EFFECT OF SOME PRIMARY TILLAGE IMPLEMENT ON SOIL PULVERIZATION AND SPECIFIC ENERGY

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ABSTRACT
This investigation was carried out to study the effect of the primary tillage implement on soil pulverization and specific energy. The studied variables are the tillage implement and the plowing speed. While specific energy, soil mean weight diameter (SMWD), soil pulverization ratio ($\Phi \leq 22$ mm), fuel consumption and specific energy efficiency (SEE) were measured and determined as a performance indicators. The tillage implement and the plowing speed affected on the energy required for plowing a unit area (SEA) and the energy required for plowing a unit volume (SEV). By increasing the plowing speed from 0.89 to 1.92, from 0.89 to 1.62 and from 1.11 to 2.06 m.s$^{-1}$. The specific energy (SEA) increased from 49.83 to 60.80, from 98.85 to 113.80 and from 21.81 to 25.62 MJ.feddan$^{-1}$, also the specific energy (SEV) increased from 79.51 to 108.02, from 102.33 to 135.48 and from 57.70 to 71.60 kJ.m$^{-3}$, all of that in case of using chisel plow, moldboard plow and disk harrow respectively. The soil mean weight diameter decreased by 18.47%, 26.01% and 16.77%, while the soil pulverization ratio increased by 28.66%, 43.61% and 5.30% as the specific energy (SEA) increased from 49.83 to 60.80, from 98.85 to 113.80 and from 21.81 to 25.62 MJ.feddan$^{-1}$, that in case of using chisel plow, moldboard plow and disk harrow respectively. The specific energy efficiencies (SEE) for the entire implement varied from 11.24% to 20.08%.

INTRODUCTION
The most important effect on crop production economy is the energy requirements. The efficiency of using the energy sources of agricultural machinery should be more studied. Primary tillage has always been one of the larger power consuming operations on a farm. And thus it is the operation that most influences the size of the power unit required for the total farm operation. Increases field capacity could be

obtained by increasing the machine width or by increasing the plowing speed. The specific energy may be affected by the field capacity. Collins et al. (1981) concluded that implement size and speed must be matched to tractor size. Bukhari and Baloch (1982) reported that the speed of operation, width of cut, depth of cut, type of soil, and skill of operator affects on fuel consumption. Bowers (1985) reported that the normal range for the overall energy efficiency (OEE) is 10 to 20% and this can be used as a quick check of the validity of fuel consumption measurements, where Energy is the specific implement energy and fuel is the fuel consumption under load. A tractor-implement combination having overall energy efficiency below 10% indicates poor load matching and low tractive efficiency, while a value above 20% indicates a good load match and high tractive efficiency. Smith (1993) reported that, the implement energy would be the energy transferred from the prime mover to the implement at the hitch point and will be limited to the energy transfer as a result of work done by draft forces. Within the scope of this definition, implement energy comparisons were made on the basis of energy required to operate the implement over an area of one feddan. El-Haddad et al. (1995) reported that the suitable soil mean weight diameter for seeding is 25 mm. Khadr et al. (1998) found that the moldboard plow gave a soil mean weight diameter greater than each of the chisel plow and the rotary plow. Al-Janobi and Al-Suhaibani (1998) applied the proposed model by Harrigan and Rotz (1995) to disk harrows, moldboard plows, disk plows, and chisel plows in sandy loam soils; they found that the specific drafts measured were less than those predicted for disk harrow implements. They attributed the difference to different soil condition, shapes and sizes of the disk harrow tested. However, specific draft for the moldboard plow and the chisel plows were very close to the predicted values. Raper et al. (2000) studied the effect of tillage depth on tillage energy requirement and they concluded the following points (1) autumn tillage tended to take slightly less energy and draft than spring tillage and (2) the effect of a winter cover crop was to slightly increase draft and energy requirements. Energy requirement and draft force increase with increasing implement velocity (Al-Jalil et al., 2001). Chandon and Kushwaha (2002) reported
that draft and vertical forces increased with an increase in speed. Keller (2004) reported that, draft force of a tillage implement is a direct measure of the energy requirement, the draft requirement for pulling a tillage implement through soil is dependent on implement parameters, tillage depth, driving speed and soil mechanical strength. Tillage to a depth greater than 10-15 cm with a chisel plow that has narrow tines without wings is not recommended. The disk harrow was shown to be energy efficient for soil fragmentation. The disk harrow had the smallest energy use for soil fragmentation, this may be attributed to the shallow working depth, but the moldboard plow is energy efficient for loosing soil (Arvidsson et. al., 2004).

