

## MANUFACTURING AND TESTING OF DATE PALM VIBRATION MOTORIZED FRONDS CUTTER

S. M. Abbood\*  
Asst.Lect.

M. R. Abbood\*  
Prof.

A. A. Jasim\*\*  
Prof.

\*Dept. Hortic. and Landscape Gardening , Coll. Agric., Univer. Baghdad,Iraq

\*\*Dept.Agric. Mach.and Equip. Coll. Agric. Univer. Baghdad,Iraq

[Shamelalajily@yahoo.com](mailto:Shamelalajily@yahoo.com)

[Moayadrajab@yahoo.com](mailto:Moayadrajab@yahoo.com)

[Raz55iq@yahoo.com](mailto:Raz55iq@yahoo.com)

### ABSTRACT

The objective of this study was manufacturing and testing a vibration motorized date palm fronds cutter equipment used to pruning date palm tree, this equipment is man back handling and easily used for cut date fronts base. Gasoline two stroke engine which handle on worker's back was used to provide a vibration movement for sharp blade to cut the fronds, machine consists of many parts includes engine, flexible shaft, fixed shaft, gear case and knife. Three knives cutting angle were used in this research. Frond cutting time ,one palm tree pruning (three rows of fronds) vibration of cutting level ,noising level and productivity were measured in this study .Randomized complete block design with three replications was used in the experiment. Least significant differences (L.S.D) under 0.05 level of probability was used to compare the means of treatments . Results showed that 45° cutting angle was superior in obtaining the lowest time of one frond cutting stood 4.30 second, the lowest variation of surface cutting level stood 5.07 mm and highest productivity reached 7.27 tree.h<sup>-1</sup> . Results also showed that there was no significant differences in noise level attributed to cutting angle. Manufacturing date palm pruning mechanical cutter equipment was successfully done at 45° cutting angle with acceptable noise level, vibration and high field productivity .

**Keywords:** date palm pruning, mechanical equipment, frond cutting time, cutting level.

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تصنيع واختبار معدة ميكانيكية لتكريب النخيل باستخدام تقنية القطع الترددي

عبد الرزاق عبد اللطيف جاسم \*\*  
أستاذ

مؤيد رجب عبود \*  
أستاذ

شامل محمد عبود \*  
مدرس مساعد

\* قسم البستنة وهندسة الحدائق، كلية الزراعة، جامعة بغداد \*\* قسم المكنان والآلات الزراعية، كلية الزراعة، جامعة بغداد

[Raz55iq@yahoo.com](mailto:Raz55iq@yahoo.com)

[Moayadrajab@yahoo.com](mailto:Moayadrajab@yahoo.com)

[Shamelalajily@yahoo.com](mailto:Shamelalajily@yahoo.com)

المستخلص

تم في هذا البحث تصنيع واختبار معدة ميكانيكية تستخدم لتكريب النخيل باستخدام تقنية القطع الترددي ، تحمل هذه المعدة على ظهر العامل وهي سهلة الاستعمال في قطع كرب النخيل من القاعدة. تتكون المعدة من أجزاء عديدة تشمل محرك بنزين ثنائي الأشواط محمول على الظهر ، وصلة مرنة، ووصلة ثابتة، وصندوق التروس والسكين. استعملت سكاكين بثلاث زوايا قطع في هذا البحث قيس زمن القطع للكربة الواحدة و زمن قطع ثلاثة ادوار كرب و استواء القطع و مستوى الضجيج والإنتاجية في هذه الدراسة استعمل تصميم القطاعات العشوائية الكاملة وبثلاثة مكررات في التجربة استعمل اختبار اقل فرق معنوي بمستوى احتمالية 0.05 لمقارنة متوسطات المعاملات. أظهرت النتائج أن زاوية القطع 45 درجة كانت متفوقة في الحصول على أقل وقت من قطع الكربة الواحدة بلغت 4.30 ثانية، وأقل تغير في مستوى قطع السطح بلغ 5.07 ملم وأعلى إنتاجية بلغت 7.27 شجرة<sup>-1</sup> ساعة<sup>-1</sup> مقارنة مع المعاملات الأخرى، في حين أظهرت النتائج عدم وجود فروق معنوية في مستوى الضوضاء المنسوبة إلى زاوية القطع. تصنيع قاطع ميكانيكي لتكريب شجرة نخيل التمر قد اثبت نجاحه باستعمال زاوية قطع مقدارها 45 درجة وبمستوى مقبول من الضجيج والاهتزاز و بإنتاجية حقلية عالية .

