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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

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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/cm^3, 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 (4x4) 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 system10), 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 (4x4), 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.

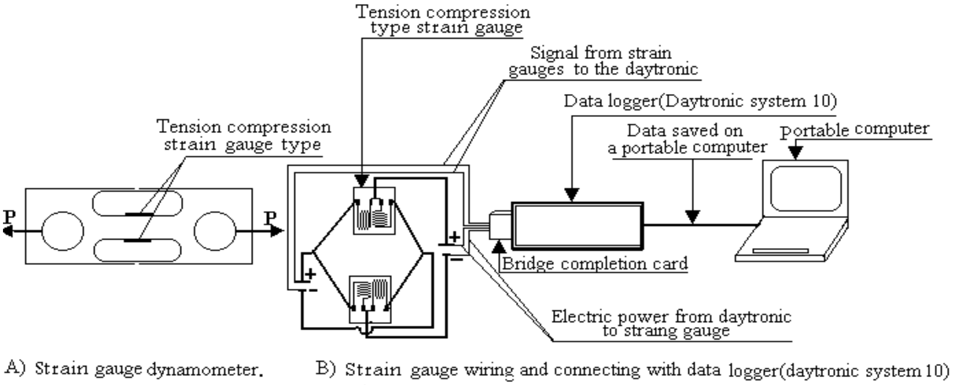
Width and depth of plowing measurements

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:

$$\text{Power} = \text{Draft (k N) x plowing speed (m.s}^{-1}\text{)}, \quad \text{kW}$$



A) Strain gauge dynamometer. B) Strain gauge wiring and connecting with data logger(daytronic system 10) and a portable computer.

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 capacity determination

The field capacity was calculated according the following formula:

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

Actual field capacity = theoretical field capacity (feddan.h^{-1}) x field efficiency (η_f), %.

Field efficiency (η_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:

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

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).

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

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

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 $Cal.Kg^{-1}$

$= [((10^4 \text{ Cal/kg}) \times (4.1868 \times 10^{-3} \text{ MJ/Cal})) / (\text{Kg} \times (\text{ L./0.84 kg})] = 35.17$ MJ/L

$\therefore$ One liter of diesel fuel has energy of 35.17 MJ.

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

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:

$$\text{SMMD} = \frac{\sum_{i=1}^{n} x_i * W_i}{W} \qquad \textbf{(Van Bavel, 1949)}$$

Where: SMWD = the mean weight diameter of soil, mm,

x_i = the mean weight diameter of i^{th} fraction

$$x_i = \frac{\Delta_{i-1} + \Delta_i}{2} \quad \text{mm}$$

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

Soil pulverization ratio ($\Phi \leq 22$ mm), %

Soil pulverization ratio is the percentage of the soil weight fraction composed of soil clods less than or equal 22 mm ($\Phi \leq 22$ 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).**

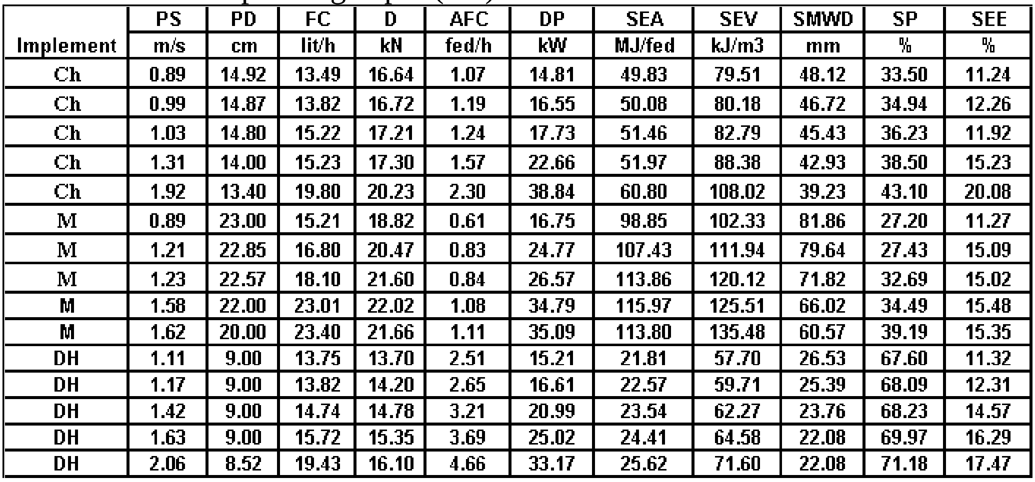
Statistical analysis

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).