We could say that the important factor that may affect crop yield is the detrimental compaction of soil by equipment traffic and tillage operations. When a farmer suspects yield-limiting compaction, remediation by tillage is typically considered. Tillage operation is considered a higher agricultural operation consuming energy, there is a problem for using the implement with unsuitable tractor, a higher power tractor more than the implement needed causes many disadvantage such as, soil compaction due to the tractor weight which affect on water infiltration rate and root growth, power and specific energy loss. When using a tractor with small power than the implement needed causes the wheels slippage which affect on power and specific energy efficiency loss and the tire wearing, therefore, the current research aimed to:

1- Study the effect of using some tillage implement at different plowing speed on tillage performance, which helps to select the matched implement with the tractor.
2- Determine the energy requirements for plowing a unit area (feddan) and a unit volume (m$^3$) from the soil.
3- Determine the relationship between the plowing speed and the energy requirements for plowing a unit area (feddan) and a unit volume (m$^3$) from the soil.
4- Determine the specific energy efficiency (SEE, %) for operating the tillage implement.
EXPERIMENTAL PROCEDURE AND METHODS

This investigation was carried out at Meet El-Deeba Rice Mechanization center, Kafr El-Sheikh Governorate. The soil is classified as a clay soil, the average soil bulk density before tilling was 1.15 g/cm³, and the average soil moisture content (d.b) was 19.8%. The studied variables were tillage implements and plowing speed. While specific energy, soil mean weight diameter (SMWD), soil pulverization ratio ($\Phi \leq 22$ mm), fuel consumption and specific energy efficiency (SEE) were measured and determined as a performance indicators.

The tractors, implement and instrumentation used in this study were (Dutz tractor model DX 6.30 ($4 \times 4$) and (Ford tractor model 6610), 7 shares chisel plow (the shares are arranged in three rows such that the shares are in staggered position resulting in a spacing of 25 cm between each consecutive shares in the three rows), 2 bottom moldboard plow and trailed disk harrow (its total width of 330 cm, it has four groups of disks, two groups in front and the others in the rear, the disks in the rear groups are completed edges, but the groups in front are notched, the average measured disk’s diameter are 59 cm, the measured distance between each two disks in each group were 23 cm. The used instrumentation in this study are soil profile meter, strain gauge dynamometer, Data logger (Daytronic system 10), portable computer, local manufacture fuel meter, stop watches, set of sieves (100, 75, 50, 25, 19, 12.5, 6.30, 4.00 and 2.00 mm sieves mesh) and weighing scale.

Data collection

Speed of operation

The speed was calculated from the time required by the tractor and implement to cover the distance of five revolutions for the tractor rear tire through tillage operation, at which the tractor and the machine usually state speed.

Draft force measurements

Strain gauge dynamometer, 10 ton, Fig. (1.A) was attached with a horizontal chain between two tractors to measure the draft. Two wheel drive tractor (Ford model 6610), of 75 hp (55.95 kW) was used as a rear (towed) on which the implement was mounted; whereas the front tractor (Dutz DX 6.30 ($4 \times 4$), 115 hp (85.8 kW) with an engine rated speed of
2400 rpm) was used to pull the towed tractor with the attached implement through the strain gauge dynamometer. The towed tractor was working on the neutral gear but the implement in the operating position; the draft was recorded and saved on the portable computer. On the same field the implement was lifted from the soil and the rear tractor was pulled to record and save the idle draft. The difference gave the draft of the implement required to cut and disturb the soil, average draft for each implement was computed from draft observations through the experiment, *Khadr (2004)* used the same instrumentation and the same method.

