The effect of tillage and pulverization equipment on beans growth and some technical indication for machinery unit

K Z Amer and K H Swain

1Dewan affairs, Mustansiriya University
2Al-furat Al-awsat Technical University Technical Institute of Karbala
khalid.zeemam@uomustansiriyah.edu.iq

Abstract. This experiment was conducted in an agricultural field in Hindiah district in the Secret province of Karbala, in a silt loam soil during the year 2019, to study the effect of two types of plows the sweep and chisel plow (factor1) and two types of pulverization equipment Rotavator and spring pulverization (factor1) on Beans growth and some technical indicators for machinery unit. The effect of these tow factors and the interactions between them on Slippage percentage, practical productivity, Fuel consumption, power requirement, percentage of knot and plant production were studied. Massy Fergusson tractor of (MF650) was adopted in the experiment, and Two parameters were used, the first one is: adopting two type of plows (the sweep and chisel plow) which represented the main plots (the Rotavator and spring pulverization), which represented the secondary plots. The experiment was conducted by the split plots according to the Complete Randomized Block Design, in three replicates. The results showed (according to the experiment conditions): that the sweep plow had have the advantage in recording the least percentage of slippage of (11.64%), least fuel consumption of (13.44%), the highest average of power requirements per area unit of (kwat. hr.h⁻¹), highest percentage of knots ratio of (13.44%) and the highest plant production of (6054kg.hr⁻¹). whereas the Chisel plow have had the advantage in recording the highest practical productivity of (1.29 hr.h⁻¹). the rotavater have had the advantage in recording the highest practical productivity of (1.35 hr.h⁻¹), highest knot ratio of (13.41%) and the highest plant production of (5932.5kg.hr⁻¹), whereas the spring harrow recorded the least slippage percentage of (9.94%) , least fuel consumption of ( 17.13 Li.hr⁻¹) and the least requirements of power ratio per area unit of ( 66.57 kwat.h.hr⁻¹). as for the dual interactions, it did impacted significantly in all the studied traits.

1. Introduction
Beans crop is taking an increased important role globally, for its high nutrition content as a food consumption for human as well as fodder for animals, because of the contents of its dry seeds of 21.39% protein and about 58.41% carbohydrates. 100 gm of dry seeds contain 90 mg of calcium, 3.6 mg of vitamin C and 100 unit of vitamin A [9].

Beans also regarded among the strategic crops in Iraq, which planted in wide areas all over the country, the nutrition importunacy comes from the fact it contains proteins, carbohydrates, oils and mineral salts. it’s used also in soil fertility improvement as winter fertilizer, [7]. Ploughs are
considered of the primary implements which used in different shapes For centuries as first step to prepare seeds bed [11]. The type of plow affects the soil properties then the crops as consequence, [12]. The mold board plow is used widely in Iraq and in the rest of the world by making a good seeds bed as well as its high ability of burring residues moreover mix it with the soil hence elimination of pathogens because the exposure of it to the sun, [15]. [19] mentioned that a lot of features that encourages the use of chisel plows due to the fact that it breaks the sub layers of the soil, moreover it breaks the hard pan and cuts the deep roots as a result improves aeration. Various soil types, diversities of climate and crops types, led to founding a large groups of implements of soil preparation, [20]. Among these groups that is used in soil preparation and harrowing equipment such as rotovater pulverization and spring pulverization [5].

2. Materials and Methods
The experiment was conducted in an Agricultural Field in Hindiah district -Secret province of Karbala, the soil classified for being as loamy silt, table 1 showed some physical and chemical traits.

Table 1. Illustrates some physical and chemical traits.

| Trait                | Unit          | Value |
|----------------------|---------------|-------|
| Electrical conductivity EC | Decimense.m⁻¹ | 4.57  |
| PH indicator         |               | 7.35  |
| Soil segregation     | sand          | 102   |
|                      | loam          | 621   |
|                      | clay          | 241   |
| Texture              | Loamy silt    |       |
| Available nitrogen   | mg.kg⁻¹ soil  | 360   |
|                      | mg.kg⁻¹ soil  | 167   |