الكلمات الدالة: تكريب نخلة التمر، معدة ميكانيكية، زمن قطع كرب النخلة، استواء القطع.

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## INTRODUCTION

Date palm (*Phoenix dactylifera* L.) for is one of a most important fruit in the arid areas for the Arabian countries , north Africa and middle east (5) .Date crops were cultivated in new areas like southern Africa and united states .date are become a main income and stable food for population in many countries and play significant factor in rural society,economy and environment in many countries. (18,21). For maintaining the date palm crown ,there are many operations that must be performed during various times of the year .Each tree must be climbed several times in the year, to do many hand operations (8,9).Cutting dry and Dead date palm leaves can be considers as an important date palm crown service because the fronds hinder the worker to climb the palm trunk to do many operations like pruning, pollination ,thinning and harvesting (3). Pruning is a significant practice to remove the date palm dry fronds and fronds bases ,also removes the fiber, spines and offshoots. These operations can be done manually or mechanically using hydraulic lift or ladders (7). Base of fronds are strongest parts of the palm leaves irrespective content of moisture and maturity (8). Using manually tools to cut the leaves base need more man power with high potential , this effort mainly comes from workers and can reduced by sharpness the edge of cutting tool and man skills, so the worker should be strong enough to maintain his energy all the day ,in fact , worker cannot be able to maintain his energy for long time and he stop when he fell tired (14,15), therefore tools and implements are doing an important role to reduce costs , efforts, and time on field operation time (20). Curved knives, sickles and chisels are widely used as cutting tools in various countries and this tools still more effective to cut fronds, offshoot and bunches because there is no alternative option to replace them (13) .Developing effective , efficient and economic cutting machine for date palm tree pruning are important to face future global competitions to reduce human effort and costs (4,11). There are two essential factors for designing cutting machines for any material included cutting mechanism and the cutter plates or knives design (6,15). Physical properties of plant

material ,react against cutting knife, cutting method , cutting speed and cutting angle are also affecting on cutting efficiency (12,19). Large influence of slide movement of the cutting process by cutting knife can appear at a particular value of cutting angle (16).The aim of this project to development and assembly motorized cutter for pruning date palm and manufacturing a cutting knife.

## MAERIALS AND METHODS

The experiment was conducted for manufacturing and testing a vibration motorized cutter used for palm fronds pruning. Three cutting angle included 45°,60° and 90° were used in this experiment. One frond cutting time , three rows of fronds cutting time, surface of cutting level , vibration of cutting level, noise and field productivity was measured in this experiment. Randomized complete block design (RCBD) with three replications was used in this study, lest significant different (L.S.D) and 0.05 level of probability was used to compare the means of treatments. Motorized vibrator cutter was manufactured and assembled at the local mechanical workshop in the department of agricultural machines and equipment, College of Agriculture, University of Baghdad, the equipment consist of many main parts. Manufacturing equipment was testing in private orchard in AL-Suwairah distract ,Wasit province –Iraq on Barhee class of date palm tree. The motorized vibrator palm pruning cutter consists of the following parts (figure 2):

- 1-Gasoline e, it has 2 hp, two stroke cycle , 3000-5000 rpm
- 2-Flexible connection, it consists of a tube of rubber and rotary flexible shaft has 0.5 cm with a rectangle section
- 3-Fixed connection ,consist of rotary circle section shaft , radius of 6.8 mm inside of aluminum pore with 2.5 cm diameter
- 4- Bevel gear case, this gear is used to convey the rotary motion to vibration motion .
- 5- Cutting tool, it is considers as a rigged curved knife locally manufacturing

### Knife Manufacturing process

**Materials :**Classic knife has length of 18 cm, width 11cm and 1mm thickness in the front. It was forged in locally workshop by using carbon alloy steel (ASTM A579).

