Egyptian Journal of Agricultural Research

Agricultural Engineering

ORIGINAL ARTICLE Egypt. J. Agric. Res., (2020), 98 (3), 533-547

Manufacturing and performance evaluation of a tractor-mounted olive harvesting machine

Morad, M. M. [1] **and G. El-Termezy** [2]

[1] *Agricultural Engineering Department, Faculty of Agriculture, Zagazig University*

[2] *Agricultural Engineering Research Institute, Agricultural Research Center, Egypt.*

(Manuscript received 15 Oct. 2020)

ABSTRACT

The main objective of the present investigation was to manufacture and evaluate the performance of a tractor-mounted machine for harvesting olive. The performance of the manufactured harvesting machine was experimentally studied under four different PTO speeds (300, 450, 600 and 750 rpm), three different vibration amplitudes (10, 15 and 20 cm) and three different vertical height clamp positions on the tree (0.5, 1.0 and 1.5 m). Evaluation of the manufactured machine was carried out taking into consideration harvester productivity, harvesting losses, specific energy and operational cost. The experimental results revealed that harvester productivity (26.7 tree/h), harvesting losses (1.8 %), specific energy (0.674 kW.h/tree) and operational cost (3.152 L.E./tree (343.64 L.E./fed)) were found using the manufactured harvesting machine at 300 rpm PTO speed, 15 cm vibration amplitude and 1.0 m vertical height clamp position on the tree.

Keywords: olive, productivity, losses, vibration amplitude, clamp position.

INTRODUCTION

Olives are considered to be among the trees widely cultivated in the Arab world, especially in the countries bordering the Mediterranean for economic, environmental and social interests. As well as cultivated in rough, sloping and desert lands, which do not affect the land grown by traditional crops. Egypt imports about 80 % of edible oil, therefore the expansion of its cultivation leads to the provision from many imported oils. Olive is the main source of many nutrients, fatty acids, carotene, vitamins, mineral salts and fiber. The olive harvesting operation is considered the main problem of the olive oil industry, as the shortage of agricultural workers represents the needs of mechanical solutions. The problem in olive harvesting lies in the lack of proper machinery for the harvesting operation as well as the lack of trained labor suitable for harvesting. Also, the harvesting operation is a cumbersome process and takes a lot of time. There are a very few publications on the mechanical harvesting operation of olives, especially on the functionality of the devices.

Measured the efficiency of three mechanical olive-harvesting systems and methods in the course of two seasons and evaluated their advantages and disadvantages. None of the trunk shakers and their associated harvesting methods were sufficiently efficient to enable the number of people needed to strike the branches with sticks to be reduced. Vine harvesters of the type used for harvesting olives were found to leave significant quantities of olives on the trees and found to be feasible. It is based on a gentle harvest of mature fruits early in the season, followed by a complementary strip-harvest at a later stage of maturity (Zion et al., 2011). Reported that there are three main technologies commonly used in olive harvesting: combs type is harvesting machines that vibrate given directly to the fruits and also the leaves and thin branches, secondly a hook type olive harvesting machine that performs the harvesting process by giving vibration to tree branches while the third is the trunk shaker type olive harvesting machines which take action from the tractor and vibrate to the trunk of the tree. As a result, it has been found that the shaker type olive harvesters have a higher performance. In contrast, the cost of this technology is higher than other olive harvesting technologies. Comb type olive harvest technologies are left behind in terms of performance compared to other harvest technologies (Tuğba and Vardar., 2019). Tracked three commercial olive harvesters during two harvesting seasons in Spain and Chile using remote and autonomous equipment that was developed to determine their time efficiency and effective based on canopy shaking for fruit detachment. These harvesters work in intensive/high-density (HD) and super-high-density (SHD) olive orchards. A saving of 40% in effective field capacity was achieved with a reduction from 4 m or higher to 3.5 m in alley width for SHD olive harvester (Francisco et al.,2015). Reported that mechanical harvesting must be developed for successful olive oil production. Both canopy contact shaking head and trunk shaking harvesters of combine harvester remove and picks up less than 80% of the efficiency required for mechanically olives harvesting. Harvesters differ in their patterns of removal, efficiency and types of tree damage. The shape of the tree must be adjusted to harvest olives mechanically successfully (Ferguson *et al*., 2010). Stated that mechanical methods of olive harvesting were: trunk shaking with and without simultaneous rod beating and with and without the application of an abscission agent. Olives were immersed in a diluted NaOH solution in the field. Mechanical harvest with rod beating reached high harvest efficiencies of 80 to 95%, whereas the elimination of rod beating significantly reduced harvesting efficiency (Isaac et al., 2014).

Developed a hand-held olive harvester suitable for small farms. Some physical and mechanical properties (dimensions, mass, fruit detachment force/mass ratio) of olive fruits that are related to the mechanical harvesting were measured and considered in the machine design. The developed machine was evaluated at two types of head length stick length of 6 cm and stick length of 17 cm) and three levels of head speed (700, 1100 and 1500 rpm). The evaluation criteria were: productivity fruit damage percentage and fruit removal percentage consumed energy and harvesting cost. His results deduced an equation and contour chart for the harvesting machine to predict the suitability of the machine to remove the fruit with different olive variety (Ibrahim, 2019). Stated that the good performance of olive mechanical harvesting by shaking depends on the suitable values of limb vibrator operating parameters (frequency and amplitude). Mathematical models of two degrees of freedom were used to estimate the natural frequency of olive fruit stem system. The results from these models indicated that the FN values were 33.9, 31.9, and 28.0 Hz for the fully mature stage, half-ripe olive, and full-ripe olive respectively. Branch vibrator was operated at three levels of frequency and 3 levels of amplitude at a vibration time of 10 s (Alzoheiry, et al., 2020).
However, to understand the effects of mechanical harvesting on olive productivity, further research is required. Therefore, the main objective of the present investigation was to manufacture a tractor-mounted harvesting machine to be used for olive harvesting. To achieve the ultimate goal, the following criteria were taken into consideration:

- Manufacture a tractor-mounted olive harvesting machine from local material.
- Optimize some different operating parameters (PTO speed, vertical height clamp position on the tree and vibration amplitude) affecting the performance of the manufactured machine.
- Evaluate the manufactured machine economically.

MATERIALS AND METHODS

The main experiments were carried out during the agricultural season of 2019 at Al Qassaseen Research Station, Ismailia Governorate, Egypt to harvest olive fruit using a manufactured tractor-mounted harvesting machine under Egyptian conditions.