**Width and depth of plowing measurements**

The actual width and depth of plowing were measured and determined by using the soil profile meter; the same instrumentation and the same method were used by *(Khadr, 1990)*.

**Power required for plowing and disturbing the soil**

The power could be estimated according to the following formula:

\[
\text{Power} = \text{Draft (kN)} \times \text{plowing speed (m.s}^{-1}) \text{, kW}
\]

**Field capacity determination**

The field capacity was calculated according the following formula:

\[
\text{Theoretical field capacity} = \frac{\text{Plowing width (m)} \times \text{speed (m.s}^{-1}) \times 3.6}{4.2} \text{ feddan.h}^{-1}
\]

Actual field capacity = theoretical field capacity (feddan.h\(^{-1}\)) \times field efficiency (\(\eta\)), \%

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Fig.(1): Sketch drawing for the strain gauge dynamometer with its wiring and connections with data logger (Daytronic system 10) and a portable computer.
Field efficiency ($\eta_f$, %) varies with type of machine; for tillage machine it varies from 75 to 85% for moldboard plow and field cultivator ranges from 77 to 90% for disk harrow (John Deere, 1992). The field efficiency is assumed to be equals 80% for chisel plow, moldboard plow and disk harrow, that to be suitable for Egyptian field conditions.

**Plowed soil volume rate (V) determination**

It could be determined according the following formula:

$$V = \frac{D(m) \times \text{actual field capacity feddan.h}^{-1} \times 4.2}{3.6} \text{ m}^3 \text{s}^{-1}$$

Where, $V$ is the plowed soil volume rate, m$^3$.s$^{-1}$ and $D$ is the plowing depth, m.

**Specific energy (SEA and SEV) determination**

The specific energy (SEA) was determined by dividing the drawbar power required for plowing and disturbing the soil per the actual field capacity (feddan.h$^{-1}$), and also the specific energy (SEV) which is the energy required for plowing a unit volume from the soil (m$^3$) was determined by dividing the drawbar power per the plowed soil volume rate (m$^3$.s$^{-1}$). The following formulas were used to determine the specific energy (SEA and SEV).

$$\text{Specific energy (S.EA)} = \frac{\text{Power (kW) \times 3.6}}{\text{field capacity (feddan.h}^{-1})} \text{ MJ.feddan}^{-1}$$

$$\text{Specific energy (S.EV)} = \frac{\text{Power (kW)}}{\text{Plowed soil volume rate(V), m}^3 \text{s}^{-1}} \text{ kJ.m}^{-3}$$

**Specific energy efficiency determination (SEE)**

The specific energy efficiency (SEE) is the ratio between the specific energy transferred from the tractor for operating the implement and the energy equivalent of the fuel consumption required to perform the operation. This ratio lumps together the performance effects from load matching between implement and tractor. Specific energy efficiency (SEE) values for chisel plow, moldboard plow and disk harrow were calculated according to the following equation:

Assume that the average lower calorific value (LCV) of the fuel = $10^4$ Cal.Kg$^{-1}$
One liter of diesel fuel has energy of 35.17 MJ.

Specific energy efficiency (SEE) = \( \frac{(3.6 \text{ MJ} / \text{kW.h}) \times \text{Energy, kW.h./ feddan}}{(35.17 \text{ MJ/L}) \times \text{Fuel, L/ feddan}} \times 100 \), %

Where, specific energy efficiency (SEE, %) is the specific implement energy and fuel is the fuel consumption under load.

**Soil mean weight diameter determination**

The soil mean weight diameter was determined by the same sieves and the same methods used by Khadr (1997); the following formula was used for determining the soil mean weight diameter. Set of sieves were used for determining the soil mean weight diameter (SMWD) by using the following equation:

\[
\text{SMMD} = \frac{\sum_{i=1}^{n} x_i \times W_i}{W}
\]

(Van Bavel, 1949)

Where:  
SMWD = the mean weight diameter of soil, mm,  
\( x_i \) = the mean weight diameter of \( i^{th} \) fraction  
\( x_i = \frac{\Delta_i - 1 + \Delta_i}{2} \) mm

Where: (\( \Delta = \text{sieve - mesh} \)), Wi = the weight of the soil retained on \( (i^{th} \) sieve), and W = the total weight of the soil sample.