In this experiment massy Fergusson tractor of (MF650), of diesel engine type, four strokes, four cylinders, of 70 hp, 2200 rpm. Number of Forward speed is 8 (4 normal and 4 slow), number of rear speed 2 (1 normal and 1 slow). two factors were used in this experiment the first one was one is : adopting two type of plows ( the sweep phow Practical width 200 cm, the total weight 421 kg Manufacture Iraq – Alexandria General Company for Mechanical Industries and chisel plow Practical width 219 cm, the total weight 513 kg manufacture Iraq – alexandria general ), which represented the main plots (the Rotavator pulverization Practical width 185 cm, the total weight 385 kg Manufacture Italy and spring pulverization Practical width 26.59 cm, the total weight 295 kg Manufacture Iraq – Alexandria General Company for Mechanical Industries). Beans were planted in the experiment as shown in figure (1). A timing watch was used to calculate the time , hence extract velocities such as slippage , practical productivity and using a metric measuring tape along with wood poling /columns for distances determination . in this experiment ,split plots were used according to the complete randomized design in three replicates . the following acquired data were collected and analyzed according to the experimental design that is used , the means were tested by using the least significant differences p<0.05.
The following indictors were studied:

2.1. Slippage percent (%): was calculated by using the following equation suggested by [21].
\[ Sp = \frac{(V_t - V_p)}{V_t} \times 100 \]
Where:
Sp: Slippage percentage (%).
Vt: Theoretical speed (km.h\(^{-1}\)).
Vp: Practical speed (km.h\(^{-1}\)).

2.2. Practical productivity (hr.h\(^{-1}\)): the practical productivity by using the following equation suggested by [16].
\[ Pp = 0.1 \times Bp \times Vp \times stp \]
Where:
Pp: Practical productivity (hr.h\(^{-1}\)).
Bp: The Practical width of the plow (m).
Vp: Practical speed (km.h\(^{-1}\)).
stp: Time optimizing constant , calculated as 0.7 as mean for the plows, coefficient of time utilization was adopted by 80% [10] and [8]. (booklet of the general company of mechanical industries /Al-Exanderia).

2.3. Fuel consumption (L.h\(^{-1}\)): the fuel consumption was calculated according to the suggested method by [4].
\[ F_c = \frac{Q \times 10000}{TL} \times Wp \times 1000 \]
Where:
Fc: The fuel consumption in hectare (L.hr\(^{-1}\)).
Q: The consumed fuel in the treatment (ml).
TL: Length of the treatment (m).
Wp: Practical width of the plow (m).

2.4. Power requirement (kwat.h.hr⁻¹): the engine power was calculated using the following equation that was suggested by [14].

\[ \text{EP} = 3.16 \times \text{FC} \]

Where:
- EP: Engine power (kwat).
- FC: fuel consumption (kwat.h.hr⁻¹).

the Power requirement was calculated using the following equation that was suggested by Embaby (1985).

\[ \text{ER} = \frac{\text{EP}}{\text{Pp}} \]

Where:
- ER: Power requirement (kwat.h.hr⁻¹).
- Pp: practical productivity (hr.h⁻¹).

2.5. Knot ratio (%): That’s calculated by collecting the flowers including the fallen ones through the flower holder and fruits, the knots ratio was calculated through dividing knotted fruits on the total flowers, then multiplying the result by the hundreds.

2.6. Plant production (kg.hr⁻¹): three plants are harvested from each experimental unit, the seeds then are taken and weighed according the plant density.

3. Results and Discussions

3.1. Slippage percentage (%).

Table (2) showed the type of the plow and the pulverization type and the interaction between them in slippage percentage, where plow type had a significant impact, hence the sweep plow recorded 11.64% and the chisel plow recorded 11.86%, that’s maybe due to the fact that the used plow type turns the soil upside down, as a result it needs more traction power which leads to slippage increasing [18].

It’s cleared out of the table also that there is a significant impact for pulverization types, spring harrow recorded 9.94%, rotovator harrow came in second place that recorded 13.47%, that’s maybe due the fact that the spring pulverization type being lighter in weight resulted in decreasing slippage percentage, [3].

