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Construction and Testing Mounted Multi Agricultural Seedbed Preparation Machine for Egyptian Soils

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THE MAIN purpose of this present study is to develop and to test mounted multi-use seedbed preparation (MSP) machine to limit soil disturbances by decreasing the number of field passes by performing one operation or more from three different operations [(ploughing (A), surface leveling (B), and soil finishing/smoothing (C)]. Manufactured machine consisted of a frame with three installed units. DevelopedMSP machine was evaluated against its ability to increase soil clods less than 100 mm with calculating the fuel consumed, effective field capacity, draft force, power requirement and specific energy. Maximum recorded value of percentages of clod mean weight diameter less than 100 mm was 79.8 % and it was recorded at all the three different parts separately and in sequence (A)+(B)+(C) were operated with forward speed of 2.6 km/h and 14.50 % soil moisture content. Fuel consumption increased with increasing the tractor forward speeds, and at lower soil moisture content and for more units to be operated with the chisel plow in one travelling pass. Maximum effective field capacity was 1 fed/h and it was achieved by using the developed machine either with chiselplow alone (A) or operating the machine with two units, chisel plough and the soil leveler A+C achieved by using at 6.9 km/h for soybean as previous crop in field (SB) with soil moisture content of 15.5 %. Operating the seedbed preparation machine with different combination parts gave higher values of powered required in corn harvested soil (CP) than SB.

Keywords: Combined farm machines, Seedbed preparation, Soil conservation.

Introduction

Agriculture is used to be and will continue as the backbone of the Egyptian economy. Agriculture is a major component of the Egyptian economy, contributing 11.3 percent of the country's gross domestic product. The agricultural sector accounts for 28 percent of all jobs, and over 55 percent of employment in Upper Egypt is agriculture-related. Egypt's agriculture sector is dominated by small farms using traditional practices that do not meet international standards (USAID, 2020). In these years, the agricultural chain is experiencing a period of significant transformation. The economic crisis affecting the entire agricultural sector led to a greater sensitivity to the production costs, so, greater attention is paid on the development of efficient processes (FAO, 2010).In the recent past, the international community frequently discusses the environmental sustainability of the agricultural products and the effects of pollution on both the public health and the product quality (Walter, 2005; Lagerberg and Brown, 1999). Ismail (2006) conformed the computation the effect of mutilation different tools to prepare the soil of potato plant. Reduction in cost, time and labour are critical factors to be considered and to be adjusted for higher farmers' profits and income from agricultural production (EL-Feel et al., 2020). Farm machinery producers have to reduce the economic costs and the environmental impact with looking towards the design of effective methods based on both the environmental and mechanical efficiency of automated agriculture. Enough information and best recommendation and possible technologies

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should be available with farmers for better and save production (Shalaby et al., 2020). Proper soil preparation provides the basis for good seed germination and the subsequent growth of crops. Careful use of various soil amendments can improve soil and provide the best possible starting ground for crops. The type of equipment to use in preparing soil depends on its size and the physical ability, time, and budget (Niemiera, 2015). Many researchers recommended that coming modern cultivation /tillage implements should be a multi-use tools. Arunkumar et al. (2020) designed and fabricate a multipurpose agricultural vehicle which is affordable by lower and creamy layered farming community. The developed vehicle was able to perform two operations (seed sowing and fertilizer spraying).They cleared the advantages of such vehicle in reducing both the time required for farming and the labour cost. Achutha et al. (2016) put concept design and analysis of multipurpose agriculture equipment (MAE) to find a new ways to reduce cost of farm machinery inputs. The final designed of MAE perform multi operations like sowing, chemical spraying, mechanical weeding, and inter cultivation. The results showed that the designof MAE can reduce cost as it can do the work instead of 4 labors a day. Sadiq et al. (2015) developed a multipurpose agricultural vehicle to performing agricultural operations such as product carrying, pesticide spraying, laddering, inter cultivating and digging operations of sandy loam deep soils, the cost of using proposed vehicle was less by 83% compared to using the 4WD tractor to perform similar operations.

Dhatchanamoorthy et al. (2018) expanded the concept of using multipurpose low cost agricultural equipment to include the harvesting operation with plowing, seeding to be performed by one machine. Similarlow-cost multipurpose units were developed too and with the concept of cost reduction and the ease of operations (Veeresha et al., 2018; Bute at al., 2018).Akbarnia et al. (2013) compared three tillage systems include: conventional or maximum tillage (Max-till), reduced tillage (Red-till) using multitask machine, and using direct planting machinery to represent the no-tillage case (No-till). The variance of wheat yield in the three tillage systems was significant at the one percentage level. Usage of the reduce tillage system is offered as an alternative to the conventional tillage and no-till systems.Jory (2002) suggested that for combined tillage systems in sustainable agriculture one can use disc, cultivator and/or chisel shank as tillage tools. Khosravani and Hemmat (2003) studied the effects of superficial and conventional tillage methods on the yield of wheat from irrigated fields. Comparison of the two tillage methods for the same planted seeds showed that superficial method resulted in 92% yield of crop. However, fuel consumption and operation times were higher in the conventional tillage method.ALkhafaji et al. (2018) conducted an experiment to evaluate the performance of a locally manufactured combined tillage implement (moldboard plow + ripper). The results of the research were showed that combining the locally manufactured ripper implement to moldboard plow resulted in significant increase in the number of soil clods with the desired diameter (5-10 cm). Some researchers studied the draft too, where draft and field capacity increased with increasing the forward speed same as the fuel consumption (Hegazy and Abdelmotaleb, 2008; Abo-Habaga et al., 2017). From review and introduction, there is still a need to perform soil tillage with minimum energy consumption and to achieve adequate soil characteristics for seedbed preparing. So, in the research work, mounted MSP machine was proposed and manufactured and its technological parameters were justified with best possible procedures for better seed to soil contact, proper seeding depth and timely atmospheric moisture for complete germination.

Material and methods

Experimental field were conducted in a farm at Rice Mechanization Research Center, Meet El-Deeba, Kafr El-Sheikh, Egypt during 2018agricultural season. The Experiments were done in clay soil type with soil mechanical analysis and bulk density as in Table 1. Experimental field area wasdivided into 2 main plots as two different soil conditions after harvesting soybean (SB) crop and corn crop (CP). Each main plot size was 150 x 60 m and it was divided into three sub-plots with 50 m width, each sup-plot again divided into 5 different sub-sub plots to run the individual machine during experimental tests. The experimental site was located in 31.116101°, 30.855688° as latitude and longitude.