**Soil pulverization ratio (\( \Phi \leq 22 \text{ mm} \)), %**

Soil pulverization ratio is the percentage of the soil weight fraction composed of soil clods less than or equal 22 mm (\( \Phi \leq 22 \text{ mm} \)) which passes from the sieve mesh of 25 mm to the total weight of all clods produced by plowing.

**Fuel consumption rate**

A local manufacture fuel meter was installed on the front tractor (Dutz DX 6.30) to measure the fuel consumption. The fuel consumption rate (L.h\(^{-1}\)) was determined with the same method and the same instrumentation used by Khadr (2004).
Statistical analysis
The field data were statistically analyzed, using two-way analysis of variance (ANOVA) for the randomized complete design with two replicates. The used software was SAS (1986) using ANOVA procedure. Comparisons among treatment means, when significant, were conducted using least significant difference (LSD) at p = 0.05 level.

RESULTS AND DISCUSSION
Results of this investigation were determined with an average value, these results are summarized in Table (1). This table include performance indicators (fuel consumption (FC), draft (D), actual field capacity (AFC), drawbar power (DP), specific energy for unit area (SEA) and specific energy for soil volume (SEV), soil mean weight diameter (SMWD), soil pulverization ratio (SP) and specific energy efficiency (SEE)) at different tillage implements, plowing speed (PS) at certain plowing depth (PD).

Table (1): Average value of performance indicators (fuel consumption (FC), draft (D), actual field capacity (AFC), drawbar power (DP), specific energy for unit area (SEA) and specific energy for soil volume (SEV), soil mean weight diameter (SMWD), soil pulverization ratio (SP) and specific energy efficiency (SEE)) at different tillage implements, plowing speed (PS) at certain plowing depth (PD).

<table>
<thead>
<tr>
<th>Implement</th>
<th>PS (m/s)</th>
<th>PD (cm)</th>
<th>FC (l/h)</th>
<th>D (kn)</th>
<th>AFC (fed/h)</th>
<th>DP (kw)</th>
<th>SEA (MJ/fed)</th>
<th>SEV (kW/m3)</th>
<th>SMWD (mm)</th>
<th>SP (%)</th>
<th>SEE (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ch</td>
<td>0.89</td>
<td>14.92</td>
<td>13.49</td>
<td>16.64</td>
<td>1.07</td>
<td>14.81</td>
<td>148.3</td>
<td>49.83</td>
<td>79.51</td>
<td>48.72</td>
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<td>16.56</td>
<td>50.00</td>
<td>80.10</td>
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<td>20.23</td>
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</tr>
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<td>15.21</td>
<td>18.62</td>
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<td>16.75</td>
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<tr>
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<td>16.80</td>
<td>20.47</td>
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<td>24.77</td>
<td>107.43</td>
<td>111.94</td>
<td>79.64</td>
<td>27.43</td>
<td>15.09</td>
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<td>1.23</td>
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<td>18.10</td>
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<td>0.84</td>
<td>26.57</td>
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<td>71.82</td>
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<tr>
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<td>9.00</td>
<td>13.82</td>
<td>14.20</td>
<td>2.65</td>
<td>16.61</td>
<td>22.57</td>
<td>59.71</td>
<td>25.39</td>
<td>68.09</td>
<td>12.31</td>
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<tr>
<td>DH</td>
<td>1.42</td>
<td>9.00</td>
<td>14.74</td>
<td>14.78</td>
<td>3.21</td>
<td>20.99</td>
<td>23.54</td>
<td>62.27</td>
<td>23.76</td>
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<td>14.57</td>
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<tr>
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<td>15.72</td>
<td>15.35</td>
<td>3.69</td>
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<td>19.43</td>
<td>16.10</td>
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<td>33.17</td>
<td>25.52</td>
<td>71.60</td>
<td>22.08</td>
<td>71.40</td>
<td>17.47</td>
</tr>
</tbody>
</table>
Statistical analysis

Tillage implement and plowing speed had significant effect on performance indicators (fuel consumption, draft, actual field capacity, drawbar power, specific energy for unit area and specific energy for soil volume, soil mean weight diameter, and soil pulverization ratio), Table (2). Meanwhile there is no significant effect on specific energy efficiency and plowing speed had significant effect on it. The interactions among treatments had significant effect on all performance indicators, Table (2).