The table also shows dual interaction between plow type and pulverization type impacted significantly in slippage percentage, where the sweep plow and rotovator pulverization recorded higher slippage percentage of 15.43%, and least slippage was of 7.85%, it was a result of an interaction between the sweep plow and spring pulverization.

| Table 2. Effect of the type of the plow and the Pulverization type on slippage percentage % |
|---------------------------------|-----------------|-----------------|---|
|                                | Pulverization    | Rate            |   |
|                                | Spring           | Rotavator       |   |
| Sweep                          | 7.85             | 15.43           | 11.64 |
| chisel                         | 12.02            | 11.51           | 11.86 |
| L.S.D. %5                      | 7.82             | 0.2             |   |
| Rate                           | 9.94             | 13.47           |   |
| L.S.D. %5                      | 0.03             |                 |   |

3.2. Practical productivity (hr⁻¹).

Table (3) showed plow and pulverization type impact as well as their interaction impact on the practical productivity. plow type had a significant different, where the sweep plow recorded 1.24 hr.h⁻¹, the chisel plow subsequently recorded 1.29 hr.h⁻¹, that’s maybe due to
the reason of the increased effective width of the chisel plow, in comparison with the sweep plow, [2].

Table (3) showed a significant different for the harrow type used, where the spring pulverization recorded 1.18 hr.h\(^{-1}\), the rotovater subsequently recorded 1.35 hr.h\(^{-1}\), that’s due to the fact of soil fineness resulted from using rotovater pulverization is more, that’s lead to a decreasing in slippage percentage between the soil and tractor’s wheels, as well as increasing in movement resistance of the wheels, which led to increasing slippage percentage that is related in direct proportion with the practical productivity [13].

The table shows dual interaction between plow and pulverization type, where it did differed significantly the practical productivity. The chisel plow and rotovater pulverization in having practical productivity, reached 1.41 hr.h\(^{-1}\), while the least practical productivity was 1.16 hr.h\(^{-1}\) resulted from the interaction between the chisel plow and spring pulverization.

**Table 3. Effect of the type of the plow and the pulverization type on Practical productivity hr.h\(^{-1}\)**

| Plows    | Pulverization       | Rate |
|----------|---------------------|------|
|          | Spring              | Rotavator |     |
| Sweep    | 1.19                | 1.29   | 1.24 |
| Chisel   | 1.16                | 1.41   | 1.29 |
| L.S.D. %5| 0.26                |        | 0.01 |
| Rate     | 1.18                | 1.35   |      |
| L.S.D. %5| 0.004               |        |      |

**3.3. Fuel consumption (L.hr\(^{-1}\)).**

Table (4) showed impact of plough and pulverization type along with their interaction in fuel consumption, plough type had a significant impact, the sweep plough recorded 15.34 L.hr\(^{-1}\), subsequently recorded 21.83 L.hr\(^{-1}\), that’s due to the fact that the chisel plough needs a greater traction power which results in more slippage and more fuel consumption [1].

The table showed significant impact for the harrow type used, thus the spring pulverization recorded 17.13 L.hr\(^{-1}\), subsequently the rotovator harrow recorded 20.04 L.hr\(^{-1}\), that’s maybe due to the fact that the spring pulverization needs a lower traction force [2].

The same table also shows a significant dual interaction between the plough and pulverization type in fuel consumption, the chisel plough and the rotovater pulverization recorded higher ratio in fuel consumption reached 23.62 L.hr\(^{-1}\), whereas the least consumption of fuel was of 14.22 L.hr\(^{-1}\) resulted from the interaction between the sweep plow and the spring pulverization.

**Table 4. Effect of the type of the plow and the pulverization type on Fuel consumption L.hr\(^{-1}\)**

| Plows    | Pulverization       | Rate |
|----------|---------------------|------|
|          | Spring              | Rotavator |     |
| Sweep    | 14.22               | 16.46   | 15.34 |
| Chisel   | 20.03               | 23.62   | 21.83 |
| L.S.D. %5| 6.75                |        | 3.31  |
| Rate     | 17.13               | 20.04   |      |
| L.S.D. %5| 2.21                |        |      |

**3.4. Power requirements per unit area (kwat.h.hr\(^{-1}\)).**

Table (5) showed plough and pulverization type impact along with its interaction in power requirement per unit of area. the plow type had a significant impact. The seep plough recorded 6423 kwat.h.hr\(^{-1}\), the chisel plow subsequently recoded 84.33 kwat.h.hr\(^{-1}\), that’s maybe due to the reason that increasing the specific soil resistance led to increasing fuel consumption, that’s due to the fact that increasing slippage percentage led to increasing power requirement per unit of area [6].
Its cleared out of the same table, existence of a significant impact in pulverization type using, the spring harrow recorded (66.57 kwat.h.hr\(^{-1}\)), subsequently the rotovater pulverization recorded (81.99 kwat.h.hr\(^{-1}\)) that’s due to the fact that increasing slippage percentage in the rotovater pulverization, thus resulted in increasing fuel consumption per unit of area, which resulted in increasing power requirement of the machinery unit [17].