**Table 1. Chemical composition of material A579**

Element	Fe%	Cu%	Al%	Ni%	Mo%	Cr%	S%	P%	Mn%	Si%	C%
Value	Bal	0.082	0.0131	0.0872	0.003	0.125	0.0186	0.0301	0.784	1.61	0.352

**Manufacturing**

Material was formed by hot foregoing process by using upper and lower die , forging temperature rich to 950 C°.

**Heat Treatment Process**

The second operation was heat treatment process , this process involved three cycle,

heating, holding and cooling . Knife material was treated with high temperature at 850 C° for hold 30 min , after that cooling by oil ,according to flowing process as shown in figure 1 (1,10).



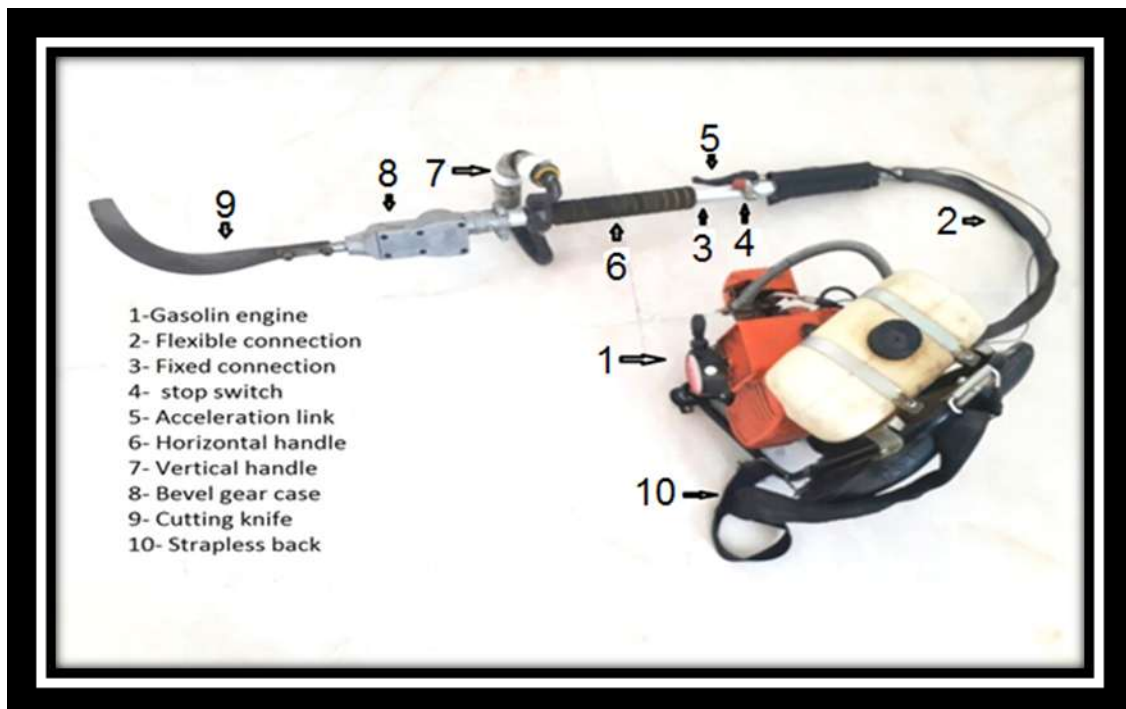
**Figure 1 . Heat treatment cycle**

**Hardness Test**

Knife material hardness was testing by Rokwell hardness method, it was amounted 64 H.R , this number is enough for wear and tear resistance ,durability and impact resistances (13).

**Components of Equipment**

After manufacturing and het treatment for material knife and final assembly with all system parts as shown in figure 2 .



**Figure 2. Motorized vibration date palm pruning cutter.**

**Studied Properties**

**Cutting one Frond Time (frond. sec):** This property indicate for speed of cutting tool

(knife) by measuring time of cutting one frond , time measured by using stop watch when the worker start cutting frond by the equipment of

cutting in palm orchard and digested time, in three replications.

