

Effect of Cutting Angle and Knives Type on Some Operational Characteristics for a Locally Manufactured Palm Pruning Motorized Vibration Cutter

Abdulrazak A. Jasim¹, Moayad R. Abbood², Shamil M. Abbood²

Prof.PhD. Prof.PhD.Asst.Lect.

¹ Dept. of Agricultural Machines and Equipment, College of Agriculture, University of Baghdad

² Dep. of Horticulture and Landscape Gardening College of Agriculture, University of Baghdad

Abstract: The experiment was conducted to evaluate the effect of cutting angles and knife type on some operations characteristics for a locally palm pruning motorized vibration cutter. An equipment was fabricated to use a vibration motion to operate the cutting knife to cut the base of date palm fronds around the date palm tree trunk. Three cutting angles included 45°, 60° and 90° with three locally manufactured knives included A, B and C types were used in this study. Time of cutting one frond, time of cutting three rows of fronds, level of cutting difference, productivity and efficiency was measured in this experiment. Randomized Complete block design with three replication was used in this experiment. Least significant differences (L.S.D.) under 0.05 level was used to compare the mean of treatment. The results can be summarized as follow: 45° cutting angle gave a lower one frond cutting time, three rows cutting time and differences of surface cutting level amounted to 2.65 sec. 1.74 min., 5.28 mm. 45° and 60° cutting angle got higher productivity stood 8.01 palm/h for both angles. Type (B) knife got lowest cutting time stood 3.22 sec. and higher productivity stood 8.80 palm/h, while type A knife got a lowest of three rows of fronds and differences of surface cutting level stood 1.68 min., 5.28 mm. also type A knife got higher efficiency amounted to 87.67%. The interaction between cutting angle and knife type has significant effect on all properties. Using vibration motorized cutter for cutting date palm fronds successfully done.

Keywords: cutting angle, knives type, frond cutting, vibration, noise, productivity and efficiency

I. Introduction

The date fruit has high energy food for both people and livestock. Since ancient times, dates are the best resource to insure food security during food shortage and crises (Ahmed et al, 2012). Many of field operations involving the date palm include manual work at the crown of the tree i.e. These operation take place at various time during the year (Akyurt et al, 2002). The date palm tree grows about 30 cm a year and it may reach a high of 35 m in age about 100 years, (Morton, 1987). Pruning is one of the important operation practices to remove the palm dry and dead levies and leave bases. This operation eliminates insects and spreading of diseases, also make the palm trunk graded to make it easier to climb, the operation can be done manually or mechanically by using a hydraulic lift or ladders (Ahmed and Andrzej, 2012 and Owda, 2014). Pruning is most difficult operation and it needs more human energy specially when used a traditional tools like knives and saws (Jelani, 1998). The knife shape and type has significant factor to cut the base of palm fronds (Person, 1987 and Ahmed et al. 2000). Also, the angle of cutting play a big role to do the cutting operation (Jelani, et al, 1998). According to the importance of mechanical pruning by using different type of knives under the different cutting angle this study was conducted.

II. Materials And Methods

The experiment was conducted for testing three types of locally manufacturing A, B and C under cutting angle knives degrees included, 45°, 60° and 90° were used in this study. Assembly motorized vibration generator with bevel gear case used to vibrate the knife in 3000-5000 rpm and movement knife stroke about 1.6 cm, (fig.1). Knives was manufacturing by hot forge in local workshop using the (ASTM579) alloy, this material consider a high a durability. Also all knives have 2mm thickness and 0.5 mm sharp edge.



Fig .1 vibration motorized cutter

Knives were forged by using oven at $790\text{ }^{\circ}\text{C}$ for 30 min then doing water cooling to give them good hardness, after that, tested the knife samples hardness by using Rockwell test, it is stood 65 HR.(fig 2). One frond cutting time, one palm fronds cutting time, surface level of cutting, productivity and efficiency were measured in this experiment. Randomized complete block design (RCBD) with three replications was used in this study. Least significant differences (L.S.D) under 0.05 level used to compare the mean of treatment.

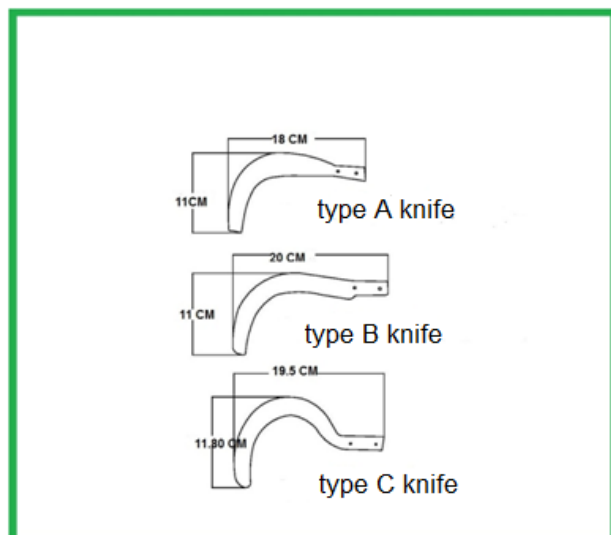


Fig. 2 types of knives

2.2 Studied properties

2.2.1. Time of cutting one frond.

Time measured by using stopwatch when the worker starts cutting frond base and registers the actual time .

2.2.2 Time of cutting three rows of palm frond min.

Time measured by using same method in 2.2.1 .

2.2.3 Surface level cutting.

It was measured the different in cutting surface level by using a filler gage and metal ruler (mm).

2.2.4 – Productivity.

It was measured by calculate the total time of cutting three rows of fronds including the lost time for rest and moving in the field also the time of refuel the implement of fuel and maintenance in palm per hour (palm.h).