1. Materials

1.1. Olive fruit

Experiments were carried out on a common cultivar of olive (Picual variety). Some properties of the olive fruits were illustrated in **Table 1.**

Table (1): Some properties of the experimental olive fruits

Variety	Picual
Average length, mm	1.78
Average diameter, mm	1.09
Average mass, g	5

The optimum date for harvesting olive was when the fruits are ripe and the oil is fully formed in them. At this date, the quantity and quality of the oil are the best possible. The ripening period starts from the appearance of purple spots on the fruit and ends when the whole pulp is colored with this color. The picking of the fruits is done when the size of the fruits is complete and the color changes from green to light green. As for black pickling olives, harvesting takes place two weeks after the completion of the black color. The harvesting to produce oil is conducted after 75% of the color of the fruit changed to black.

Olive fruit distribution usually varied in mass and number according to its location on the tree. Fruits are distributed along olive-tree as 45% of total tree fruit found in middle portion, compared with 40% in the top portion. Meanwhile, tree bottom portion had 15% of total olive-tree fruits. Factors involving nature of the tree growth, and climatic conditions may cause variation in fruit quality and quantity. Fruits at the top and middle portion of olive-tree are more exposed to the sunlight, and air compared with shaded fruits located at the tree bottom.

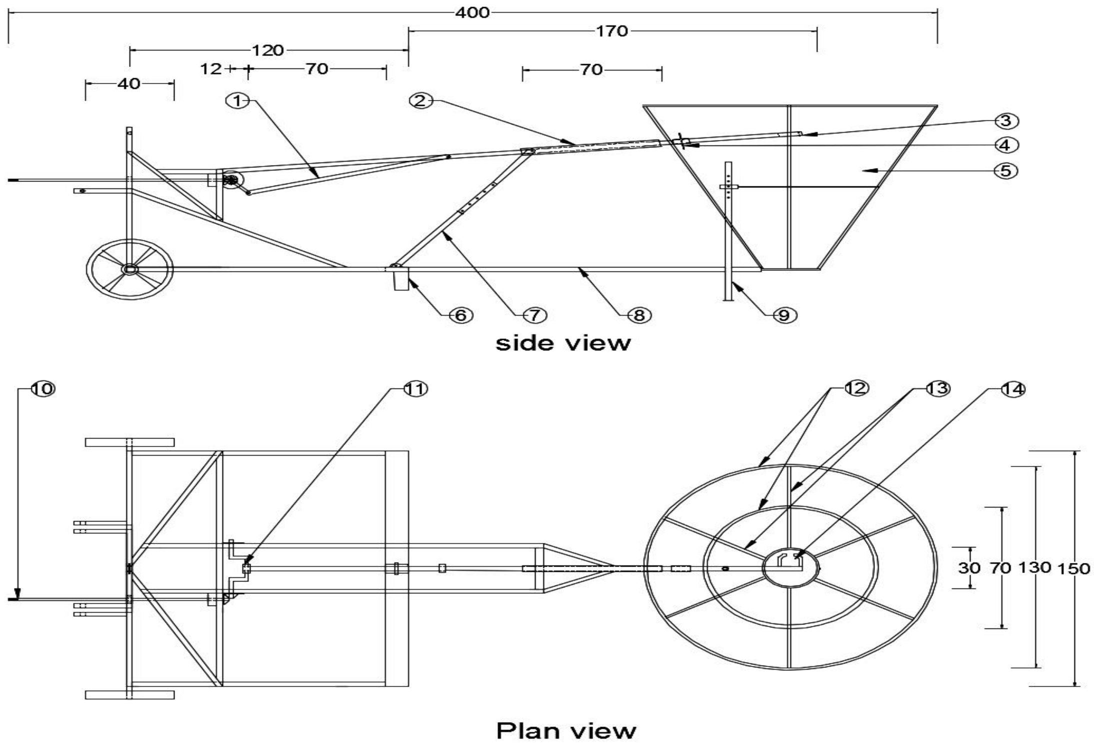
1.2. Tractor-mounted olive harvesting machine

A tractor-mounted olive harvesting machine was manufactured from local material to overcome the problems of high power and cost requirements under the use of imported machines. The olive harvesting machine was manufactured especially for this work and constructed at a small workshop in Zagzig city, Sharkia Governorate, Egypt. The harvesting machine was mounted on the front of the tractor and attached by the tractor 3- point hitch, operated by a hydraulic control while its vibration motion, transported to the olive tree trunk was powered from the tractor PTO. A gear on the PTO shaft is connected to a gear on the machine crankshaft to give an offset to the farmer holding the tree. The total mass of the manufactured olive harvesting machine was 350 kg. Fig. 1 shows a schematic of the harvesting machine and its components.

The harvesting machine consists of machine frame, crankshaft, sliding beam, delivery implant, vibration implant, clamping device and umbrella.

- Machine frame:

The machine frame is the component that holds all parts of the machine together for efficient functioning. The frame was manufactured from steel right angle with dimensions of (80 ×80 × 0.5 mm) width, height and thickness respectively.



Dim. In cm

1	P.T.O shaft	8	Substrate
2	Crank Shaft	9	Hydraulic cylinder
3	Delivery implant	10	Umbrella beam
4	Sliding beam	11	Umbrella holder
5	Rotary bushing	12	Collar
6	Vibration implant	13	Skewers
7	clamping device	14	Umbrella

Fig. 1: The tractor-mounted olive harvesting machine

- Crankshaft:
The crankshaft was manufactured from iron steel. Vibration amplitudes were determined by measuring the offset of the crank and multiplying it by 2. So, holes with different distances of 5, 7.5 and 10 cm on the crankshaft side were made, so that the installation of the connecting rod is controlled to give the required vibration amplitudes of 10, 15 and 20 cm.

- Sliding beam:
The sliding beam with 10 cm diameter and 70 cm length was fixed on the machine frame by iron corners with a hinge system to control raising and lowering the vibration implants using a hydraulic cylinder. The hydraulic cylinder is connected to the sliding beam and the machine chassis. Inside the sliding beam, another beam with 9.5 cm diameter and 110 cm length is connected from the first end to the delivery implant and from the other end to the vibration implant.

- Delivery implant:
A delivery implant is connected from one side to the crankshaft and from the other side to the sliding beam.

- Vibration implant:
Vibration implant is a pipe with 5.0 cm diameter. It is connected to the sliding beam and ends with the onyx holder so that the onyx holder can be directed when fixed with the onyx.