Implement	PS	PD	FC	D	AFC	DP	SEA	SEV	SMWD	SP	SEE
	m/s	cm	lit/h	kN	fed/h	kW	MJ/fed	kJ/m3	mm	%	%
Ch	0.89	14.92	13.49	16.64	1.07	14.81	49.83	79.51	48.12	33.50	11.24
Ch	0.99	14.87	13.82	16.72	1.19	16.55	50.08	80.18	46.72	34.94	12.26
Ch	1.03	14.80	15.22	17.21	1.24	17.73	51.46	82.79	45.43	36.23	11.92
Ch	1.31	14.00	15.23	17.30	1.57	22.66	51.97	88.38	42.93	38.50	15.23
Ch	1.92	13.40	19.80	20.23	2.30	38.84	60.80	108.02	39.23	43.10	20.08
M	0.89	23.00	15.21	18.82	0.61	16.75	98.85	102.33	81.86	27.20	11.27
M	1.21	22.85	16.80	20.47	0.83	24.77	107.43	111.94	79.64	27.43	15.09
M	1.23	22.57	18.10	21.60	0.84	26.57	113.86	120.12	71.82	32.69	15.02
M	1.58	22.00	23.01	22.02	1.08	34.79	115.97	125.51	66.02	34.49	15.48
M	1.62	20.00	23.40	21.66	1.11	35.09	113.80	135.48	60.57	39.19	15.35
DH	1.11	9.00	13.75	13.70	2.51	15.21	21.81	57.70	26.53	67.60	11.32
DH	1.17	9.00	13.82	14.20	2.65	16.61	22.57	59.71	25.39	68.09	12.31
DH	1.42	9.00	14.74	14.78	3.21	20.99	23.54	62.27	23.76	68.23	14.57
DH	1.63	9.00	15.72	15.35	3.69	25.02	24.41	64.58	22.08	69.97	16.29
DH	2.06	8.52	19.43	16.10	4.66	33.17	25.62	71.60	22.08	71.18	17.47

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).

Source of Variation	DF	FC	D	AFC	DP	SEA	SEV	SMWD	SP	SEE
		lit/h	kN	fed/h	kW	MJ/fed	kJ/m^3	mm	%	%
Tillage implement	2	**	**	**	**	**	**	**	**	N.S
Plowing speed	4	**	**	**	**	**	**	**	**	**
Tillage implement ×Plowing speed	8	**	**	**	**	**	**	**	*	**

*** 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.

Treatments	FC	D	AFC	DP	SEA	SEV	SMWD	SP	SEE
	lit/h	kN	fed/h	kW	MJ/fed	kJ/m^3	mm	%	%
Moldboard plow	19.30a	20.91a	0.89c	27.59a	109.99a	119.08a	71.98a	32.20c	14.43a
Chisel plow	15.51b	17.62b	1.47b	22.12b	52.82b	87.78b	44.49b	37.25b	14.13a
Disk harrow	14.75c	14.83c	3.34a	22.19b	23.59c	63.17c	23.97c	69.01a	14.44a
LSD	0.03	0.28	0.08	0.67	1.39	1.69	1.30	1.39	0.37
S5	20.88a	19.33a	2.69a	35.70a	66.74a	105.03a	40.63d	51.16a	17.63a
S4	17.99b	18.22b	2.11b	27.49b	64.12b	92.82b	43.68c	47.65b	15.67b
S3	16.02c	17.86c	1.77c	21.76c	63.24b	88.39c	47.00b	45.72c	13.84c
S2	14.81d	17.13d	1.56d	19.31d	60.03c	83.94d	50.58a	43.49d	13.20d
S1	14.15e	16.39e	1.40e	15.59e	56.83d	79.85e	52.17a	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.

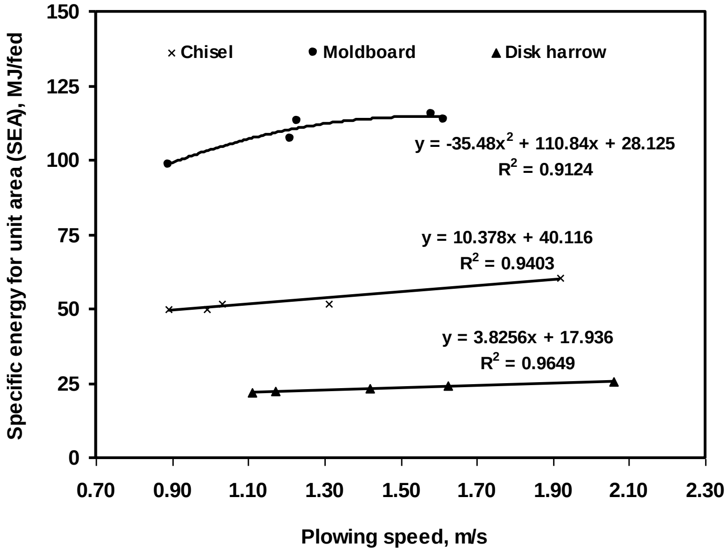


Fig. (2): Effect of plowing speed on energy required for plowing a soil unit.

