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Study the Physical and Mechanical Properties affecting on Date Palm Tree Mechanical Serves

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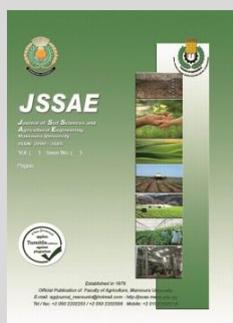
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ABSTRACT

This research aims to studying the physical and mechanical properties affecting the palm tree mechanical serves. Data of five farms in Giza, Ismailia, Wahat and The new Valley. Results indicated that the average height of the trunk was 12, 15, 3, 4 and 5 m for Giza (Amhaat), Ismailia (Hayani), Wahat El Bahariya (farms 3 (Sewi) and 4 (Magdool)) and Farafra (Sewi) farms respectively. The approximate diameter of the trunk ranged from 60 to 90 cm. The preparation time was 2 – 4 (Traditional climbing), 8 – 12 (Multi trees climber), 10 – 15 (Hydraulic scissor) and 6 – 10 (Long ladders) min/palm tree for traditional climbing, multi trees climber, hydraulic scissor and long ladders respectively. The time of servicing was 10 – 25, 15 – 30, 15 – 30 and 20 – 35 min/palm tree for traditional climbing, multi trees climber, hydraulic scissor and long ladders respectively. The total operation time was 12 – 29, 23 – 42, 25 – 45 and 26 – 45 min/one palm for traditional climbing, multi trees climber, hydraulic scissor and long ladders respectively. The efficiency was 83 – 86, 65 – 71, 60 – 66 and 76 – 78 % for traditional climbing, multi trees climber, hydraulic scissor and long ladders respectively. The productivity ranged from 0.25 to 0.5 and from 0.3 to 0.75 hour/palm tree by using the traditional climbing and the multi trees climber respectively. While it ranged from 0.5 to 0.75 hour/tree when using the hydraulic scissor and the long ladder. The total cost of servicing the palm was 15 – 25, 20 – 40, 25 – 40 and 25 – 40 LE/tree for traditional climbing, multi trees climber, hydraulic scissor and long ladders respectively.

Keywords: Palm tree service equipment, Climbing palm trees, Long ladders, Hydraulic scissor, Multi trees climbing.



INTRODUCTION

Egypt is at the second place in the world concerning the production of dates. The total number of productive date palms is of nearly 7 million. Date palms are present in all the places where irrigated agriculture is possible. By the way, Date palm tree requires particular care process, such as thinning, pruning, de-thorning, clusters arrangement, pollination, spraying, and positioning of anti-breakage-supports, covering and, finally harvesting and bagging. All these operations are still carried out manually at the most of farms, which requires a lot of time and cost, as well the danger of palm climbing. Palm properties as possible for use in date palm mechanization are age, tree height, crown height, trunk diameter, distribution in the field and also cutting resistance of the leaves. The trunk is clothed from the ground up with upward-pointing, overlapping, persistent, woody leaf bases (Figure 1). The feather-like leaves, up to 6 m long, are composed of a spiny petiole, a stout midrib, and slender, gray-green or bluish-green pinnate 20 to 40 cm long, and folded in half lengthwise. Each leaf emerges from a sheath that splits into a network of fibers remaining at the leaf base. Small fragrant flowers (the female whitish, the male waxy and cream colored), are borne on 25 to 150 strands 30 to 75 cm long on female plants, and only 15 to 22 cm long on male plants. One large bunch of flowers may embrace 6,000 to 10,000 flowers^[5].