Mounted MSP Machine

MSP machine was manufactured to utilize and equip multiple tools on a single frame and to be connected with tractor using a 3-point linkage. It was designed to be as close as possible to the tractor hitch and has a centre of gravity which even stabilizes the set with tractors without weighing. Machine was developed to limit soil disturbances by decreasing the number of field passes needed for land preparation by performing one or more of different three operations (plowing, surface leveling, and soil finishing/smoothing by fining and compaction).The local manufactured machine used in the current study has a frame with three installed units (plough, soil leveler, rolling harrow) additional spike tooth harrow manufactured and added for optional use as in (Fig.1). The overall dimensions of MSP machine were 1400 x 1200 x 1200 mm as length, width and height respectively (Fig. 2).

TABLE 1. Soil particle size distribution and its bulk density.

Soil components,%								**Soil texture**		
Clay			Silt		Sand					
55			33		12		Clay			
	Depth of the soil, mm									
	< 50		50 - < 100		100 - < 150		150 - < 200		> 200	
	MS*	Db°	MS	Db	MS	Db	MS	Db	MS	Db
Bulk density	232.6	1.18	245.0	1.24	254.8	1.28	262.6	1.32	271.1	1.37

*M_S = Soil mass, g °D_b = Soil bulk density, g /cm^3

Fig. 1. Actual developed mounted MSP machine.

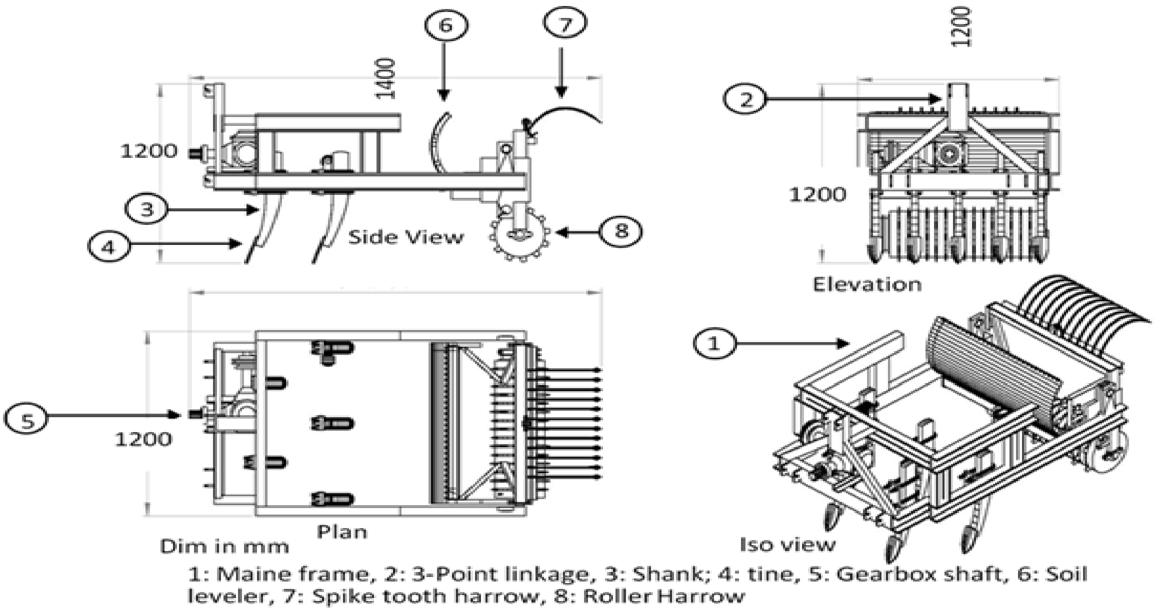


Fig. 2. Engineering drawing, component and overall dimensions of MSP machine.

Chisel plow (A)

To achieve the main purpose of ploughing for loosening of soil to improve air circulation and firmly plant holding and for better roots penetration, two rows of 5 rigid tines were manufactured and were attached to the main frame of developed machine. Material used to manufacture the rigid tines was quality ductile steel with geometrical types of 90º rake angle shank and 40º chisel (share) entrance angle (chisel entrance angle is adjustable from 25 º to 40 º if the farmers are using lower horsepower tractor. The cross section of each tine is 50 x 90 x 4 mm as width, length and thickness respectively and it was fixed on C-45 steel chisel shanks with cross-section of 250 x 25 x 40 mm as length, thickness and width respectively. (Fig. 3). The maximum observed ploughing depth was 300 mm.

Soil Leveler (B)

For surface leveling in uneven soils, a simple bucket scraper was manufactured and it was attached to the developed unit to move the soil as basic soil transportation with the help of notched end of scraper. Specification of used leveling unit is presented in Fig. 4, where its working width is 1150 mm and its height is 550 mm and it was made from 3 mm M 238 steel sheet with 235 radius of curvature.

Rolling Harrow (C)

It was manufactured and attached toMSP machine to provide constant soil compacting independently of ground and providing the finer soil fraction for soil finishing. The harrow is powered through the tractor PTO to make it independent from machine traveling speed for more accurate and fine soil preparation. Roller diameter is 300 mm and its working width is 1150 mm. The outer diameter with the prominent teeth distributed around roller perimeter is 380 mm. Teeth placed on same lines have equal distances of 100 mm (Fig. 5).

Spike-tooth harrow

For partial soil smoothing and the potential for taking out crop residues and field cleaning, one row of spring curved spike-tooth harrow was manufactured with 1100 mm working width. 12 movable teeth were placed equally with 80 mm distance. Each spike-tooth has 550 mm height and 25 mm diameter steel bars (Fig. 6).

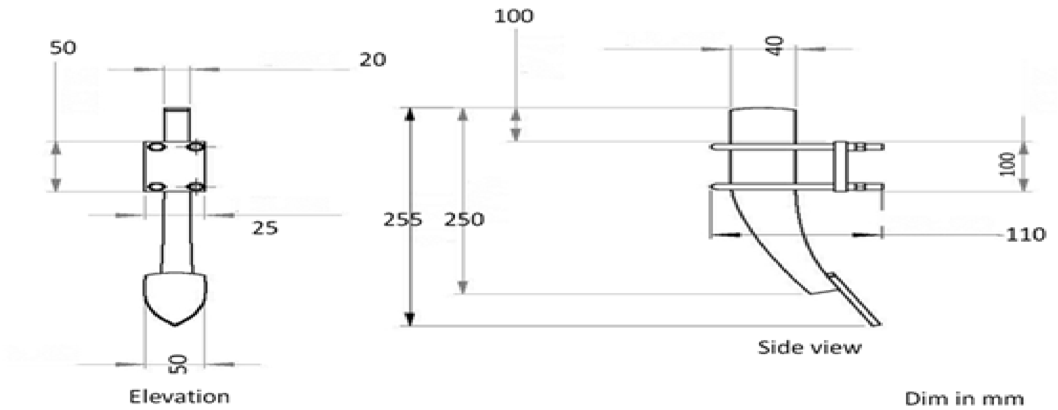


Fig. 3. Tine and shank dimensions in MSP machine.

