Int.J.Curr.Microbiol.App.Sci (2018) *7*(6): 2550-2557

International Journal of Current Microbiology and Applied Sciences
***ISSN: 2319-7706* Volume 7 Number 06 (2018)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2018.706.301

Development and Performance Evaluation of Banana Comb Cutting Tool

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Keywords

Banana (*Musa acuminate*, *Musa balbisiana*), cutting tols

Article Info

Accepted:
20 May 2018
Available Online:
10 June 2018

A B S T R A C T

Banana (*Musa acuminate*, *Musa balbisiana*) is one of the important fruits grown in India. India leads the world in banana production with an annual output of about 14.2 MT. Maharashtra ranks seconds in annual production after Tamil Nadu. Cutting of bunches often become problem for farmers or workers of banana plantations. During the process of cutting down combs of banana from the bunch using sickle and thread, that take a lot of time to cut combs off from the bunch, bananas also still had a few cuts, scratches and bruises. Hence this is aimed for cutting banana combs from the bunch to gain a nice and neat cutting-edge and at the same time, it saves more time in the cutting process. An advantage of this "developed tool" is easy to use and operate. This tool does not cause damage and scratches to bananas. Also, the performance of developed tool was far more efficient than the other methods. Cutting time required by tool was precisely 34 seconds while that of sickle and thread was 64 and 154 seconds respectively. The post-harvest losses (damaged banana) was observed negligible for developed tool, while 30% more and 60% more damaged banana were recorded for sickle and thread respectively. An efficiency of nearly 100% was seen for developed tool, while that of sickle was observed to be 97.40% and that of thread was 98.80%. We can see that the efficiency of all methods lies in close proximity but differs in cutting time and losses which ultimately affects the adaptability, productivity and justify the overall process in terms of profitability.

Introduction

Banana (*Musa acuminate / Musa balbisiana*) is the most nutritious and oldest abundantly cultivated tropical fruit crop grown in India. Banana is the common name for a fruit; also, it is called as 'Apple of paradise' and this herbaceous plant of the genus Musa which is commonly used as eaten fruits. Banana is one of the most important fruit crops grown in India. In respect of area, it ranks second and first in production only after mango. India leads the world in banana production with an annual output of about 14.2 MT. It shows that the average cultivable area for banana in India and Maharashtra is 831.6 and 53.18 ha and the average production of banana in India and Maharashtra is 28908 MT and 3917.60 MT respectively

Different methods for Banana Comb cutting

Using Sickle

Sickle is the one of the most ancient equipment used in almost every agricultural activity associated with horticultural crops. It consists of handle for holding purpose and blade for cutting or harvesting. Blade of the

sickle is made up of alloy metal which as anti-resistant properties.

Drawbacks of using sickles

The harvesting practices require highly skilled labour of profound accuracy.

It is a time-consuming process.

Using Thread

To overcome the drawbacks of banana comb cutting by sickle, thread is used to cut banana comb.

This is relatively simple method of removing banana comb from the attachment. In this method, thread is wrapped around the comb attachment and the comb is removed from the attachment.

The accuracy of this method is somewhat random and unstable.

Drawbacks of using Thread

Ease of operation is not possible.
This is also a time-consuming process.

Materials and Methods

Different parts of the tool

Wooden handle and Hand grip

Wooden handle (length – 21 cm) was made of wood and was given circular shape to which connecting rod and hand guard were attached.

It was light in weight and hence makes the operation suitable, comfortable and flexible. Hand grip was basically circular rubber roll provided on the outer surface of the handle for effective grip of the tool.

Hand guard

It was fixed on hand grip and extend up to 21 cm. It provided protection as well as support to hand for easy operation. It was fabricated by giving shape to MS bar. Hand guard was useful to reduce the strain which the farmer/worker had observed while cutting the banana Comb.

Blade

Blade of the tool was fabricated from Galvanized steel and was given circular shape. It was present at the end of the connecting rod having dimensions 7x7.5 cm. It had sharp edge to facilitate smooth comb cutting and have resistant and anti-corrosion properties.

Connecting rod

A connecting rod having length 18 cm and width 16 cm as shown in below Fig.3.6 were provided for easy operation. It was fabricated by giving shape to angle Iron bar. The blade was welded permanently at one end while at the other end serves housing for the upper assembly (Handle and Hand guard).

Performance evaluation of Developed Tool

The Performance evaluation of developed tool with sickle and thread was carried out on the basis of following parameters.

Height of bunch: The average height of banana bunches of K-9 varieties was measured.

Diameter of bunch: The average diameter of banana bunches of K-9 varieties was measured.

Cutting time: The average time required for cutting of banana combs from bunches was observed.

Number of combs: The average number of combs in bunches of K-9 varieties was recorded.

Number of damaged banana: The average number of damaged banana was recorded.

Tool efficiency: The tool efficiency was calculated on the basis of simple mathematical efficiency formula expressed as,

Efficiency = (output / input) * 100 (1)

Now modifying the above equation (1) on the basis of number of combs,

No of fingers (banana's), and number of damaged banana in order to find the overall efficiency of developed tool.

 Overall efficiency of developed tool (η_{tool}) = (N_{out} / N_{in}) * 100

Where,

η_{tool} = Tool efficiency, (%)

N_{out} = Cutting output of tool.