Table (2): Summary of the analysis of variance for the effect of tillage implements and plowing speed on fuel consumption (FC), draft (D), actual field capacity (AFC), drawbar power (DP), specific energy for unit area (SEA) and specific energy for soil volume (SEV), soil mean weight diameter (SMWD), soil pulverization ratio (SP) and specific energy efficiency (SEE).

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>DF</th>
<th>FC</th>
<th>D</th>
<th>AFC</th>
<th>DP</th>
<th>SEA</th>
<th>SEV</th>
<th>SMWD</th>
<th>SP</th>
<th>SEE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tillage implement</td>
<td>2</td>
<td>**</td>
<td>**</td>
<td>**</td>
<td>**</td>
<td>**</td>
<td>**</td>
<td>**</td>
<td>**</td>
<td>N.S</td>
</tr>
<tr>
<td>Plowing speed</td>
<td>4</td>
<td>**</td>
<td>**</td>
<td>**</td>
<td>**</td>
<td>**</td>
<td>**</td>
<td>**</td>
<td>**</td>
<td>**</td>
</tr>
<tr>
<td>Tillage implement × Plowing speed</td>
<td>8</td>
<td>**</td>
<td>**</td>
<td>**</td>
<td>**</td>
<td>**</td>
<td>**</td>
<td>**</td>
<td>*</td>
<td>**</td>
</tr>
</tbody>
</table>

* and ** significant at the 5% and 1% level of probability, respectively
N.S= not significant

Effect of plowing speed on specific energy

As indicated in Table (1), and Figs. (2 and 3), the energy required for plowing a unit area, SEA (MJ.feddan⁻¹) and the energy required for plowing a unit volume from the soil, SEV (kJ.m⁻³) increase as the plowing speed increases in case of using chisel plow, moldboard plow and disk harrow respectively, that may be due to the increase of the soil pulverization which requires more power from the tractor consequently increases the specific energy, the determined specific energy (SEA and SEV) values are valid through the experimental field condition, the plowing speed range and the tillage implement with its condition. The specific energy (SEA and SEV) in
case of using the moldboard plow is higher than that in case of using the chisel plow and the disk harrow, that may be due to the high operating depth compared with the chisel plow and the disk harrow, that requires higher operating power from the tractor, also the operating width of the moldboard plow is less than that in case of using both of the chisel plow and the disk harrow which decreases the actual field capacity, thus increases the specific energy.

Table (3) shows mean values of performance indicators as effect by tillage implement and plowing speed. However, for fuel consumption, the moldboard plow had higher fuel consumption compared to other implements. Also, for specific energy efficiency, there was no significant among chisel, moldboard and disk harrow and moldboard plow had higher value, Table (3).

Table (3): Mean fuel consumption (FC), draft (D), actual field capacity (AFC), drawbar power (DP), specific energy for unit area (SEA) and specific energy for soil volume (SEV), soil mean weight diameter (SMWD), soil pulverization ratio (SP) and specific energy efficiency (SEE) as affected by tillage implements and plowing speed.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>FC (lit/h)</th>
<th>D (kN)</th>
<th>AFC (kW)</th>
<th>DP (kW)</th>
<th>SEA (MJ/m²)</th>
<th>SEV (mm)</th>
<th>SMWD (mm)</th>
<th>SP (%)</th>
<th>SEE (%)</th>
</tr>
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<tbody>
<tr>
<td>Moldboard plow</td>
<td>19.30a</td>
<td>20.91a</td>
<td>0.89c</td>
<td>27.59a</td>
<td>109.99a</td>
<td>71.98a</td>
<td>32.20c</td>
<td>14.43a</td>
<td></td>
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<tr>
<td>Chisel plow</td>
<td>15.51b</td>
<td>17.62b</td>
<td>1.47b</td>
<td>22.12b</td>
<td>52.82b</td>
<td>87.78b</td>
<td>44.49b</td>
<td>13.13a</td>
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<tr>
<td>Disk harrow</td>
<td>14.75e</td>
<td>14.85e</td>
<td>3.34a</td>
<td>22.19b</td>
<td>23.59c</td>
<td>63.17c</td>
<td>23.97c</td>
<td>69.01a</td>
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<tr>
<td>LSD</td>
<td>0.05</td>
<td>0.28</td>
<td>0.08</td>
<td>0.07</td>
<td>1.39</td>
<td>1.69</td>
<td>1.50</td>
<td>0.57</td>
<td></td>
</tr>
</tbody>
</table>