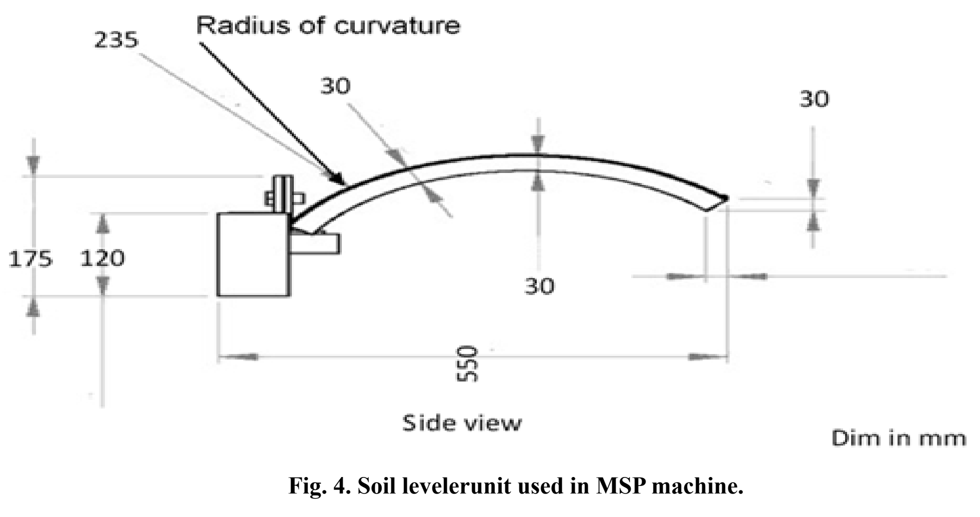


Fig. 4. Soil levelerunit used in MSP machine.

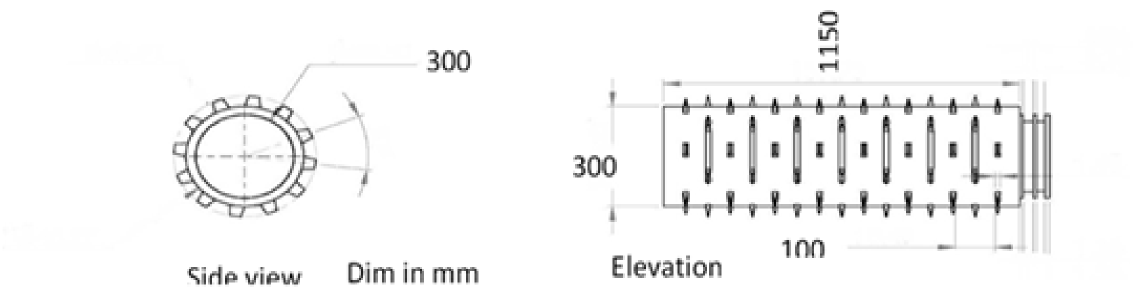


Fig. 5. Rolling harrowunit used in MSP machine.

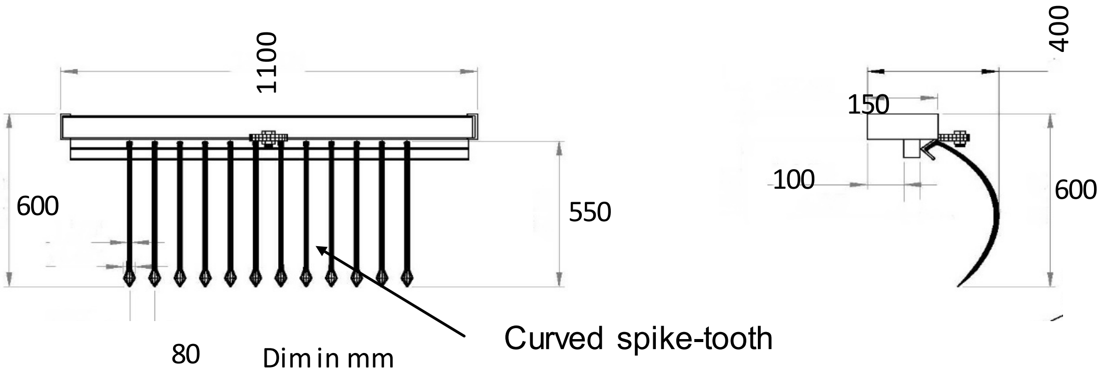


Fig. 6. Tooth harrowunit attached to MSP machine.

Experimental design and study variables

The experiments were done as split-split plots on the basis of randomized complete block design. In field experiments, developed MSP machine was attached to Lamborghini model cross 814-9 tractor and it was evaluated against its ability to increase soil clods to less than 10 cm with calculating the fuel consumed, effective field capacity, draft forcepower requirement, specific energy. Study variables were forward speed (four tractor forward speeds of 2.6, 3.8, 5.6, 6.9 km/h), two soil conditions (soil with soybean as previous crop "SB" and with corn as previous crop "CP"), and the combination of used parts in MSP machine (A: chisel plough, B: rolling harrow unit, and C: soil leveler unit) and tooth harrow not been used. Soil moisture content was recorded during main experimental trails.

Measurement of different parameters

Moisture content was determined according to ASAE Standard S353 DEC97(ASAE, 1988). It was determined for random samples during main experimental trails. The samples were taken at duringmain experimental trailsdepth from 0 to 300 mm and oven-dried. It was measured using the gravimetric method based on equation 1.

$$\text{Moisture content, \%} = \frac{\text{mass of samples} - \text{mass of dry samples}}{\text{mass of samples}} \text{X100} \ldots (1)$$

Time for covering the marked distance was noted with a stop watch and forward tractor spe

$$\text{Speed, } \left(\frac{\text{km}}{\text{h}}\right) = \frac{\text{Distance (m)}}{\text{Time (sec)}} \text{x } 3.6 \ldots\ldots\ldots\ldots (2)$$

Fuel consumption was obtained by measuring the volume of fuel consumed for implementing developed MSP machine under different conditions. The theoretical field capacity ( ) was calculated by using the formula 3.

$$\text{Tfc} = \frac{\text{W X Sp}}{4.2} \text{ Fed/h} \ldots\ldots\ldots\ldots (3)$$

where, W is the working width of implement, m; Sp is average implement forward speeds km/h.