The table also shows the duel interaction between the ploughs and pulverization type, were it did impacted significantly power requirements per unit of area. the chisel plow and the rotovater had the advantage of in recording the higher requirements per unit of area of (94.74kwat.h.hr\(^{-1}\)), while the least power requirement was of (59.21 kwat.h.hr\(^{-1}\)) resulted out of the interaction between the sweep plow and spring pulverization.

**Table 5.** Effect of the type of the plow and the Pulverization type on Power requirements per unit area kwat.h.hr\(^{-1}\)

| Plows     | Pulverization | Rate |
|-----------|---------------|------|
|           | Spring        | Rotavator |
| Sweep     | 59.21         | 69.25  | 64.23 |
| Chisel    | 73.92         | 94.74  | 84.33 |
| L.S.D. %5 | 66.57         | 29.89  | 14.53 |
| Rate      |               | 81.99  |       |
| L.S.D. %5 |               | 12.32  |       |

3.5. Knot ratio (%).

The table (6) showed the impact of plough and pulverization type along with their interaction in knot ratio. the plough type had a significant impact. the sweep plow recorded 13.44% subsequently the chisel plow recorded 12.12%.

The table also shows that the used harrows type had a significant impact, where the spring pulverization recorded 12.15 %, subsequently the rotovater recorded 13.41%.

The same table also shows the duel interaction between plough type and pulverization type in knot ratios, where the sweep plow recorded the higher ratio knots of 13 .95%, while the least knot ratio was 11.36%, resulted from the interaction between the chisel plow and the spring pulverization.

**Table 6.** Effect of the type of the plow and the Pulverization type on Knot ratio %

| Plows     | Pulverization | Rate |
|-----------|---------------|------|
|           | Spring        | Rotavator |
| Sweep     | 12.93         | 13.95  | 13.44 |
| Chisel    | 11.36         | 12.87  | 12.12 |
| L.S.D. %5 | 12.15         | 1.93   | 1.82  |
| Rate      |               | 13.41  |       |
| L.S.D. %5 |               | 1.01   |       |

3.6. Plant production (kg.hr\(^{-1}\)).

The table (7) shows the impact of the plough and pulverization type along with their interaction in plant production. where the plough type had a significant impact, thus the sweep plow recorded 6054 kg.hr\(^{-1}\), subsequently the chisel plow recorded 5290 kg.hr\(^{-1}\).

The table (7) illustrates an existence of a significant impact of pulverization used in productivity, the spring pulverization recorded 5411.5 kg.hr\(^{-1}\), the rotovater pulverization subsequently recorded 5932.5kg.hr\(^{-1}\).

The same table shows the duel interaction of plough and pulverization type in plant production, the sweep plow and pulverization type had a significant advantage in recording a higher plant production of 6327 kg.hr\(^{-1}\), while the least Plant production was 5042 kg.hr\(^{-1}\), resulted of the interaction of the chisel plow and the spring pulverization.
Table 7. Effect of the type of the plow and the pulverization type on Plant production kg.hr⁻¹

| Plows    | Pulverization | Rate  |
|----------|---------------|-------|
|          | Spring        | Rotavator |     |
| Sweep    | 5761          | 6327    | 6054 |
| Chisel   | 5042          | 5538    | 5290 |
| L.S.D. %5| 55.16         |         | 46.43|
| Rate     | 5411.5        | 5932.5  |       |
| L.S.D. %5| 42.21         |         |       |

4. Conclusions
We recommend using the sweep plow and pulverization rotavator so as to get the best seed production, and recommend further studies for better results.

5. Acknowledgements
Authors would like to express their high appreciation to the Higher Education and Scientific Research Ministry/ Mustansiriya University and al-furat al-awsat technical University technical institute of kARBALA for providing the facilities utilized in accomplishing of to this research project.