The growth habit of palms is a cylindrical, no branching stem, and relatively tall trunk. The date palm tree commonly grows to a height of about 10 to 15m and features a slender trunk of more or less constant diameter from the base to the crown. Knowledge of date palm characteristics is necessary for mechanization date palm tree. Any new harvester machine must be able to reach the average height of palm of 10.5 m. Moreover, it must be able to carry a maximum payload of around 1100-1300N and have a length less than 3 m. Fig (2) shows the variable methods of climbing palm trees for servicing and harvesting. For palm date services, the belt is very cheap and can be used in every farm. The belt also is strong, healthy, and trained workers are required. The use of the belt for climbing the palm date tree was classified as dangerous. The date palm service machine is very expensive needs more than one worker. The service machine is stable and safe but Not suitable to all farms. Traditional palm tree climbing techniques, workers have to apply tiring and risky techniques to reach the top of the trunks. A self-moved ladder, consisting of 15 m extendable sliding ladder mounted on a mini tracked dumper has been developed. Operating this equipment is simple and requires no effort for the worker who can then climb the trunk up to a height of 15 m tacking advantage of all the security accessories developed for ladder borne operations.

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Shamsi and Mazloumzadeh (2009) conducted to find some important physical and mechanical properties of date palm trees to be applicable in mechanization of date palm cultural operations industry. And resulted that the longitudinal tensile strength and longitudinal compressive strength are 60 and 5.34 MPa respectively. It was also indicated that the radial compressive strength is 2.96 MPa and longitudinal shear strength is 1.10 MPa. the tree leaf base radial compressive strength is 6.38 MPa and the longitudinal leaf base shear strength is 1.00 MPa. Ahmed and Francisco (2014) developed model of cluster dates harvesting machine. The machine includes four components: stabilizing platform, lifting device, lowering device and cutting device, can be carried around manually and fixed at the base of any palm trunk and used to cut and lower whole clusters without having to climb the palm. Shivarama and Arunachalam (2014) discusses the biomechanisms and kinetics of foot adaptation to the rigors of climbers and analysis the cause of accidental falls, even though most of the accidental fall victims have had a number of years of climbing experience. Statistical Crop Area and Plant Production 2020 Total area of Palm crop reached 113.2 thousand feddan in 2017/2018 compared to 119.7 thousand feddan in 2016/2017 a decrease of 5.4% and the production reached 1.6 million tons in 2017/2018 compared to 1.5 million tons in 2016/2017, an increase of 1.4%. Fruitful Palm reached 14.1 million Fruitful Palm in 2017/2018 compared to 13.6 million Fruitful Palm in 2016/2017 an increase of 3.4% Giza governorate occupied the first rank, where production reached 225.3 thousand tons a rate of 14.4%. Khaled (2016) designing a robot to climb date palm trees to perform some operations. the a robot has been designed to climb the tree and carry out some tasks such as spraying insecticides or picking dates. Moustafa (2005) developing and testing tractor-mounted date palm

tree service machine. And compared this system with the traditional way of serving palm trees, where a worker climbs the tree using a piece of rope, the system provides a safer and more comfortable working environment. The developed system was tested in the field and compared with manual traditional practices. And found out that using the developed device increases worker's productivity. Salice *et al* (2015) designing a tree climbing robot. The mechanical structure is designed to move the structure upwards against the gravitational forces in successive upper body and lower body movements similar to a tree climber. The gripping is designed in a way to dig the upper or lower part of the structure in to the tree facilitating the upward movement. The results show that it can successfully climb the trees. Tree climbing robot has the potential to be applied to various pursuits, such as harvesting, and tree maintenance.

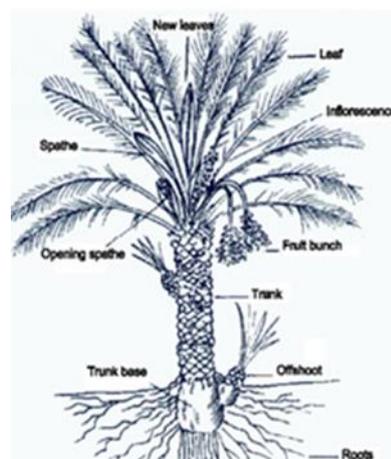


Fig (1) The annual cycle of the date palm (Barrevel, 1993).