-clamping device:

The onyx holder is a wicker-shaped of iron installed on the vibration implant and the other end is also a wicker-shaped of iron connected to the rotating shaft of the vibration implant to be held by the trunk. It is covered with rubber to avoid damage to the tree trunk during the harvesting process.

- The umbrella:

The umbrella consists of two parts, connected to open and close the canopy. Each part is made of 3 skewers installed in iron shears in the form of a half-circle with a diameter of 60 cm from the bottom so that the skewers move up and down. Another semi-circle shears with a diameter of 110 cm are installed on those skewers. The size of the canopy is controlled to match the size of the olive tree.

1.3. The used tractor

Tractor Agro master brand (model TST. 450AC), made in China with a maximum power of 33 kW (45 hp) was used to operate the manufactured olive harvesting machine.

2. Methods

The main experiments were carried out to develop and evaluate the performance of the harvesting machine.

2.1. Fruit removal force to weight ratio (f/w)

The olive is small fruit attached strongly to the limb. As a result, the ratio of removal force to weight (f/w) is high. **Awady et al. (2003)** illustrated that the basic principle involved in removing fruit by shaking is to accelerate each fruit so that the inertia force developed is essential: **F = m . a**

Where: F - The removal force,

m - Fruit mass,

a - The acceleration.

Removal force must be greater than the detachment force between the fruit and the tree stem. Fruit removal force is a function of both vibration amplitude and shaking frequency. So, the adjustment of shaking frequency of the olive harvesting machine is of great importance to providing the force required for removing olive fruits.

2.2. Adjustment of shaking frequency of the olive harvesting machine

Shaking frequency was determined by measuring the cycles/minute of the crank. The frequency was measured directly at crank to avoid measuring errors.

It is desirable to know the optimal frequency or range of frequencies for vibratory fruit removal. Experiments were conducted on olive shaking harvesters to find the relation of shaking frequencies and shaking amplitude on total amount of harvested olive fruits. His results indicated that the total removed olive fruit varied with changing frequency. Low shaking frequency of 10.44 Hz, seems to reduce total removed fruits compared with frequency of 16.15 Hz which was much effective in fruit removal. Raising frequency to 22 Hz slightly decreased the total amount of removed fruit **(El-Attar, 2004)**.

It seems from the previous results that low frequencies (less than 10 Hz), as well as high frequencies (more than 20 Hz), gave bad results concerning removing olive fruits. In the present investigation, frequencies for all tests were set by changing PTO shaft speed which through a set of belt and pulley reducers enables getting frequencies of between 10 and 20 Hz.

2.3. Experimental conditions

The performance of the manufactured olive harvesting machine was experimentally measured under the following parameters:

- Four different PTO shaft speeds (300, 450, 600 and 750 rpm).
- Three different vertical height clamp positions on the tree (0.5, 1.0 and 1.5 m).
- Three different vibration amplitudes (10, 15 and 20 cm).

2.4. Measurements and determinations

The performance of the manufactured olive harvesting machine was evaluated taking into consideration the following indicators:

2.4.1. Machine productivity

Machine productivity was determined using the following equation:

HP = Q/ t

Where: HP - Machine productivity, tree/h,

Q - The harvested olive trees, tree,

t - The time required to harvest an olive tree, h.

2.4.2. Harvesting losses

The harvester losses were determined using the following equation:

$HL = M_{ah} / M_{bh} \times 100$

Where: HL - The harvester losses, %,

M_{ah} - Mass of mature olive left on the tree after harvesting, Mg

M_{bh} - Mass of mature olive on the tree before harvesting, Mg.

2.4.3. Required power

The required power was estimated from the consumed fuel during the harvesting operation using the following formula **(Hunt, 1983):**

$$P = \left[F_c \left(\frac{1}{3600} \right) P_E \times \text{ L.C.V. } \times \eta_{th} \times \eta_m \times \frac{427}{75x\,1.36} \right]$$

Where: P – Required power, kW,

F_c - Fuel consumption, l/h

PE - Density of fuel (kg/l), (for diesel fuel 0.85)

L.C.V - Calorific value of fuel, (10000 kcal/kg)

η_{th} - Thermal efficiency of the engine, (for diesel engine, 35%)

427 - Thermo-mechanical equivalent, (kg. m/kcal)

η_m - Mechanical efficiency of an engine, (for diesel engine, 85%).

During the operation, fuel consumption was determined by measuring the fuel required to refill the fuel tank after the working period using a graduated glass cylinder.

2.4.4. Specific energy

Specific energy can be calculated using the following formula:

SE = P / HP

Where: SE – Specific energy, kW.h/tree

2.4.5. Operational cost

The manufactured machine hourly cost (HC) was calculated according to the conventional method of estimating both fixed and variable costs.

The hourly cost (L.E/h) = fixed cost (L.E/h) + variable cost (L.E/h)

The operational cost per tree was determined using the following equation:

OC/tree = HC / HP

Where: OC/tree – Operational cost per tree, L.E./tree

As one feddan contains 109 trees, so the operational cost per feddan can be determined as follows:

OC/feddan = OC/tree × 109

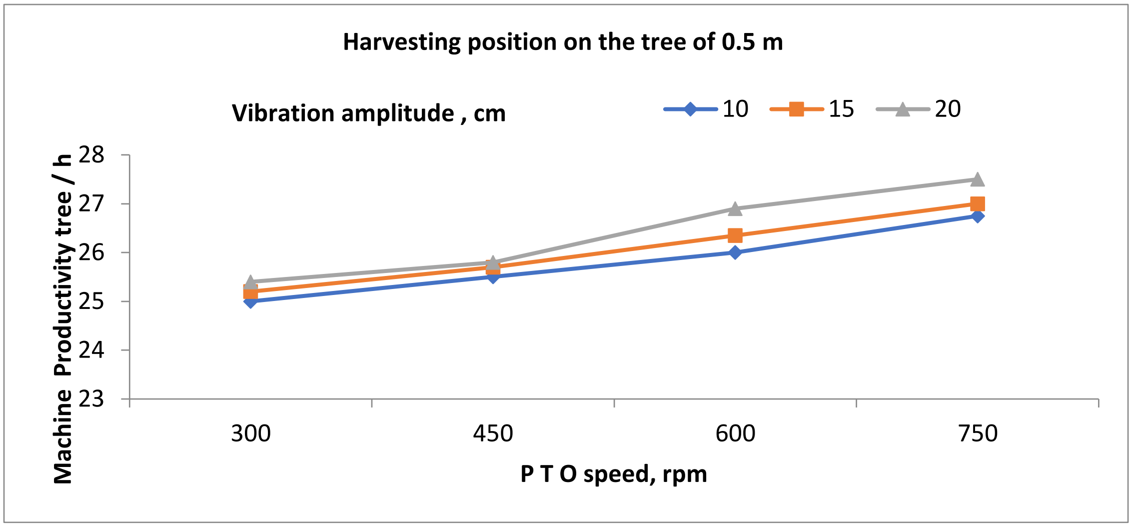
RESULTS

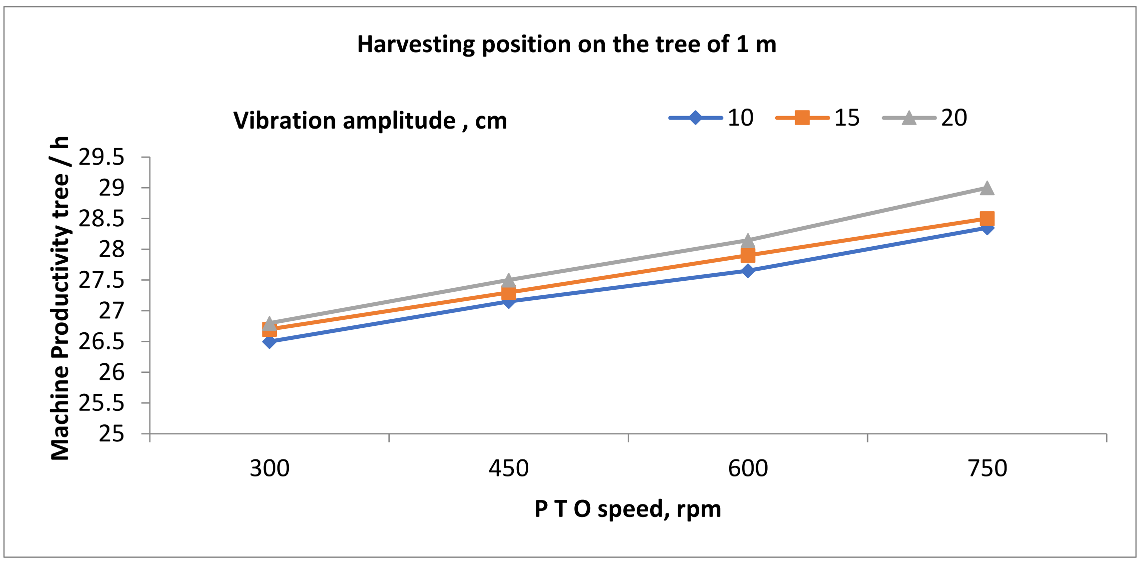
The results of the present research will cover the effects of the studied parameters (PTO speed, vertical height clamp position on the tree and vibration amplitude) on the olive harvesting machine performance in terms of harvester productivity, harvesting losses, specific energy and operational cost**.**

Representative values of harvester productivity versus PTO speed are given for the three vibration amplitudes through various harvesting positions on the tree in Fig. 2. While the effect of PTO speed for the three vibration amplitudes through various harvesting positions on the harvesting losses is represented in Fig. 3.

The specific energy is affected by the required power as shown in Fig. 4 which in turn affected by both PTO shaft speed and vibration amplitude under any vertical height clamp position as shown in Fig. 5.

The tractor capital cost added to the cost of manufacturing the olive harvesting machine was 67000 LE according to the year of 2019 price level. Table (2) recorded a complete cost analysis to enable calculating the hourly cost for both the used tractor and the manufactured olive harvesting machine. While Fig. 6 illustrates the values of the operational cost per feddan required to operate the manufactured machine at different PTO shaft speeds and different vibration amplitudes under any vertical height clamp position.





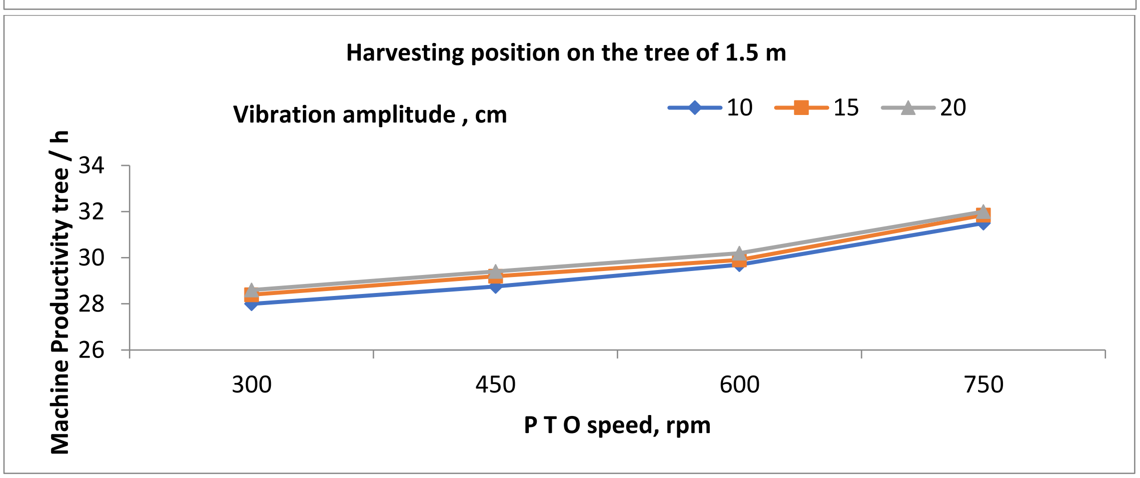


Fig .2: Effect of PTO shaft speed and vibration amplitude on machine productivity under different vertical height clamp positions on the tree.