References
[1] Abed Ali, K. M.2013. The Effect of the plow type at different depths of plowing and velocity in some technical indicators of the mechanic unit and the growth characteristics and the flower of the sun, Al-Furat Journal of Agricultural Sciences, 5 (3): 288-302.
[2] Amer, K. Z. 2019. The Effect of Tillage Systems on Some Machinery Unit Performance Indicators and oil corn yield. Diyala Journal of Agricultural Sciences 11(1).
[3] Al-Fahdawi, H. A. J.2001. Field performance of Massey Forexen MF 285 with rotary plow and its effect on some physical properties of soil. Master Thesis - Faculty of Agriculture - University of Baghdad.
[4] Al-Gerah, M. A. 1998. Loading The Tractor Two Types fro Plow and Measure Special Effects Consumption of Fuel under Conditions of Rain-Fed Agriculture. M.Sc. Thesis, Dept. of Agric. Mech., Coll. of Agric., Univ. of Mosul.
[5] AL-Hashemy, L. A. 2010. Effect of the type of softness and seed speed in some technical and economic indicators and capacity requirements of the mechanistic unit. The Iraqi Journal of Agricultural Science. 13(6): 114-124.
[6] Al-Sabbagh, A. A.; L. A. Z. Al-Hashemi and F.F. Al-Mkhiol. 2012. Evaluate the performance efficiency of triple disc plow with New Holland tractor by using different disc tilt angles. Iraqi Journal of Soil Sciences. 12 (1): 10 -115.
[7] Al-shityowi, I. N.2000. Production of vegetable crops. Volume I. University of omar Mukhtar. Libya. P. 311.
[8] Al-Talabani. J. H. N.2012. The effect of Pulverization Equipment types and tractor velocities on some technical indicators for unit. J. Agric. Sci. and Technology. USA. 22(3):1005 -1009
[9] Al-younis, A. H. A.1993. Production and improvement of field crops. part one. Cereal crops and legumes crops. Baghdad University. Ministry of Higher Education and Scientific Research. Iraq. P. P. 469.
[10] Bakhari, S. B., J. M. Baloch and A. N. Mirani.1989. soil manipulation with tillage implements. Agric. Mech in Asia and Lation America. 20(1):17-19.
[11] Bell, Brain .1996. Farm Machinery, 4th ed. Farming Press-Book, United Kingdom.
[12] Boydas, M.G and N. Turgut. 2007. Effect of tillage implements and operating speeds on. soil physical properties and wheat emergence. Turkish Journal of Agriculture and Forestry, 31, 399-412.
[13] Coates, E.W .2002. Agricultural Machinery Management Publication College of Agric. and Life Sci. Cooperative Extension. University of Arizona. p. 124-131.
[14] Embaby, A. T. 1985. A Comparison of the Different Mechanization System for Cereal Crop production. M.Sc. Coll. Of Agriculture.
[15] Kasisira, L. L. and H. L. M. du plessis .2006. Energy optimization for subsoilers in tandem in a sandy loam, Soil and Tillage Research, (86):185 – 198.
[16] Kepner, R.A. and R.Bainer and E. L. Barger.1972., "Principles of Farm Machinery". 2nd ed, Westport. Connecticut.
[17] Madlol. K. M.; L. A. Z. Al-Hashemi and F.F. Al-Mkhiol.2013. the effect of Harrow type, speeds and depths of drill seeder on some economical, technical performance indicators and energy requirements for machinery unit. The Iraqi Journal of Agricultural Science 44(3):373-383.
[18] Mamkg, A.M.A.2009. Some factors affecting the sliding of agricultural tracto wheels when pushing wheels. Jordanian Journal of Agricultural Sciences,University of Jordan, 5(4): 519-525.
[19] Muhamed Ali, L. H. and T. F. Dumian.1986. Fundamentals of Agricultural Equipment and Machinery, College of Agriculture, University of Baghdad, Ministry. of Higher Education and Scientific Research, Republic of Iraq, p. 400.
[20] Smith, H. P., and W. Lambert. 1990. Farm Machinery and Equipment. Mac Graw Hill Publishing Co.Ltd .New Delhi,India .pp114.
[21] Zoz, F. M. 1972. Predicating tractor field performance. Transactions of Action ASAE, 15:249-255.