S5: 20.88a 19.33a 2.69a 35.70a 66.74a 105.03a 40.63d 51.16a 17.63a
S4: 17.59b 18.22b 2.11b 27.49b 64.12b 92.82b 43.68c 47.65b 15.67b
S3: 16.02e 17.86c 1.77e 21.76c 63.24e 88.39c 47.00c 45.72e 13.84c
S2: 14.81d 17.13d 1.56d 19.31d 60.033c 83.94a 50.58a 43.49d 13.20d
S1: 14.15e 16.39e 1.40e 15.59e 56.83d 70.85a 52.17d 42.79d 11.28e
LSD: 0.04 0.36 0.15 0.86 1.80 2.18 1.68 1.80 0.48

+Means followed by different letters in each column are significantly different at P = 0.05.

LSD = least significant difference. S = plowing speed

**The relationship between the specific energy and both soil mean weight diameter and soil pulverization ratio**

As indicated in Table (1), the soil mean weight diameter (SMWD) has a reverse relationship with the specific energy for the studied tillage implements, it decreased by 18.47%, 26.01% and 16.77%, while the soil
pulverization ratio increased by 28.66%, 43.61% and 5.30% as the specific energy (SEA) increased from 49.83 to 60.80, from 98.85 to 113.80 and from 21.81 to 25.62 MJ.feddan\(^{-1}\), that in case of using chisel plow, moldboard plow and disk harrow respectively. We may say that, the soil pulverization requires more energy for breaking the soil to small pieces which decreases the soil mean weight diameter and increases the pulverization. The energy required for cutting and pulverizing a unit volume (SEV) from the soil increased with the increase of the plowing speed, it increased from 79.51 to 108.02, from 102.33 to 135.48 and from 57.70 to 71.60 kJ.m\(^{-3}\), as the plowing speed increased from 0.89 to 1.92, from 0.89 to 1.62 and from 1.11 to 2.06 m.s\(^{-1}\), all of that in case of using chisel plow, moldboard plow and disk harrow respectively.

\[ y = 10.378x + 40.116 \quad R^2 = 0.9403 \]
\[ y = -35.48x^2 + 110.84x + 28.125 \quad R^2 = 0.9124 \]
\[ y = 3.8256x + 17.936 \quad R^2 = 0.9649 \]

Fig. (2): Effect of plowing speed on energy required for plowing a soil unit.

**Specific energy efficiencies (SEE)**

It was noticed that the specific energy efficiencies (SEE) for the implements as indicated in Table (1) ranged from 11.24% to 20.08%, these values depends on the tractor condition, tillage implement and condition, the experimental field type and condition, previous crop and the operating factors. The maximum specific energy efficiencies (SEE) were 20.08, 15.48
and 17.47% at plowing speeds of 1.92, 1.58 and 2.06 m.s\(^{-1}\) in case of using chisel plow, moldboard plow and disk harrow respectively, we may say that, the optimum operating conditions which gave the maximum specific energy efficiency. The tractor power has a high effect on the specific energy efficiency. We may say that, the specific energy efficiencies (SEE) is low in case of using tractors which have a high power compared to the implement power needed, that may return to excess fuel consumption which increases the fuel energy consequently decreases the specific energy efficiency. Also in case of using tractors which have a low power compared to the implement power needed, the specific energy efficiency (SEE) is low, as increasing the tractor wheel slippage causes a drawbar power loss, consequently decreases the specific energy efficiency (SEE). Values of the specific energy efficiency are valid through the experimental conditions.

