity % |
|------------------|------------------|-------------------------|
| 11-13            | 14               | 501.698                 |
| 13-15            | 16               | 496.813                 |
|                  | 18               | 424.414                 |
| LSD=0.05         |                  | 474.308                 |
| Means of plowing depth cm | 499.354 | 451.169 |
| LSD=0.05         |                  | 411.653                 |
|                  |                  | 29.339                  |
Figure 6. Effect of soil humidity and plowing depth on the number of grain per ear.

Table 9. The effect of soil humidity and plowing depth on corn productivity t.ha\(^{-1}\).

| Soil humidity % | Plowing depth cm | Mean of soil humidity % |
|-----------------|------------------|-------------------------|
| 11-13           | 4.521            | 4.163                   |
| 13-15           | 4.050            | 3.724                   |
| LSD=0.05        | 0.141            |                         |

Means of plowing depth cm

| 14 cm | 16 cm | 18 cm |
|-------|-------|-------|
| 4.286 | 3.955 | 3.590 |
| LSD=0.05 | 0.254 |       |

Figure 7. Effect of soil humidity and plowing depth on the corn productivity.

3.3. Germination percentage

The increase in the plowing depth leads to decrease the germination percentage and the evaluations were 92.346, 87.840 and 86.180% respectively. The growth environment was good with low plowing depth [5]. Table 5. The soil humidity 11-13% was meaningfully well than soil humidity 13-15%. The evaluations were 89.523 and 88.048% . The growth environment was bad with soil humidity decreased for its effect on spread of roots. The greatest evaluations (93.011%) have come from the overlap among the plowing depth of 14 cm and 11-13% soil humidity. The germination ratio at dissimilar circumstances is shown in Figure 3 for the plowing depth and soil humidity.

3.4. Length plant

Table 6. shows that increase in the plowing depth leads to decrease the length plant and the evaluations were 153.70, 143.53 and 141.85 cm, respectively. The growth environment was good with low plowing depth [10]. The soil humidity 11-13% was meaningfully best than soil humidity 13-15%. The evaluations were 148.85 and 143.86 cm respectively. The growth environment was bad with soil humidity decreased for its effect on spread of roots. The greatest evaluations (155.61 cm) have
come from the overlap among the plowing depth of 14 cm and 11-13% soil humidity. The length plant at dissimilar circumstances is shown in Figure 4 for the plowing depth and soil humidity.

### 3.5. 1000 – weight grain

Table 7. Increase in the plowing depth leads to decrease the 1000-weight grain and the evaluations were 226.58, 215.04 and 200.58 g respectively. With low plowing depth provide all growth requirements from ventilation and food for the plant[11]. The soil humidity 11-13% was meaningfully best than soil humidity 13-15%. The evaluations were 218.85 and 209.29 g respectively. The growth environment was bad with soil humidity decreased for its effect on spread of roots. The greatest evaluations (235.16 g) have come from the overlap among the plowing depth of 14 cm and 11-13% soil humidity. The 1000-weight grain at dissimilar circumstances is shown in Figure 5 for the plowing depth and soil humidity.

### 3.6. Number of grain per ear

The number of grain per ear was affected by the influence of soil humidity which is indicated that the 11-13% soil humidity was meaningfully well than the 13-15% soil humidity and were evaluations 474.308 and 433.810 grain.ear$^{-1}$ respectively. Table 8. At plowing depth 14 cm, the number of grain per ear was highest of 499.354 grain.ear$^{-1}$, and at the plowing depth 18 cm indicated the lowest number of grain per ear 411.653 grain.ear$^{-1}$. Increased soil fragmentation with low plowing depth unlike increasing plowing depth which led to reduce the soil physical properties and reflected negatively on the number of grain per ear for maize crop[4]. The greatest result (501.698 grain.ear$^{-1}$) was obtained by chisel plow at 14 cm plowing depth and soil humidity 11-13%. The number of grain per ear at dissimilar circumstances is shown in Figure 6 for the plowing depth and soil humidity.

### 3.7. Corn productivity

Table 9 shows the influence of tillage distances on the corn productivity t.ha$^{-1}$. The increasing of the plowing depth, led to the decrease of the production of the corn crop and the evaluations were 4.286, 3.955 and 3.590 t.ha$^{-1}$ respectively [16]. It is indicated that the corn productivity with the soil humidity 11-13% was meaningfully best than the soil humidity 13-15%; the evaluations were 4.163 and 3.810 t.ha$^{-1}$ respectively. The greatest evaluations (4.521 t.ha$^{-1}$) was achieved for chisel plow, at 11-13% soil humidity and 14 cm plowing depth. The corn productivity at dissimilar circumstances is shown in Figure 7 for the plowing depth and soil humidity.

### Conclusions

The soil humidity 11-13% was meaningfully best than the soil humidity 13-15% in all studied parameters, the plowing depth 14 cm was meaningfully superior from two levels 16 and 18 cm in all studied parameters. The greatest evaluations were obtained by Chesil plow at soil humidity 11-13% and 14 cm plowing depth for corn crop.

### Recommendation

Preferable using other plows types and know its effect, on the corn type and productivity.

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