Fig 2. Various methods of climbing for servicing and harvesting palm date.

The lack of properly designed, economically operated palm date servicing/harvesting machine force the farmers to skip many of necessary activities that result in poor production, insect infected, poor quality, poor nutrition, contaminated and not profitable date production. So that the aims of this study is to studying the physical and mechanical properties affecting the palm tree mechanical serves.

MATERIALS AND METHODS

The activities of data collection included:

I-Survey of date palm field conditions:

- Palm trees farm size and soil conditions.
- Farm age.

- Irrigation systems
- Planting distances and trees layout
- In-farm road conditions.
- Other constraints related to the crops may be planted in the soil of the palm date farm.

II- Study palm trees and trunk physical and characteristics related to climbing and servicing: The study may include the following:

- Trunk height
- Trunk diameter.
- Trunk steps and climbing conditions.
- Palm tree trunk curvature and tilt orientation.
- Trunk elongation rate, cm/year.

III- Performance of palm trees servicing methods and technology. The items of performance may include:

- Availability of labor and technology.
- Labor exhaustible level.
- Labor productivity.
- Operation cost.

Description of tools used in traditional climbing:

Traditional methods used to climb up the trunk of palm trees are self-belayed climbing with a doubled-rope technique, single-rope technique, belt straps (Fig.2,3 and 4) or long ladders. date palm workers climb up and down by lapping a long rope or straps over a limb and ascending the fallen end using a friction knot. So that it is in the form of a closed-loop between the climber and the tree trunk. By using hands and legs the climber can move upward and down.



Fig. 3. Date palm tree pruning



Fig. 4. Traditional climbing

Description of the multi trees climbing system:

Fig. (5) shows the multi trees climber during the operation. The multi trees climber has a seating provision. There are two metallic frames, one upper and one lower used for climbing up and down. This climber is operated

manually by hands and feet. The upper frame is operated by hand while the lower one is operated by the leg.

Hydraulic lifting equipment:

It is lifting equipment not specially designed to serve palm trees. Their operation efficiency depends on the field conditions of the farm Fig. (6).



Fig. 5. Multi trees climber



Fig. 6. Self- propelled lift.

RESULTS AND DISCUSSIONS

I. Survey of date palm field conditions:

Data collected from five commercial date palm farms. It was classified and arranged as indicated in Table (1). It show that the irrigation method on the Giza and Ismailia farms was surface irrigation, while the irrigation method at the Wahat El Bahariya and Farafra farms was drip irrigation. Ages of farms varying where they are 15, 35, 6, 7 and 8 for Giza, Ismailia, Wahat El Bahariya (farms 3 and 4) and Farafra farms respectively. Farms produce different date varieties, which are Amhaat, Hayani, Sewi and Magdool. On the Giza farm, palm trees were planted randomly, while on the Ismailia farm, palm trees were planted on rectangular corners 8×7 . In the rest of the farms, palm trees were planted on square

corners 8 × 8. In Giza and Ismailia farms. Roads between the rows of trees are considered unpaved, while the roads were unpaved in the rest of the farms. Date productivity was 200-250, 150-200, 80-100 and 100-110 kg/one palm for Giza, Ismailia, Wahat El Bahariya (farms 3 and 4) and Farafra farms respectively. Also, it can be notes that the suitable method of serving the date palm tree should be more durable, easy in carrying and mutative in motion and suite the field conditions due to the varying in irrigation method, date palm tree ages, roads cases, planting distances, tree productivity, and tillering rate of trunk elongation annually.

Table 1. Survey of date palm field conditions.