2.2.5 - Field efficiency

Field efficiency was measured by using the following question which proposed by (hunt, 1980)

$$Fe = P_p / P_t \times 100$$

Whereas: Fe= Field Efficiency %.

P_p= Practical productivity Palm/ h.

P_t= Theoretical productivity Palm/ h.

III. Results And Discussion

3.1 Time of cutting one frond, (sec).

Table 1 shows the effect of cutting angle and knife type on time for one front cutting , 45° cutting angle showed the superiority in the time of cutting one frond stood 2.65 sec compared with 60° and 90° they got 3.87 and 4.15 sec respectively.. These results agreed with the results which proposed by (Jelani, 1998). Type A knife got the less cutting time stood 2.93 sec. comparing with B and C type .the overlap between the 45° cutting angle and B type of knife obtained the lowest cutting time amount 2.03 sec. and the highest cutting time achieved 4.89 sec. for the overlap of 90° cutting angle and C type knife.

Table 1 effects of cutting angle and type of knife I time of cutting one frond sec.

Cutting angle	Type of knife			Average
	A	B	C	
45°	2.06	2.03	3.86	2.65
60°	3.56	3.78	4.28	3.87
90°	3.71	3.87	4.89	4.15
L.S.D	0.186			0.097
Average	2.93	3.22	4.34	
L.S.D	0.118			

3.2 Time of cutting three rows of palm frond,(min).

Table 2 shows the effect of cutting angle and type of knife on time of cutting three rows of date palm fronds ,90° cutting angle showed a significant effect on the time of cutting it was got a highest time stood 2.72 min ,while no effect between A and B knife type they got 2.40 , 2.43 min respectively, this results agree with the results of (Jelani,et al,1998). The overlap between 45° and the A type of knife obtained the Lowest time of cutting amounted to 1.68 min and the highest cutting time achieved 4.40 min for the 90° cutting angle with a C type of knife.

Table 2 effects of cutting angle and type of knife on time of cutting three fronds rows (min)

Cutting angle	Type of knife			Average
	A	B	C	
45°	1.68	1.69	3.83	2.40
60°	1.69	1.69	3.91	2.43
90°	1.86	1.91	4.40	2.72
L.S.D	0.173			0.114
Average	1.74	1.76	4.04	
L.S.D	0.291			

3.3 Surface level cutting,(mm).

Table 3 showed the effect of cutting angle and knife type on surface cutting level. 45 cutting angle showed the superiority in the difference on level surface of frond cutting amounted to 5.28 mm compared with 90 cutting angle which got 6.17 mm. Type (A) knife got a lowest difference in surface level stood 5.28 mm. The overlap between cutting angle and type of knife obtained the lowest difference of surface `cutting level amounted to 5.16 mm.

Table 3 effects of cutting angle and type of knife surface cutting level (mm).

Cutting angle	Type of knife			Average
	A	B	C	
45°	5.16	5.29	5.41	5.28
60°	5.41	5.46	5.69	5.61
90°	6.40	5.40	6.68	6.17
L.S.D	0.193			0.129
Average	5.65	5.38	5.92	
L.S.D	0.111			

3.4- Productivity, (palm/h).

Table (4) showed the effect of cutting angle on one palm cutting with tree rows of fronds ,there is not difference in result between 45 and 60 cutting angle amounted to 8.01 palm / h. for both angles ,but the results showed a significant effect in used 90 cutting angle was stood 7.62 palm/ h . Using (B) type of knives got a higher productivity stood 8.80 palm/ h. compare with 45 and 90 cutting angles which they got 8.77 and 6.09 palm/ h. respectively .The overlap between cutting angle and knives type obtained the highest productivity amounted to 8.91 palm/h ,and the lowest productivity achieved 5.75 palm /h .

Table 4.the effect of the cutting angle and the knives type on equipment productivity palm/h.

Cutting angle	Type of knife			Average
	A	B	C	
45°	8.89	8.91	6.25	8.01
60°	8.85	8.97	6.23	8.01
90°	8.57	8.51	5.75	7.62
L.S.D	0.271			0.215
Average	8.77	8.80	6.09	
L.S.D	0.135			

3.5. Field efficiency, (%).

The result in table(5) showed the significant effect of used 45 cutting angle on field efficiency it got 80.23% compared with 60 and 90 angles which they got 79.51 and 75.51 % respectively .Type (A) knife got a higher efficiency amounted to 87.67% compare with (B) and (C) type which they got 78.36 and 60.90% respectively. The results in table 5 showed the interference between cutting angles and knives type ,45 cutting angle and (B) knife type got higher efficiency stood 89.10% and the lower efficiency in interference of 90 cutting angle and type (C) knife which got 57.85% .The reason may be for a speed of cutting for 45 , 60 angle and (B) knife type are more easily than 90 and (C) type of knives.

Table 5. Effect of cutting angles and knives types on field efficiency%

Cutting angle	Type of knife			Average
	A	B	C	
45°	89.05	89.10	62.55	80.23
60°	88.55	87.70	62.30	79.51
90°	86.00	82.70	57.85	75.51
L.S.D	0.324			
Average	87.76	87.36	60.90	
L.S.D	1.747			

IV. Conclusion and Recommendation

Using different cutting angles with three types of cutting knife in motorized vibration cutter used to cut the date palm fronds is successfully done. The above results are shown clearly that increase the cutting angle from 45° to 90° led to increase the time of cutting one frond, three rows of fronds cutting time and difference of surface cutting level, also decrease the productivity and efficiency. Therefore, we recommend using 45° cutting angle with one of (A) and (B) type of knife which gave the best time of cutting, high productivity and efficiency.

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