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.

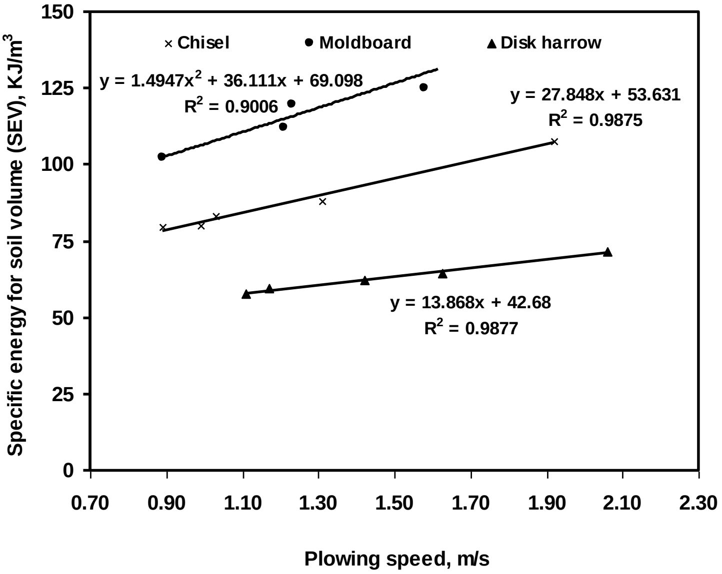


Fig. (3): Effect of plowing speed on energy required for plowing a soil unit volume.

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

Al-Jalil, H.F, A. Khdair and W. Mukahal (2001). Design and performance of an adjustable three-point hitch dynamometer. Soil & Tillage Research 62,153-156.

Al-Janobi, A.A. and S.A. Al-Suhaibani (1998). Draft of primary tillage implements in sandy loam soil. Applied Engineering in Agriculture 14(4):343– 348.

Arvidsson, J., T. Keller and K. Gustafsson (2004).Specific draft for moldboard plow, chisel plow and disk harrow at different water contents. Soil & Tillage Research. Vol. (79):221-231.

Bowers, J. C.G. (1985) Southeastern tillage energy data and recommended reporting. Transaction of the ASAE, Vol. 28(3):731-737.

Bukhari, Sh.B. and J.M. Baloch (1982). Fuel consumption of tillage implements, AMA, Vol. (13): 20-22.

Chandon, K. and R.L. Kushwaha (2002). Soil Forces and Shank Vibration on Deep Tillage, ASAE Annual International Meeting, Chicago, Illinois, USA.

Collins, N.E., T.H. Williams, and L.J. Kemble (1981). Measured machine energy requirements for grain production system. ASAE Publ. 4-81: 407-411.

El-Haddad, Z.A., M.Y. El-Ansary, and M. T.M. Tohamey (1995). Identifying a proper seedbed preparation system using locally manufactured machinery. Misr J. Ag. Eng. Vol. 12 (1): 36-45.

Harrigan, T.M. and C.A. Rotz (1995). Draft relationships for tillage and seeding equipment. Applied Engineering in Agriculture, 11(6):773–783.

John Deere (1992). Machinery management. Deere & Company service publications, Dept. FOS/FOM, John Deere road, Moline Illinois 61265-8098; Dpt. Manger: Alton E. Miller. Pp: 28.

Keller, T. (2004). Soil compaction and soil tillage – studies in agricultural soil mechanics. Ph.D. thesis Swedish University of Agric. Sciences Uppsala 2004.

Khadr, KH.A.A. (1990). Investigation of some factors affecting the chisel plough performance, M.Sc., Faculty of Agriculture, Menofeia University.

Khadr, KH.A.A. (1997). Development of a combination unit for seed-bed preparation and seeding, Ph.D, Faculty of Agriculture, Mansoura University.

Khadr, Kh.A.A. (2004). Energy requirements for some seed-bed preparation implement under Egyptian conditions, the 12th annual conference of the "Misr Society of Agricultural Engineering", PP: 481-491.