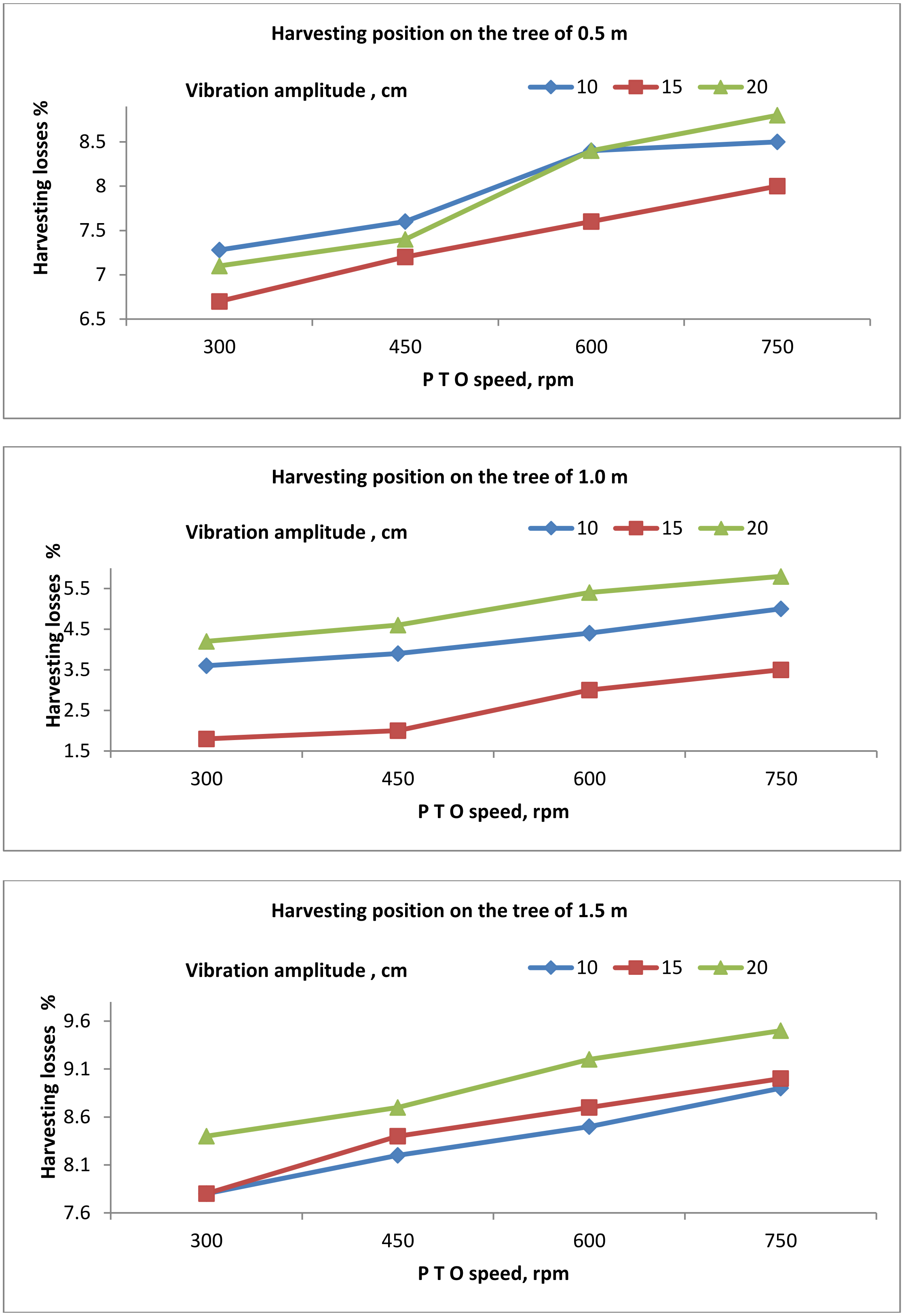


Fig. 3: Effect of PTO shaft speed and vibration amplitude on harvesting losses under different vertical height clamp positions on the tree

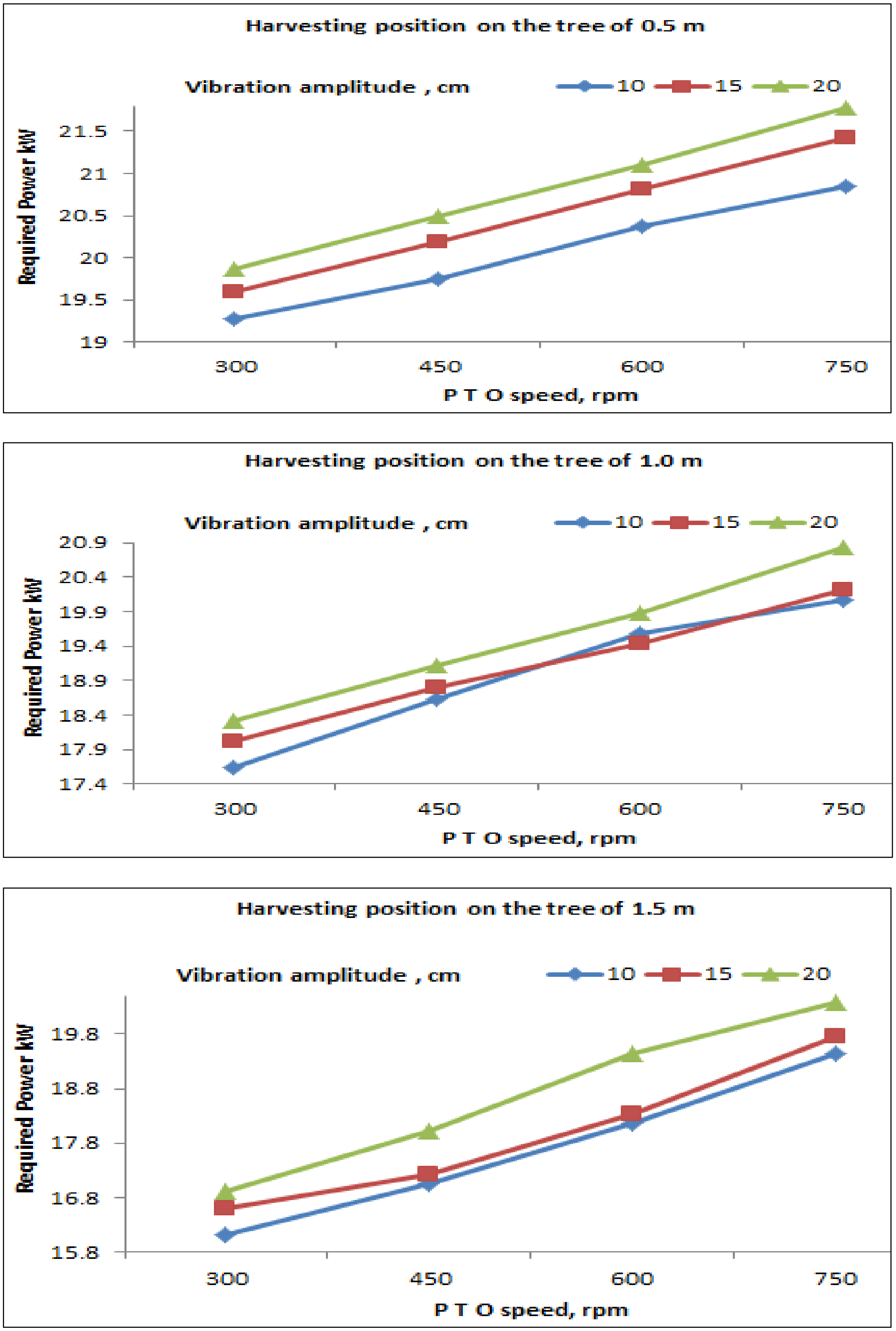


Fig. 4: Effect of PTO shaft speed and vibration amplitude on the required power under different vertical height clamp positions on the tree