### Three rows cutting time of palm frond (tree.min).

Date palm grow about three rows every year, so it need to remove three rows yearly. Time measured by using same method as above

### Variation in surface cutting level ,(mm)

To keep date palm trunk gradual and easy to climb, the frond base surface should cut in smooth cutting, so the surface cutting level measured the different in cutting surface level variance (mm) by using leveling ruler and filler gage

**Noise:** Noise was measured by using noise meter (db).

**Vibration** ( $m.sec^{-2}$ ): Vibration is one of operational property of safety machine operation, It was measured by using digital vibration meter fixit on cutting tool arm and register amount of vibration.

**Field Productivity** ( $tree.h^{-1}$ ): It was measured by calculate the total time of cutting including the lost time for rest and moving in the field also the time of refuel the engine and maintenance one palm, field productivity it means a numbers of date palm served per one hour ( $tree.h^{-1}$ ).

## RESULTS AND DISCUSSION

**Cutting one frond time:** Table 2 shows the effect of cutting angle on the time for one frond cutting,  $45^\circ$  cutting angle showed the superiority in abating the time of cutting for one frond stood 4.30 sec compared with  $60^\circ$  and  $90^\circ$  which got 5.00 and 5.73 sec respectively. the reason of that may be of decrease the friction between the knife and plant material. The results agreed with the results which got by Jelani et al. (14).

### Cutting for one date palm time

Table 2 shows the effect of cutting angle on time of cut three rows of date palm tree,  $45^\circ$  cutting angle showed the superiority in the cutting time stood 3.13 min compared with  $60^\circ$  and  $90^\circ$  which they got 3.25 and 3.90 min

respectively. Therefore, the  $45^\circ$  cutting angle got a less time to cut three rows of date palm fronds, the reason for that because the  $45^\circ$  cutting angle need less force and energy required than  $90^\circ$ , this results agree with the results of Jelani et al. (13).

**Variation in surface cutting level:** The results in Table 2 shows the effects of cutting angle in surface cutting level.  $45^\circ$  cutting angle showed the superiority in variation of cutting level, it is stood 5.07 mm compared with  $60^\circ$  and  $90^\circ$  which they got 5.26 and 6.86 mm respectively.  $45^\circ$  cutting angle got the less differences in leveling of cutting, the reason for that may be because the  $45^\circ$  cutting angle need less force and energy required than  $90^\circ$ .

**Noising level.:** Table 2 shows the results of noise level test of an equipment no significant differences.  $45^\circ$  cutting angle got 78.86db. compared with  $60^\circ$  and  $90^\circ$  which they got 78.16 and 78.77db. respectively

**Productivity:** The results in Table 2 shows the significant effect of cutting angle on field productivity in numbers of date palm tree fronds cutting in one hour, the results showed decrease the number of trees served by increase the cutting angle, the productivity in  $45^\circ$  degree cutting angle amounted  $7.27 tree \cdot h^{-1}$ , when the  $90^\circ$  degree stood on  $6.48 tree \cdot h^{-1}$ . From the above results shows that obviously observe of the manufacturing equipment excited the pruning of date palm with less time potential good cutting level for date palm fronds at  $45^\circ$  cutting angle this result agree with the results of Jelani et al. (13), also got high practical productivity with acceptable level of noise due the (17) comparing with conventional methods which has less productivity and need lot of effort from workers and costly operation. As conclusion, an equipment for cutting Barhee palm fronds from the base was successfully done with best  $45^\circ$  knife cutting and high productivity.

**Table 2. Effect of the cutting angle on the time of frond cutting, one palm tree fronds cutting time, cutting surface leveling, noise and productivity.**

Angle	One frond cutting time (sec)	One palm fronds cutting time(min)	Cutting surface leveling(mm)	Noise. (db)	Productivity $tree.h^{-1}$
$45^\circ$	4.30	3.13	5.07	78.86	7.27
$60^\circ$	5.00	3.25	5.26	78.16	7.07
$90^\circ$	5.73	3.90	5.89	78.77	6.48
LSD	0.118	0.333	0.147	1.848	0.093

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