Khadr, Kh.A.A., M.A. El-Saadawy and A.I. Moussa (1998). Investigation of some tillage methods on soil physical properties and yield response. Misr J. Ag. Eng. Vol. 15(3): 608-620.

Raper, R.L., D.W. Reeves, C. H. Burmester and E.B. Schwab (2000). Tillage depth, tillage timing, and cover crop effects on cotton yield, soil strength, and tillage energy requirements, ASAE Paper No. 98-1112.

SAS (1986). User's guide, statistical analysis system. SAS Ins., Inc., SAS Circle, P.O.Box 8000, Cary, N.C.

Smith, L.A. (1993). Energy requirements for selected crop production. Soil & Tillage Research, Vol. 25(4): 281– 299.

Van Bavel, A.N. (1949). Mean weight diameter of soil aggregation as statistical index of aggregation. Soil sc., Soc., Amer., Proc., 14: 20-23.

الملخص العربي

"تأثير بعض آلات الحرث الرئيسي علي إثارة التربة والطاقة النوعية"

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أجريت التجارب العملية بمركز ميكنة الأرز بميت الديبة- محافظة كفر الشيخ لدراسة تأثير بعض آلات الحرث الرئيسي(محراث حفار، محراث قلاب مطرحي ومشط قرصي) وسرعة الحرث علي الطاقة اللازمة لحرث وحدة المساحة (SEA) وكذلك الطاقة اللازمة لحرث وحدة الحجوم من التربة (SEV)، متوسط قطر قلاقيل التربة(SMWD)، ونسبة تفتيت التربة (نسبة وزن قلاقيل التربة التي متوسط قطرها أقل من أو يساوي ٢٢ مم أي ($\Phi \leq 22$ mm) إلي الوزن الكلي لقلاقيل التربة، الكفاءة النوعية للطاقة (SEE).

أوضحت النتائج مايلي:

١- بزيادة سرعة الحرث من ٠,٨٩ إلي ١,٩٢، من ٠,٨٩ إلي ١,٦٢، ومن ١,١١ إلي ٢,٠٦ م.ث-١ زادت الطاقة اللازمة لحرث وإثارة وحدة المساحة(SEA) من ٤٩,٨٣ إلي ٦٠,٨٠، من ٩٨,٨٥ إلي ١١٣,٨٠، ومن ٢١,٨١ إلي ٢٥,٦٢ (ميجا جول.فدان-١)، وكذلك زادت الطاقة اللازمة لحرث وإثارة وحدة الحجوم من التربة(SEV) من ٧٩,٥١ إلي ١٠٨,٠٢، من ١٠٢,٣٣ إلي ١٣٥,٤٨، ومن ٥٧,٧٠ إلي ٧١,٦٠ (كيلو جول.م-٣) وذلك لكل من المحراث الحفار، المحراث القلاب المطرحي والمشط القرصي علي الترتيب.

٢- تتراوح الطاقة اللازمة لحرث وإثارة وحدة الحجوم من التربة بين ٧٩,٥١ إلي ١٠٨,٠٢، بين ١٠٢,٣٣ إلي ١٣٥,٤٨، و بين ٥٧,٧٠ إلي ٧١,٦٠ كيلوجول.م-٣ وذلك عند استخدام المحراث الحفار، المحراث القلاب المطرحي والمشط القرصي علي التوالي.

٣- قل متوسط قطر قلاقيل التربة بمعدل ١٨,٤٧٪، ٢٦,٠١٪، ١٦,٧٧٪ بينما زادت نسبة تفتيت التربة بمعدل ٢٨,٦٦٪، ٤٣,٦١٪، ٥,٣٠٪ وذلك بزيادة الطاقة النوعية(SEA) من ٤٩,٨٣ إلي ٦٠,٨٠، من ٩٨,٨٥ إلي ١١٣,٨٠، ومن ٢١,٨١ إلي ٢٥,٦٢ ميجاجول.فدان-١، وزيادة الطاقة النوعية (SEV) من ٧٩,٥١ إلي ١٠٨,٠٢، من ١٠٢,٣٣ إلي ١٣٥,٤٨، ومن ٥٧,٧٠ إلي ٧١,٦٠ كيلو جول.م-٣وذلك لكل من المحراث الحفار، المحراث القلاب المطرحي والمشط القرصي علي الترتيب.

٤- تتراوح الكفاءة النوعية للطاقة (النسبة بين الطاقة علي قضيب الجر واللازمة لحرث وحدة المساحة إلي الطاقة المكافئة لاستهلاك الوقود) ما بين ١١,٢٤- ٢٠,٠٨ %.

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

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