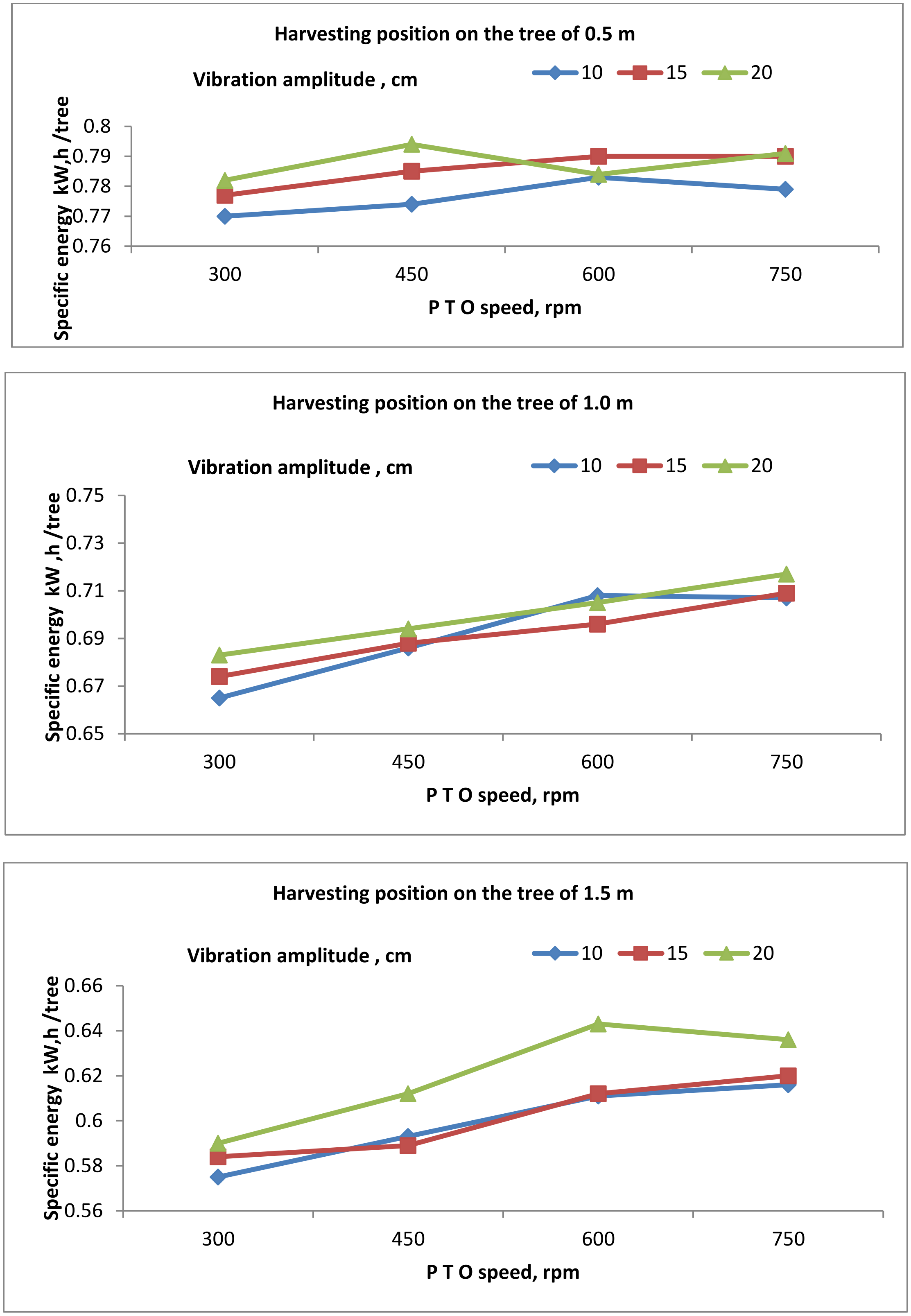


Fig. 5: Effect of PTO shaft speed and vibration amplitude on the specific energy under different vertical height clamp positions on the tree