Item	Farm 1	Farm 2	Farm 3	Farm 4	Farm 5
Location	Giza	Ismailia	Wahat El Bahariya		The new Valley Elfarafra
Irrigation method	Surface irrigation		Drip irrigation		
Age, year	15	35	6	7	8
Variety	Amhaat	Hayani	Sewi	Magdool	Sewi
Planting distances	Random planting	Rectangle 8 × 7 m.	Square 8 × 8 m		
In-farm road conditions	There are no roads inside the farm	Unpaved roads	Paved roads	Good roads inside the farm	
Roads between rows	No roads	Flat-land planted	Flat-land. Not level		
Temporary crop single palm (Kg/one palm)	200-250	150-200	80-100	100-110	

Table 3. Performance of palm trees servicing methods and technology.

Evaluation criteria	Traditional climbing	Multi trees climber	Hydraulic scissor	Long ladders
Availability of professional persons.	Workers are available on farm 1, workers scarce in the rest of the farms.	Farm 1 begins to use it and train the workers	Limited producers trying to use it	It is used in farms 3, 4 and 5, for short trees.
Preparation Time (min/one palm)	2 – 4	8 – 12	10 – 15	6 – 10
Time of servicing (min/one palm) (Variable according to the operation)	10 – 25	15 – 30	15 – 30	20 – 35
Total operation time (min/one palm) (Variable according to the operation)	12 – 29	23 – 42	25 – 45	26 – 45
Efficiency, (%) (Variable according to the operation)	83 – 86	65 – 71	60 – 66	76 - 78
Harvested bunch handling.	Using a circular cloth around the tree to collect the falling bunches.	Possible to lowering bunches by rope.	Includes a basket.	By rope
Effect of trunk surface conditions	Good steps are necessary	There is an effect	No effect	
Maximum height to climb.	May be safe up to 12 m according to the tree's surface conditions.		Up to 7 m.	Up to 6 m.
Limits of save operation.	Safe up to 12 m. If the palm tree trunk surface has good steps.	Fair safety up to 8 m. If the parts are not heavy and the design is flexible	Safe if the flat soil and compacted. Limited to 7 m high.	Safe if the ladder base is firmly fixed on the ground. Limited to 5 m.
Productivity, hour/tree (Variable according to the operation)	0.25 – 0.5	0.3 – 0.75	0.5 – 0.75	0.5 – 0.75
Labor exhaustible.	High exhaustible		Low exhaustible	
Applicability.	The most practical and applicable method		Low applicable	Poor applicable
The total cost of servicing the palm LE/tree.	15 – 25	20 – 40	25 – 40	25 – 40

The operation cost is estimated for the labor wage only & 50 LE/operation hours

The results showed that the availability of professional persons, who are able to use traditional climbing of palm trees in the Giza farm and workers scarce

Palm trees physical characteristics related to climbing operation:

The results of physical characteristics of palm trees related to climbing and service operations are summarized in Table (2). The rate of trunk elongation ranged from 40 to 60 cm/year. The average heights of the trunk were 12, 15, 3, 4 and 5 m for Giza, Ismailia, Wahat El Bahariya (farms 3 and 4) and Farafra farms respectively. The approximate diameter of the trunk ranged from 60 to 90 cm. The data showed that in Giza and Ismailia farms, trunk steps and climbing conditions were no good steps in the lower part of the trunk, while it was good steps for labor climbing in the rest of the farms.

Table 2. Physical characteristics related to the climbing operation.

Item	Farm 1	Farm 2	Farm3	Farm4	Farm5
Rate of trunk elongation cm/year	40	50	60	60	60
Trunk height, m	12	15	3	4	5
Approximate diameter, m	0.8	0.8	0.9	0.6	0.9
Trunk curvature	There is a curvature			No	
Trunk steps and climbing conditions.	No good steps in the lower 3m of the trunk	No good steps in the lower part of the trunk	Good steps	Good steps for labor climbing	

II. Performance of palm trees servicing methods and technology:

Summary of the results obtained for the performance of palm tree servicing methods and technology are shown in Table (3).