The effective field capacity of a machine is an expression of the actual rate of operation without losing in time as turning at the ends of field, stopping to check performance, and the amount of overlap into previous traveled area. The effective field capacity (Efc) was determined based on equation 4:

$$\text{Efc} = \frac{1}{\text{affective total time per fed}} \text{ Fed/h} \ldots\ldots\ldots\ldots (4)$$

To determine the clod mean mass diameter, soil samples were randomly taken from the tilled soil, with three replications, using a special auger at the 0-30 cm depth. Samples were allowed to air dry, the air dried soil sample was sieved using a set of sieves (mesh openings <100 mm) with a shaking time of 30 s and the percentage of clod mean weight diameter less than 100 mm was calculated. Power required under different treatments was calculated based on the fuel consumed.

Specific energy (SE) was calculated by multiplying power with effective field capacity.Spring analog dynamometer fixed between a pulling tractor and the tractor that mount the developed unit. The dynamometer indicator used to record draft pull force required for moving tractor that mount the developed unit during different operations. For determination soil bulk density, random samples of the soil were collected from the experimental field for different depth and placesand soil bulk density was determined by collecting a known volume of soil using a metal ring pressed into the soil (intact core), and determining the weight after drying (McKenzie et al. 2004).

Results and Discussion

Identification of percentage of clod mean mass diameter (CMMD)

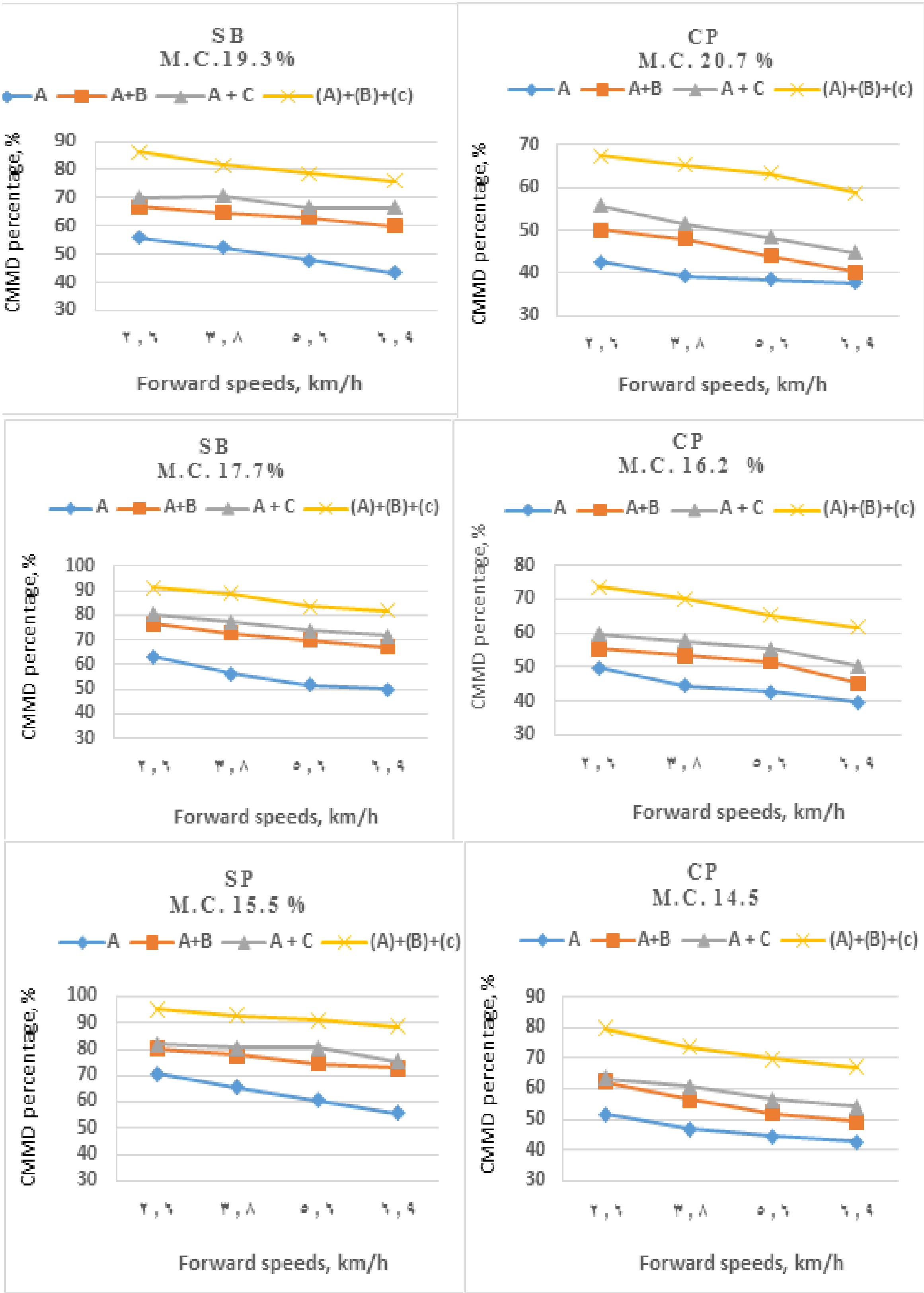
Average percentages of clod mean mass diameter (CMMD) less than 100 mm were calculated and presented in Fig 7. In SB, percentages of clod mean mass diameter less than 100 mm decreased with increasing the tractor forward speed under all the combination of used parts in MSP machine and increased with decreasing the moisture measured in the soil. Minimum value of percentages of CMMD less than 100 mm was 43.5 % and it was obtained at using chisel plow alone(A) with forward speed of 6.9 km/hand 19.3 % soil moisture content. maximum recorded value of percentages of CMMD less than 100 mm was 95.3 % and it was recorded when all the three different parts separately and in sequence (A+B+C) were operated with forward speed of 2.6 km/hand 15.50 % soil moisture content.In CP, the recorded value of percentages of CMMD less than 100 mm followed same trend as in SB. The Minimum value of percentages of CMMD less than 100 mm was 37.7 % and it was obtained with using chisel plow alone (A)and forward speed of 6.9 km/hand 20.7 % soil moisture content. maximum recorded value of percentages of CMMD less than 100 mm was 79.8 % and it was recorded when all the three different parts separately and in sequence (A)+(B)+(C) were operated with forward speed of 2.6 km/h and 14.50 % soil moisture content.It was clear also that operating the MSP machine with different parts gave lower value of percentages of CMMD less than 100 mm in CP compared to its performance in SB.