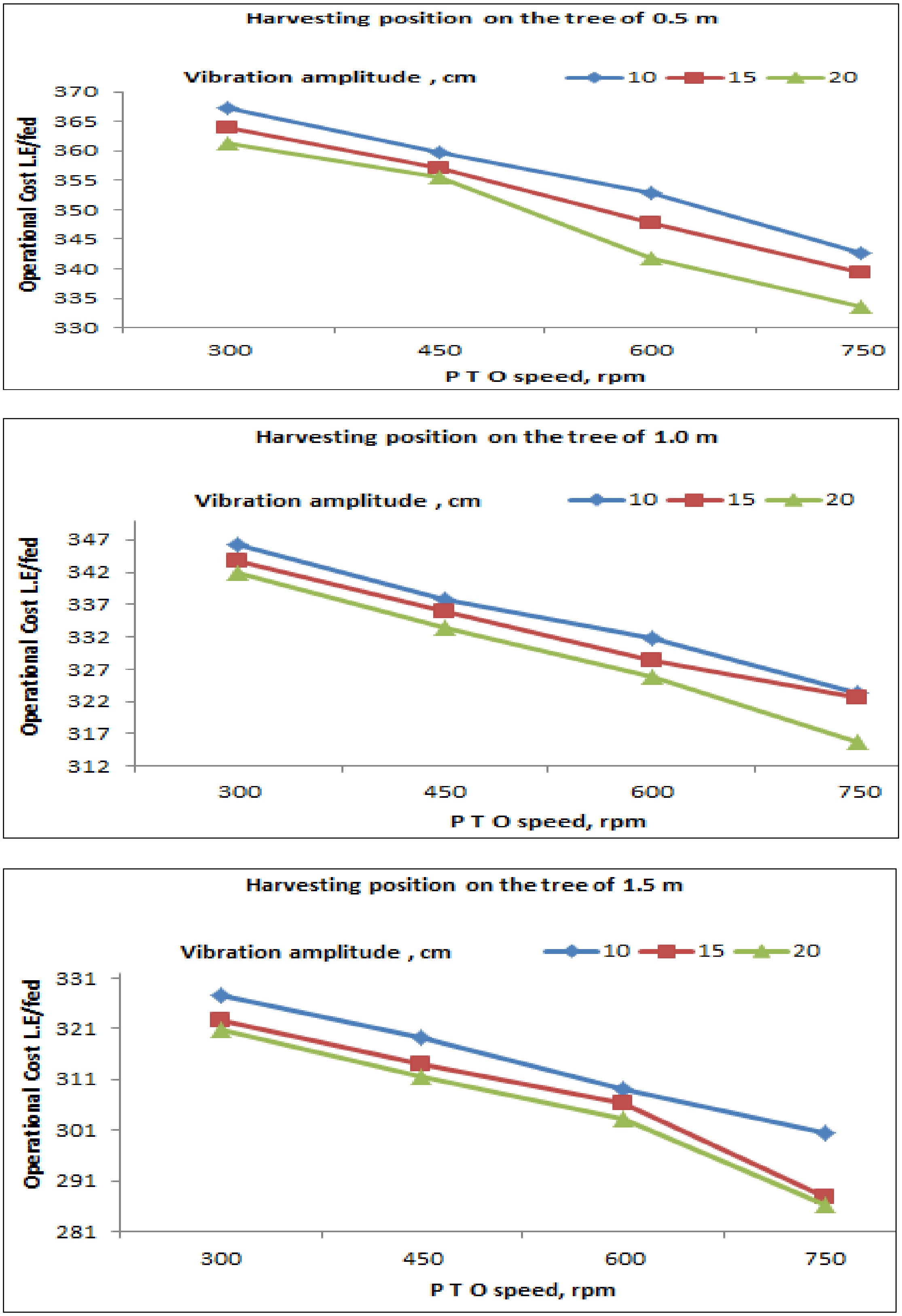


Fig. 6: Effect of PTO shaft speed and vibration amplitude on operational cost under different vertical height clamp positions on the tree

Table (2): Cost analysis of different equipment.

The Equipment	capital investment, L.E.	Yearly operational hours	Expected life, year	Interest rate, %	Taxes and over head, %	Repair and maintenance, %	Engine power, hp	Specific fuel consumption, L/hp.h	Price of fuel, L.E. L.E/H	Hourly cost L.E./h
The olive harvesting machine	7000	500	8	15	5	6	-	-	-	13.46
Tractor TST. 450AC	60000	1000	10	15	5	10	45	0.111	6.75	70.97

DISCUSSION

The discussion will cover the obtained results under the following heads:

1. Effect of some operating parameters on machine productivity

Results in Fig. (2) show that the machine productivity reached its maximum value of 32 tree/h using PTO speed of 750 rpm, vibration amplitude of 20 cm and vertical height clamp position on the tree of 1.5 m. While minimum value of 25 tree/h were found using PTO speed of 300 rpm, vibration amplitude of 10 cm and vertical height clamp position on the tree of 0.5 m.

Increasing PTO speed from 300 to 750 rpm, and using vibration amplitudes of 10, 15 and 20 cm, increased productivity from 25 to 26.7, from 25.2 to 27.0 and from 25.4 to 27.5 tree/h, respectively at constant vertical height clamp position of 0.5 m. While the increased of productivity were from 26.5 to 28.35, from 26.7 to 28.5 and from 26.8 to 29.0 tree/h using vertical height clamp position of 1.0 m. Also, productivity increased from 28 to 31.5, from 28.4 to 31.85 and from 28.6 to 32.0 tree/h using vertical height clamp position of 1.5 m, under the same previous conditions.

The previous data show that increasing PTO speed, increased machine productivity that is may be due to that the increase of the PTO speed increased the effect of shaking, which decreased time required for harvesting results in an increase in machine productivity that tends to improve the machine performance. Also, increasing vibration amplitude increased machine productivity that is may be due to increasing the kinetic energy of shaking which decreased time required for the harvesting operation. In addition, increasing vertical height clamp position on the tree increased machine productivity that is may be due to expanding of vibration all over the olive tree as a result reduced time required for harvesting that tends to increase machine productivity. These results agreed with Vieri (2002) who recorded shaker efficiency equipped with a circular conical canopy for collecting fruit and reported 90% of the fruits were harvested at a rate of 27 trees/h.

2. Effect of some operating parameters on harvesting losses

The obtained data in Fig. (3) show that the harvesting losses reached its maximum value of 9.5 % using PTO shaft speed of 750 rpm, vibration amplitude of 20 cm and vertical height clamp position of 1.5 m. While minimum value of 2 % was found using PTO shaft speed of 300 rpm, vibration amplitude of 15 cm and vertical height clamp position of 1.0 m.

Increasing PTO shaft speed from 300 to 750 rpm, increased losses from 7.28 to 8.5, from 6.7 to 8.0 and from 7.1 to 8.8 % under vibration amplitudes of 10, 15 and 20 cm, respectively at constant vertical height clamp position of 0.5 m, while increased losses from 3.6 to 5.0, from 1.8 to 3.5 and from 4.2 to 5.8 % at constant vertical height clamp position of 1.0 m. Also, losses increased from 7.6 to 8.9, from 7.8 to 9.0 and from 8.4 to 9.5 % at constant vertical height clamp position of 1.5 m under the same previous conditions.

The previous data show that increasing PTO speed, increased harvesting losses because PTO speed increased the effect of shaking, which increased impact force between olive fruits that injured them, resulting in more losses. Results also show that vibration amplitude of 10 cm increased harvesting losses because 10 cm is not sufficient to shake the olive tree, as a result most of olive fruits did not fall from the tree. Also, vibration amplitude of 20 cm increased harvesting losses because 20 cm caused high vibration and high shaking force that injured olive fruits resulting in more losses. Meanwhile, data show that increasing vertical height clamp position from 0.5 to 1.0 m decreased harvesting losses because harvesting at 0.5 m did not generate the required shaking force for harvesting. Any further increase in vertical height clamp position more than 1.0 up to 1.5 m increased harvesting losses that is may be due to the high shaking force applied on the olive tree and expanding of vibration all over the olive tree as a result, most of olive fruits injured causing more losses.