in the rest of the farms. The results indicated that the Giza farm begins to use it and train the workers on using the multi trees climber. It is clear that the preparation time varies

according to each method and the area around each palm. The preparation time was 2 – 4, 8 – 12, 10 – 15 and 6 – 10 min/one palm for traditional climbing, multi trees climber, hydraulic scissor and long ladders respectively. The time of servicing varies according to the type of operation required for the palm tree (pruning, harvesting, etc.). Also, the time of servicing depends on the condition of each palm tree and how comfortable the worker is to perform the task. The time of servicing was 10 – 25, 15 – 30 and 20 – 35 min/one palm for traditional climbing, (multi trees climber, hydraulic scissor) and long ladders respectively. The total operation time is the time required to prepare the climbing technique plus the service operation time. The total operation time was 12 – 29, 23 – 42, 25 – 45 and 26 – 45 min/one palm for traditional climbing, multi trees climber, hydraulic scissor and long ladders respectively. Based on the time lost in preparing the climbing technique, the efficiency were 83 – 86, 65 – 71, 60 – 66 and 76–78% for traditional climbing, multi trees climber, hydraulic scissor and long ladders respectively. Harvested bunch handling varies according to the technology used.

When using traditional climbing is used a circular cloth around the tree on the ground to collect the falling dates bunches. Either in the case of use multi trees climber or long ladders, there is a possibility of lowering dates bunches by rope. The hydraulic scissor has a basket of 65 × 90 × 100cm the dates bunches are collected in it. The results showed that the trunk surface conditions had a significant effect on climbing performance by the traditional method and multi trees climber. While the performance of hydraulic scissor or long ladders are not affected by the trunk surface conditions. Maximum height to climb by using the traditional method and multi trees climber may be safe up to 12 m according to the trees surface conditions. While it is may up to 7 m when using the other methods. As for the safety level, using the traditional method is safe up to 12 m if the palm tree surface has good steps and clever healthy labor. In the case of other methods, the level of safety depends on other factors, such as machine balance, careful, the flat and compacted soil. Using the multi trees climber gives a fair safety up to 8 m high If the parts are not heavy and the design is flexible. But using the hydraulic scissor and the long ladder give up to 7 and 5 m high respectively. Also, these results indicated that the Operation time ranged from 0.25 to 0.5 and from 0.3 to 0.75 hour/tree by using the traditional climbing and the multi trees climber respectively. While it ranged from 0.5 to 0.75 hour/tree when using the hydraulic scissor and the long ladder. Using the traditional climbing and the multi trees climber was high exhaustible but using hydraulic scissor and the long ladder was low exhaustible. These results showed that traditional climbing was the most practical and applicable method compared to other methods. The operation cost is estimated for the labor wage only. The total cost of servicing the palm was recorded 15 – 25, 20 – 40, 25 – 40 and 25 – 40 LE/tree for traditional climbing, multi trees climber, hydraulic scissor and long ladders respectively.

Finally, the traditional climbing is the prevailing method for various purposes of palm trees servicing. Traditional climbing using the robe is fast and easy. The owner of the farm should maintain good conditions of the palm tree trunk for easy and safe climbing. In case of date

palm trees of heights over 12 m, only clever labors should limb it by rob.

The multi trees climber was developed for trees of smooth trunk surface and many of farmers try to use it for date palm trees. The climber is exhaustible and consume longer time to adjust its situation before start climbing. The labor get exhausted because he has to pull up the lower frame by his leg.

It will be difficult for any to use the climber for trees of heights over 8 m. The hydraulic scissor equipped with a plate farm for palm date servicing is a unique unit found to be used by an Egyptian farms. It may be really to find the trees sulfated to be served by such machine. The tree trunk has to be up right standing. The trunk has to be uniform in diameter and of smooth surface. The soil on which the machine stand has to be level and compacted. And the base of the tree has to be free from tillers and problems and the trunk has to be free from curvatures.

The conventional ladder also face araney problems because of the probability of sliding its upper end around the trunk as its lower end on the soil in addition to its limited reach that may not exceed 6 m.