\[
y = 27.848x + 53.631 \quad R^2 = 0.9875
\]
\[
y = 1.4947x^2 + 36.111x + 69.098 \quad R^2 = 0.9006
\]
\[
y = 13.868x + 42.68 \quad R^2 = 0.9877
\]

![Graph](image)

**Fig. (3):** Effect of plowing speed on energy required for plowing a soil unit volume.

**CONCLUSION**

The following conclusions were made from this study:
- The soil mean weight diameter (SMWD) has a reverse relationship with the specific energy (SEA), while the soil pulverization ratio (\(\Phi \leq 22\) mm) increased with the increase of it.
- The energy required for cutting and pulverizing a unit volume from the soil (SEV) increased with the increase of the plowing speed.
- The moldboard plow has energy efficient for loosening soil and therefore, shallow moldboard plowing may be an interesting concept for reducing energy requirement while maintaining the benefit of a moldboard plow (e.g. incorporation of crop residues).
- The specific energy efficiency for all tested implements varied from 11.24% to 20.08%. The maximum specific energy efficiencies (SEE) were at higher plowing speed for chisel plow moldboard plow and disk harrow.

REFERENCES


الملخص العربي

"تأثير بعض آلات الحرف الرئيسي على إثارة التربة والطاقة النوعية" 

خالد أبوالعلا عبدالعزيز خضر

أجريت التجارب العملية بمركز ميكنة الأرز بميت الديبة - محافظة كفر الشيخ لدراسة تأثير بعض آلات الحرف الرئيسي (محراث حفار، محراث قلاب مطرحي ومشط قرصي) وسرعة الحرف على الطاقة اللازمة لحرث ووحدة الحجوم (SEA) وكذلك الطاقة اللازمة لحرث ووحدة الحجوم (SMWD) من التربية (SEV)، متوسط قطر قلاقل التربة، ونسبة تغشنت التربة (نسبة وزن قلاقل التربة التي متوسط قطرها أقل من أو يساوي 22 مم أي (ϕ ≤ 22 mm) إلى الوزن الكلي لقلاقل التربة، الكفاءة النوعية للطاقة (SEE).

أوضح النتائج مايلي:

1- بزيادة سرعة الحرف من 0.89 إلى 1.62، من 1.11 إلى 2.06، ومن 1.11 إلى 2.06، حيث زادت الطاقة اللازمة لحرث وإثارة وحدة المساحة (SEA) من 49.83 إلى 60.80، من 98.85 إلى 113.80 (ميجا جول.ف.م مث) وذلك لكل من المحراث الحفاز، المحراث القلاب المطرحي والمشط القرصي على الترتيب.

2- تتراوح الطاقة اللازمة لحرث وإثارة وحدة الحجوم من التربية بين 79.51 إلى 108.02، بين 135.48 إلى 165.48 (كم.م -3) وذلك عند استخدام المحراث الحفاز، المحار قلاقل الرئيسي والمشط القرصي على التوالي.

3- قل متوسط قطر قلاقل التربة بمعدل 18.47%، 18.1%، 16.77%، بينما زادت نسبة تغشنت التربة متوسطية (SEV) من 57.7% إلى 71.20% إلى 82.70%، وذلك عند استخدام المحار قلاقل الرئيسي والمشط القرصي على التوالي.

4- تتراوح الكفاءة النوعية للطاقة بين الطاقة على قضيب الجر واللازمة لحرث ووحدة المساحة إلى الطاقة المكافئة لاستهلاك الوقود ما بين 20.08- 11.51%، وذلك عند استخدام جرار ذات قدرة تتناسب مع ما تتطلبه المعدة من قدرة تشغيلية.

5- يجب استخدام جرار ذات قدرة تتناسب مع ما تتطلبه المعدة من قدرة تشغيلية.

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