Identification of fuel consumption (FC) L/h

Fig 8 shows the average amounts of fuel consumed by tractor under different operation variables and conditions. In SB, fuel consumption increased with increasing the tractor forward speed under all the combination of used parts in MSP machine and decreased with decreasing the moisture measured in the soil. Minimum value of fuel consumption was 7.5 l/h and it was obtained with using chisel plow with only (A+B) with forward speed of 2.6 km/h and 17.7 % soil moisture content. Maximum recorded value of fuel consumption was 12 l/h and it was recorded when chisel plow was operated with roller harrow unit A+B with forward speed of 6.9 km/hand 19.3 % soil moisture content.In CP, the recorded value of fuel consumption followed same trend as in SB. The minimum value of fuel consumption was 9.5 l/h and it was obtained with using chisel plow unit alone A with forward speed of 2.6 km/hand 14.5 % soil moisture content. Maximum recorded value of fuel consumption was 13.6 l/h and it was recorded when chisel plow was operated alone A with forward speed of 6.9 km/hand soil moisture contentof 20.7 %. It was clear also that operating the seedbed preparation machine with different parts consumed more fuel in CP compared to the performance in SB, that maybe because of the nature of residue and hard soil in CP.

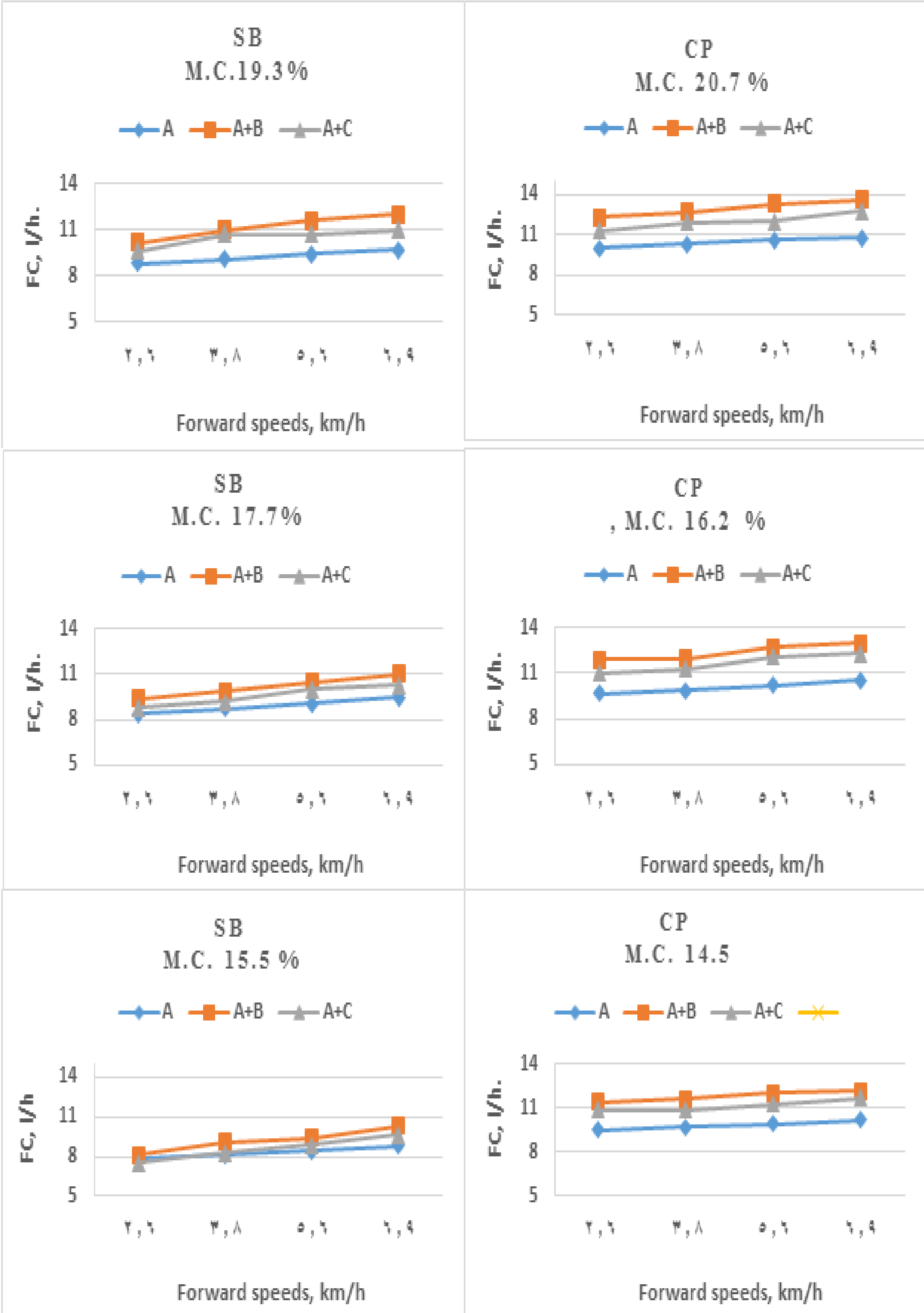
Effective field capacity, fed/h.

There was decrease in effective field capacity for all operated soil preparation combination units in experimental field when the developed machine was operated in CP compared to the effective field capacity obtained in SB. As forward speed is key variable parameter in calculating effective field capacity, increasing forward speed increased the effective field capacity under different moisture contents and with all combination of implemented unites and for both soil conditions. Under each calculated forward speed, decreasing soil moisture content led to increase in the effective field capacity for both soil conditions and for all machine operated units. Maximum effective field capacity was 1 fed/h and it was achieved by using the developed machine either with chisel unit alone (A) or operating the machine with two units, chisel plough and the soil leveler A+C achieved by using at 6.9 km/h in SB and soil moisture content of 15.5 % (Table 2).