CONCLUSION

- Date palm farms condition are variable and in must cases is not suitable for machines that may be used for palm trees services.
- Date palm trees characteristics has significant influence on the method of production services specially mechanical methods.
- Traditional method of servicing palm trees still considered the easiest and fast method. Traditional climbing of palm trees for servicing purpose was estimated as the most efficient method.
- Other mechanical climbing methods such as hydraulic scissor Or long ladders may be considered of low efficiency and not suitable for most of trees conditions.
- Multi trees climber is exhaustible most of the farmers try the multi trees climber avoid using it again.
- Tends to design and developing asmall machine to serve the date plam tree easiest in use and covering the deferent physical and mechanical date palm tree properties and field methods.

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دراسة الخصائص الطبيعية والميكانيكية وتأثيرها على خدمة نخيل البلح

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يهدف هذا البحث إلى دراسة خصائص أشجار النخيل والتكنولوجيا المتاحة لصعود النخيل بهدف خدمة أشجار النخيل. تم جمع البيانات من خمس مزارع نخيل تجارية هي مزرعة الجيزة والإسماعيلية ومزرعتين بالوحدات البحرية ومزرعة الفرافرة بالوادي الجديد. أظهرت النتائج أن معدل استئالة الجذع تراوح من 40 إلى 60 سم/سنة. متوسط ارتفاع الجذع بلغ 12 ، 15 ، 3 ، 4 ، 5 متر في مزرعة الجيزة ، الإسماعيلية ، الوحدات البحرية (المزارع 3 و 4) ومزارع الفرافرة على التوالي. وقد تراوح القطر التقريبي لجذع النخلة من 60 إلى 90 سم. كما أظهرت النتائج أن وقت إعداد وتجهيز وسائل التسلق 2 - 4 ، 8 - 12 ، 10 - 15 و 6 - 10 دقيقة / نخلة واحدة للتسلق التقليدي ، متسلق الأشجار المتعددة ، المقص الهيدروليكي والسلالم الطويلة على التوالي. اختلف زمن أداء الخدمة على حسب نوعها حيث كان 10-25 و 15-30 و 20-35 دقيقة/ نخلة واحدة للتسلق التقليدي (المتسلق متعدد الأشجار ، المقص الهيدروليكي) والسلالم الطويلة على التوالي. وكان إجمالي وقت التشغيل 12 - 29 ، 23 - 42 ، 25 - 45 و 26 - 45 دقيقة / نخلة واحدة للتسلق التقليدي ، متسلق الأشجار المتعددة ، المقص الهيدروليكي والسلالم الطويلة على التوالي. وقد كانت الكفاءة 83 - 86 ، 65 - 71 ، 60 - 66 و 76 - 78٪ للتسلق التقليدي ، متسلق الأشجار المتعددة ، المقص الهيدروليكي والسلالم الطويلة على التوالي. أقصى ارتفاع للتسلق باستخدام الطريقة التقليدية ومتسلق الأشجار المتعددة قد يكون أمناً حتى 12 متراً. في حين أنه قد يصل إلى 7 أمتار عند استخدام الطرق الأخرى. تراوحت الإنتاجية من 0.25 إلى 0.5 ومن 0.3 إلى 0.75 ساعة / شجرة باستخدام التسلق التقليدي ومتسلق الأشجار المتعددة على التوالي. بينما تراوحت بين 0.5 إلى 0.75 ساعة / شجرة عند استخدام المقص الهيدروليكي والسلالم الطويل. كانت التكلفة الإجمالية لخدمة نخيل 15 - 25 ، 20 - 40 ، 25 - 40 و 40 جنيهاً مصرياً / للشجرة للتسلق التقليدي ومتسلق الأشجار المتعددة والمقص الهيدروليكي والسلالم الطويلة على التوالي. مما يشير إلى الحاجة إلى تصميم وتطوير آلة لخدمة نخيل البلح ، سهولة الاستخدام وتناسب الخواص الطبيعية والميكانيكية المختلفة لنخيل البلح وظروف الزراعة والحقل.