3. Effect of some operating parameters on the specific energy

Results in Fig. (6) show that the specific energy reached its maximum value of 0.791kW.h/tree under PTO shaft speed of 750 rpm, vibration amplitude of 20 cm and vertical height clamp position of 0.5 m. While minimum value of 0.575 kW.h/tree was found under PTO shaft speed of 300 rpm, vibration amplitude of 10 cm and vertical height clamp position of 1.5 m.

Increasing PTO shaft speed from 300 to 750 rpm, Increased specific energy from 0.770 to 0.779, from 0.777 to 0.790 and from 0.782 to 0.791 kW.h/tree under vibration amplitudes of 10, 15 and 20 cm, respectively at constant vertical height clamp position of 0.5 m. While increased energy from 0.665 to 0.707, from.0.674 to 0.709 and from 0.683 to 0.717 kW.h/tree at constant vertical height clamp position of 1.0 m. Also, energy increased from 0.575 to 0.616, from 0.584 to 0.620 and from 0.590 to 0.636 kW.h/tree at constant vertical height clamp position of 1.5 m under the same previous conditions.

Increasing PTO shaft speed, vibration amplitude and vertical height clamp position increased specific energy because the rate of increase in required power under the all mentioned parameters is higher than the increase in machine productivity resulting in energy increase.

4. Effect of some operating parameters on the operational cost

Results in Fig. (6) show that the operational cost reached its maximum value of 367.27 L.E./fed under PTO shaft speed of 300 rpm, vibration amplitude of 10 cm and vertical height clamp position of 1.5 m. While minimum value of 286.21 L.E./fed was found under PTO shaft speed of 750 rpm, vibration amplitude of 20 cm and vertical height clamp position of 0.5 m.

Increasing PTO shaft speed from 300 to 750 rpm, decreased operational cost from 327.58 to 300.57, from 322.53 to 287.90 and from 320.83 to 286.21 L.E./fed under vibration amplitudes of 10, 15 and 20 cm, respectively at constant vertical height clamp position of 0.5 m. While decreased operational cost from 346.16 to 323.36, from 343.64 to 322.52 and from 341.94 to 315.76 L.E./fed at constant vertical height clamp position of 1.0 m. Also, operational cost decreased from 367.27 to 342.78, from 363.89 to 339.40 and from 361.36 to 333.49 L.E./fed at constant vertical height clamp position of 1.5 m under the same previous conditions.

Increasing PTO shaft speed, vibration amplitude and vertical height clamp position decreased operational cost that is may be due to the increase in machine productivity under the all-mentioned parameters. This is in agreement with Alzoheiry, et al. (2020) who stated that the good performance of olive mechanical harvesting by shaking depends on the suitable values of vibrator operating parameters (frequency and amplitude).

CONCLUSION

The main objective of the present investigation was to manufacture and evaluate the performance of a local tractor-mounted machine from local material to be used for harvesting olive. The experimental results revealed that harvester productivity (26.7 tree/h), harvesting losses (1.8 %), specific energy (0.674 kW.h/tree) and operational cost (343.64 L.E./fed (3.152 L.E./tree)) were in the optimum region under the following conditions:

- Using the local manufactured machine for harvesting olive fruits.
- Adjusting the manufactured olive harvesting machine at 300 rpm PTO shaft speed, 15 cm vibration amplitude and 1.0 m vertical height clamp position on the tree.

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الملخص العربي

تصنيع وتقييم أداء آلة معلقة على الجرار لحصاد الزيتون

محمد مراد[1] وجمال الترمذى[2]

1 قسم الهندسة الزراعية - كلية الزراعة – جامعة الزقازيق

2 معهد بحوث الهندسة الزراعية – مركز البحوث الزراعية

اجريت هذة الدراسة خلال موسم الحصاد الزراعى لعام 2019 م فى مزرعة محطة بحوث القصاصين بمحافظة الأسماعيلية حيث تم تصنيع وتطوير الة معلقة على الجرار لتناسب حصاد الزيتون من نوع بيكوال 0

و كانت اهداف الدراسة كالاتى :

تطوير الة الحصاد المعلقة على الجرارلحصاد الزيتون و ذلك بواسطة زراع الاهتزاز الذى ينتهى بماسك مغطى بالكاوتش للامساك بالشجرة لعدم تجريح جذع الشجرة ،الكمرة المنذلقة التى تاخذ حركتها من زراع التوصيل المتصل بكرنك الالة وكرنك الالة.وكذلك يتم التحكم فى ارتفاع و انخفاض زراع الاهتزاز بواسطة بستم هيدروليكى ، المظلة تتصل بشاسية الألة وهى عبارة عن جذئين متصلين ببعضهم بشكل مفصلى لفتح او غلق المظلة بحيث يتم التحكم فى قطر المظلة لتتناسب مع حجم شجرة الزيتون 0

وقد تم اختبار أداء الآلة تحت عوامل الدراسة الآتية:

1- أربع سرعات لعمود ال P.T.O (300-450 -600 -750 لفة/دقيقة)0
2- ثلاث سعات مختلفة للكمرة المنزلقة (10 – 15 - 20 سم)0
3- ثلاث ارتفاعات للإ مساك بجزع الشجرة (0.5 –.1 – 1.5م)0

ومن النتائج المتحصل عليها يمكن التوصية بما يلى:

- إستخدام آلة الحصاد المطورة أدى الى تقليل وقت الحصاد وزيادة معدل الأداء وتقليل فاقد وتكاليف حصاد المحصول.
- كانت انسب الظروف لتشغيل الة الحصاد محصول الزيتون عند سرعة 300P.T.O لفة / دقيقة وسعة الكمرة المنذلقة 15سم و نقطة التعليق 1م على جذع الشجرة حيث أعطت اقل فواقد 1,8% واقل طاقة مستهلكة 0.674 كيلووات0ساعة / شجرة. واقل تكاليف 343.64 جنيه / فدان (251, 3) جنية للشجرة حيث ان تكاليف الحصاد اليدوى تصل الى 3600 جنية / فدان.

الكلمات المفتاحية: الزيتون، الإنتاجية، الخسائر، سعة الاهتزاز، موضع المشبك.