A: chisel plough, B: rolling harrow unit, and C: soil leveler unit

Fig. 7. Factors affecting CMMD percentage less than 100 mmذ



A: chisel plough, B: roller harrow unit, and C: soil leveler unit

Fig. 8. Factors affecting fuel consumption, l/h.

TABLE 2. Effect of forward speeds, soil condition, and the combination of used parts on effective field capacity, fed/h.

Forward speed, km/h	Combination of used parts	Effective field capacity, fed/h.					
		SB			CP		
		19.3 % M.C.	17.7 % M.C.	15.5 % M.C.	20.7 % M.C.	16.2 % M.C.	14.5 % M.C.
2.6	A	0.53	0.55	0.57	0.44	0.47	0.49
	A+B	0.51	0.53	0.55	0.41	0.44	0.46
	A+C	0.52	0.56	0.56	0.43	0.45	0.48
3.8	A	0.67	0.70	0.73	0.47	0.49	0.51
	A+B	0.65	0.68	0.71	0.45	0.47	0.49
	A+C	0.66	0.69	0.73	0.46	0.48	0.50
5.6	A	0.85	0.89	0.91	0.56	0.58	0.60
	A+B	0.83	0.86	0.88	0.53	0.55	0.58
	A+C	0.85	0.88	0.90	0.55	0.57	0.60
6.9	A	0.93	0.97	1.0	0.64	0.67	0.71
	A+B	0.9	0.94	0.98	0.62	0.64	0.68
	A+C	0.92	0.955	1.0	0.635	0.66	0.70

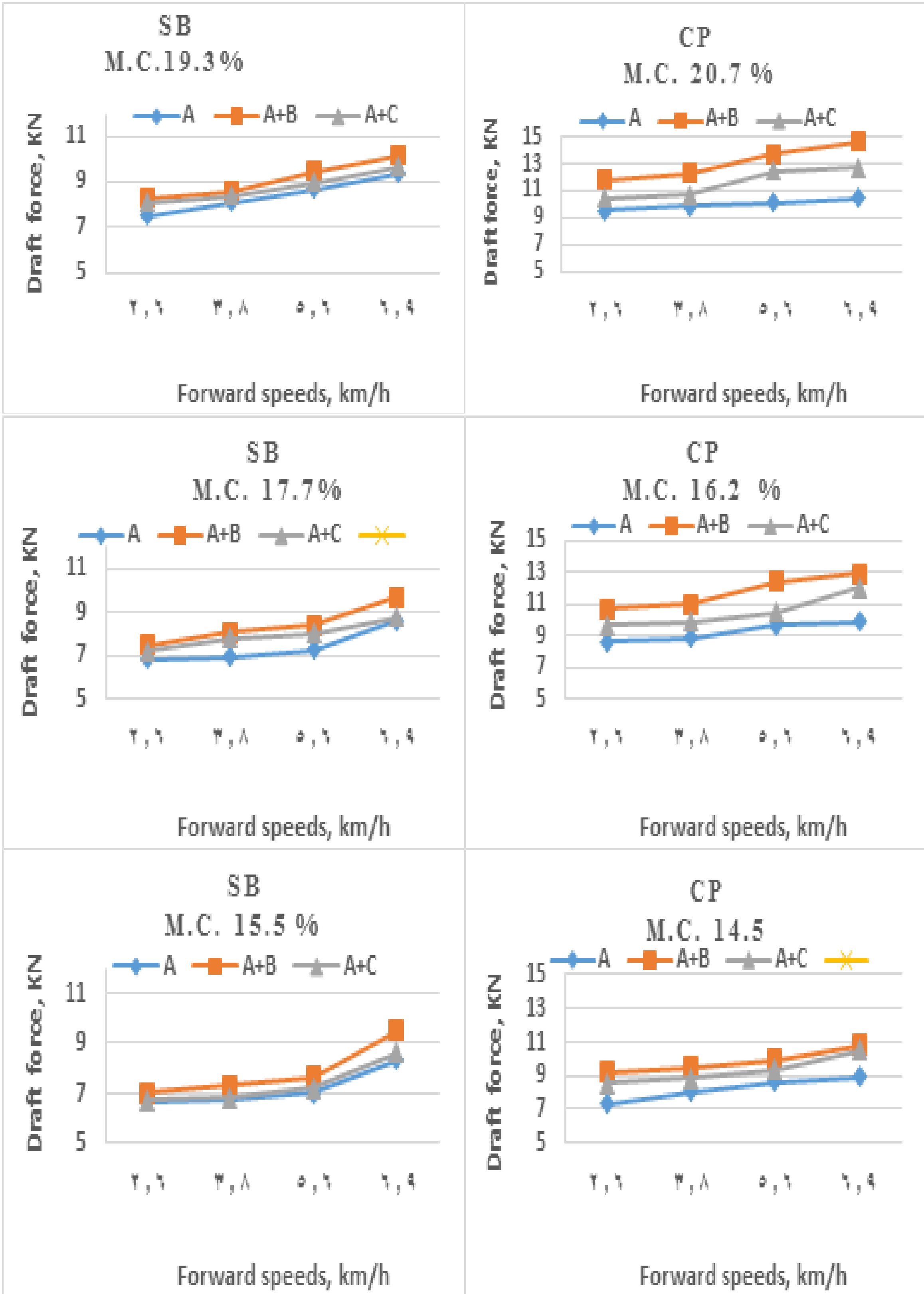
A: chisel plough, B: rolling harrow unit, and C: soil leveler unit

Draft force, kN

Recorded draft forces significantly were affected by tractor forward speed, where increasing the tractor forward speeds increased the values of draft forces under different soil moisture contents and for both soil conditions (Fig. 9). For each forward speed, draft forces decreased with decreasing soil moisture content and for all used operated parts of developed machine. Highest average draft force recorded was 14.7 kN and it was obtained by using chisel unit with roller harrow unit in one pass A+B at 6.9 km/h forward speed under 20.7% soil moisture content in CP. While, lowest recorded draft force was 6.65 kN and it was obtained bu using chisel unit alone A at 2.6 km/h forward speed under 15.5 % soil moisture content in SB. It was notable that adding either roller harrow or soil leveler raised the draft force required compared to operating the chisel unit alone under different forward speeds and soil moisture contents for both soils, however, operating soil lever unit always gave lower draft forces when operated with chisel than operating the roller harrow with the chisel unit.

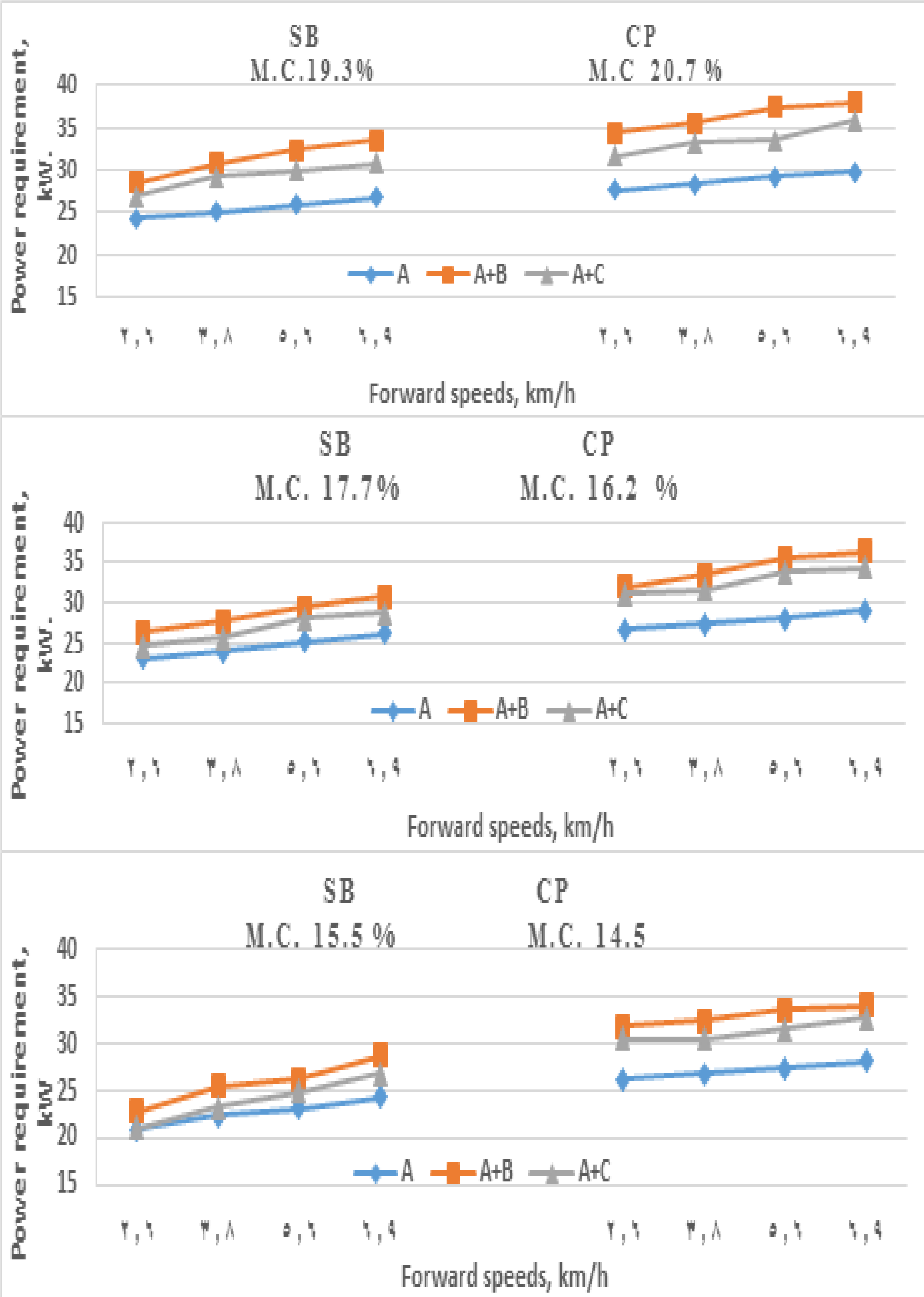
MSP power requirements, Kw.

Average amounts of powered required under different operating variables and conditions are presented in Fig. 10. In SB, powered required increased with increasing the tractor forward speed under all the combination of used parts in MSP machine and it decreased with decreasing the moisture measured in the soil. Minimum value of powered required was 20.9 kW and it was obtained atusing chisel plow unit alone (A) with forward speed of 2.6 km/h at soil moisture content of 15.5 %. Maximum recorded value of powered required was 33.6 kW and it was recorded when chisel plowwith the roller harrow unit A+B with forward speed of 6.9 km/hat soil moisture content of 19.3 %.In CP, the recorded value of powered required followed same trend as in SB. The minimum value of powered required was 26.22 kW and it was obtained with using chisel plow unit A with forward speed of 2.6 km/hat soil moisture content of 14.5 %. Maximum recorded value of powered required was 38.08 kW and it was recorded when chisel plow with the roller harrow unit A+B with forward speed of 6.9 km/h at soil moisture content of 20.7 %. Also, operating the seedbed preparation machine with different combination parts gave higher values of powered required in CPthan SB due to the more consumption of fuel as it is the indicator for the power required in such difficult soil.Operating soil fining unit needed higher power required when operated with chisel than operating the laser leveler and that is because the additional power to operate the roller from tractor PTO.



A: chisel plough, B: roller harrow unit, and C: soil leveler unit.

Fig. 9. Factors affecting draft force.



A: chisel plough, B: roller harrow unit, and C: soil leveler unit.

Fig. 10. Factors affecting power requirement, kW.

"MSP" specific energy, kW h/ fed

There was significant increase in specific energy for all operated soil preparation combination units in experimental field when the developed machine was operated in CP compared to the specific energy obtained in SB. Increasing forward speed decreased the energy requirement per unit area under different moisture contents and with all combination of implemented unites and for both soil conditions. Under each calculated forward speed, decreasing soil moisture content led to decrease in the specific energy for both soil conditions and for all machine operated units. Maximum specific energy was 84 kW.h/fed and it was achieved by using the developed machine with chisel plough with powered operated roller harrow A+B at 2.6 km/h and in CPat soil moisture content of 20.7 %. Minimum specific energy was 24.28 kW.h/fed and it was achieved by using the developed machine with chisel plough unit only (A) at 6.9 km/h in SB with soil moisture content of 15.5 % (Table 3).

Conclusion

Developedmounted MSP was used successfully under two different soil conditions and approved its ability to perform one or more of required seedbed preparation operations in the field at same travelling field pass or in a sequence when it is needed. Developed mounted MSP machine increased percentages of clod mean weight diameter less than 100 mm, and to maximize the benefits behind using the machine, it should be operated in a sequence (chisel separately then soil fining separately then leveling) or as combined chiseling and soil levelling in one pass to achieve highest possible soil preparation in term of clod mean mass diameters. It is better to operate the developed machine at low possible forward speeds to reduce fuel consumption, draft forces, power required but to make the required balance with the needed effective field capacity. Considering the higher required power draft and fuel consumption with developed machines at higher forward speeds, it better to operate the machine with forward speed from 3.8 km/h to 5.6 km/h to achieve effective field capacity from 0.69 to 0.87 fed/h for soil similar to SB or to achieve effective field capacity from 0.48 to 0.54 fed/h for difficult condition soils similar to CP.

Author Contributions

Conceptualization, Rashad A. Hegazy and Adel F. Abd-Rabou; Methodology, Ahmed M. El Sergany and Ismail A. Abdelmotaleb; Drawing Software, Ahmed M. El Sergany; ValidationAdel F. Abd-Rabou; Formal analysis, Ismail A. Abdelmotaleb; Investigation, Ahmed M. El Sergany and Rashad A. Hegazy and Adel F. Abd-Rabou; Writing—original draft preparation, Rashad A. Hegazy; Writing—review and editing, Rashad A. Hegazy and Ahmed M. El Sergany and Ismail A. Abdelmotaleb; Visualization Adel F. Abd-Rabou; Supervision and administration, Ismail A. Abdelmotaleb and Rashad A. Hegazy. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest

The authors declare no conflict of interest.

TABLE 3. Effect of tractor forward speeds, soil conditions, and the combination of used parts in MSP machine on specific energy, kWh/fed.

Forward speed, km/h.	Combination of used parts	Specific energy, kW.h/fed.					
		SB			CP		
		19.3 % M.C.	17.7 % M.C.	15.5 % M.C.	20.7 % M.C.	16.2 % M.C.	14.5 % M.C.
2.6	A	45.81	42.14	37.75	62.72	56.95	53.51
	A+B	56.0	49.66	41.23	84.0	72.54	69.39
	A+C	51.69	45.21	36.0	73.58	74.04	63.58
3.8	A	37.47	34.28	30.61	60.46	55.75	52.49
	A+B	47.38	40.76	35.88	79.02	71.48	66.28
	A+C	45.39	37.33	32.05	73.32	68.91	61.04
5.6	A	30.51	28.21	25.47	52.23	48.53	45.76
	A+B	39.13	34.18	29.9	70.62	64.65	57.93
	A+C	35.45	32.0	27.84	61.09	59.43	53.17
6.9	A	28.78	27.03	24.28	46.56	43.44	39.64
	A+B	37.33	32.76	29.42	61.42	56.87	50.23
	A+C	33.66	30.19	26.88	55.18	52.18	46.8

A: chisel plough, B: roller harrow unit, and C: soil leveler unit

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تصنيع واختبار آلة معلقة متعددة الاستخدامات لاعداد المهد المناسب للبذور في الاراضي المصرية

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الهدف الرئيسي من هذه الدراسة هو تطوير واختبار آلة لاعداد وتمهيد مرقد البذرة معلقة ومتعددة الاستخدامات للحد من عدد مرات اثارة التربة عن طريق تقليل مرور ا لآلات الزراعية اللازمة لإعداد الأرض ومن خلال القدرة إجراء ثلاث عمليات مختلفة (الحرث وتسوية السطح وانهاء / تجانس التربة) وذلك لتحسين اتصال البذور بالتربة ووضعها علي العمق المناسب وضمان المحتوي الرطوبي لإنباتها. تتكون الآلة المصنعة من ثلاث وحدات (المحراث، أداة تسوية التربة، المشط المتدحرج) مثبتة علي إطار ،مع اضافة مشط أسنان إضافي مُصنَّع ومُضاف للاستخدام الاختياري حسب الحاجة اليه. الابعاد الكلية للآلة كانت ١٤٠ × ١٢٠ × ١٢٠ سم كطول وعرض وارتفاع على التوالي. أجريت التجارب في مزرعة بمركز أبحاث ميكنة الأرز، ميت الديبة، كفر الشيخ، مصر، خلال الموسم الزراعي ٢٠١٨ بتصميمالقطعالمجزأة على أساس القطاعات العشوائية الكاملة. في التجارب الميدانية، تم تقييم آلة إعداد مرقد البذور متعددة الاستخدامات من خلال دراسة قدرتها على زيادة كتل التربة الاصغر حجماً والتي أقل من ١٠ سم مع حساب الوقود المستهلك، والسعة الحقلية الفعلية، ومتطلبات القدرة، ومتطلبات الطاقة لكل وحدة مساحة، وقوة السحب. كانت متغيرات الدراسة هي السرعة الأمامية للجرار المستخدم وقت اجراء التجارب (أربع سرعات أمامية للجرار ٢,٦ ، ٣,٨ ، ٥,٦ ، ٦,٩ كم / ساعة) ، وظروف التربة (التربة بعد حصاد محصول فول الصويا وبعد حصاد الذرة)، الأجزاء المستخدمة من الآلة متعددة الاستخدامات المصنعة (A: المحراث ، B: وحدة التنعيم ، C: وحدة تسوية التربة). كانت القيمة القصوى المسجلة للنسب المئوية لقطر متوسط وزن الكتلة أقل من ١٠٠ مم ٧٩,٨٪ وتم تسجيلها عندما تم تشغيل جميع الأجزاء الثلاثة المختلفة بشكل منفصل وبالتسلسل (C) + (B) + (A) بسرعة أمامية ٢,٦ كم / ساعة عند ١٤,٥٠٪ محتوى رطوبي التربة. زاد استهلاك الوقود مع زيادة السرعات الأمامية للجرار ومع انخفاض محتوى رطوبة التربة وعند إضافة المزيد من الوحدات ليتم تشغيلها معاًفي جره واحده. كانت السعة الحقلية الفعلية القصوى ١ فدان / ساعة وتم تحقيقها باستخدام الآلة المطورة إما باستخدام المحراث منفردا او اشراك وحدة التسوية للتربة A + C باستخدام سرعة ٦,٩ كم / ساعة وبعد حصاد فول الصويا بمحتوى رطوبي للتربة ١٥,٥٪ ، أعطى تشغيل الآلة في التربة المحصودة بعد محصول الذرة قيماً اعلي لاستهلاك الوقود ولمتطلبات الطاقة وقوى السحب المطلوبةمقارنة بتشغيل الآلة في الارض بعد حصاد محصول فول الصويا.