N_{in} = Cutting input of tool.

Cutting output

$N_{out} = N_b - N_d$

Where,

N_b = Total numbers of banana in a bunch

N_d = Total numbers of damaged bananas obtained after cutting operation.

N_c = average number of combs in a bunch (taken as 15 for K-9 varieties)

$N_b = N_c * 15$

 $N_{out} = \{(N_c * 15) – N_d)$ (2)

Cutting input

$N_{in} = N_c * 15$ (3)

Combining the equations (2) and (3), the tool efficiency formula (1) is modified as,

$\eta_{tool} = \{[(N * 15) – N] / (N * 15)\} * 100$ (4)

Results and Discussion

From Table 4.1, performance evaluation was done by considering the above listed parameters such as height of bunch, diameter of comb and tool efficiency.

It was observed that the tool efficiency was approximately 100% for various heights of banana bunch and diameters of the banana comb. From the above data obtained from the field testing at Banana plantation field, Workshop and laboratories of Department of Farm Machinery and Power Engineering, Dr. D.Y. Patil CAET, Talsande.

The above fig.4.1 shows the physical properties of banana bunch of K-9 variety in terms of height and diameter of bunches. The average height of banana bunch was observed 97.4 cm and the average diameter of bunch was observed to be 44.6 cm.

The performance of developed tool was found very satisfactory. Cutting time required by tool was precisely 34 seconds. The post-harvest loss (damaged banana) was observed negligible for developed tool. An efficiency of nearly 100% was seen for developed tool. We can see that the efficiency of banana comb cutting methods lies in close proximity but differs in cutting time and losses which ultimately affects the adaptability, productivity and justify the overall process in terms of profitability.

Table.1 Performance results for developed tool

Sr. No.	Bunch Number	Height of bunch, (cm)	Diameter of bunch, (cm)	Operating time, (seconds)	Tool efficiency (Percent)
1	1	90	50	33	100
2	2	103	36	29	99.4
3	3	86	40	34	100
4	4	105	44	34	100
5	5	98	52	40	99.6
6	6	108	48	32	100
7	7	94	44	37	100
8	8	102	40	35	100
9	9	96	44	33	100
10	10	92	48	35	100
	Average	**97.40**	**44.60**	**34.20**	**99.90**

Fig.1 Wooden handle and Hand grip

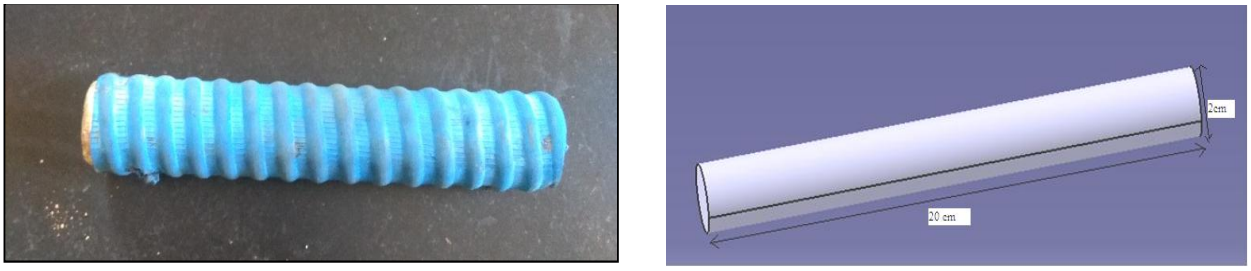


Fig.2 Hand guard

Fig.3 Blade

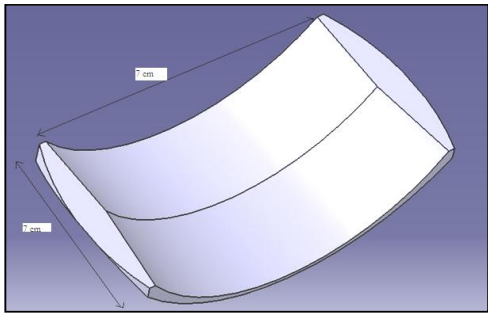
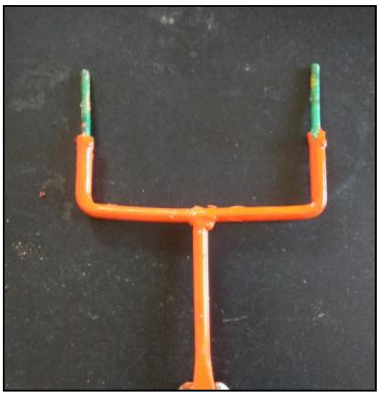


Fig.4 Connecting rod



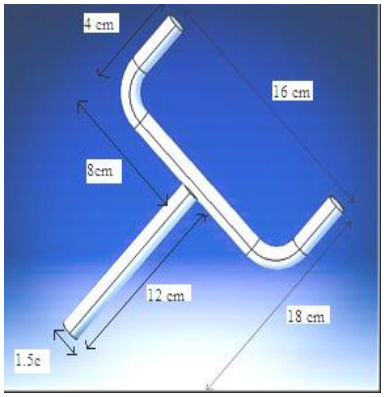


Fig.5 Developed tool

Fig.6 Physical properties of banana bunch

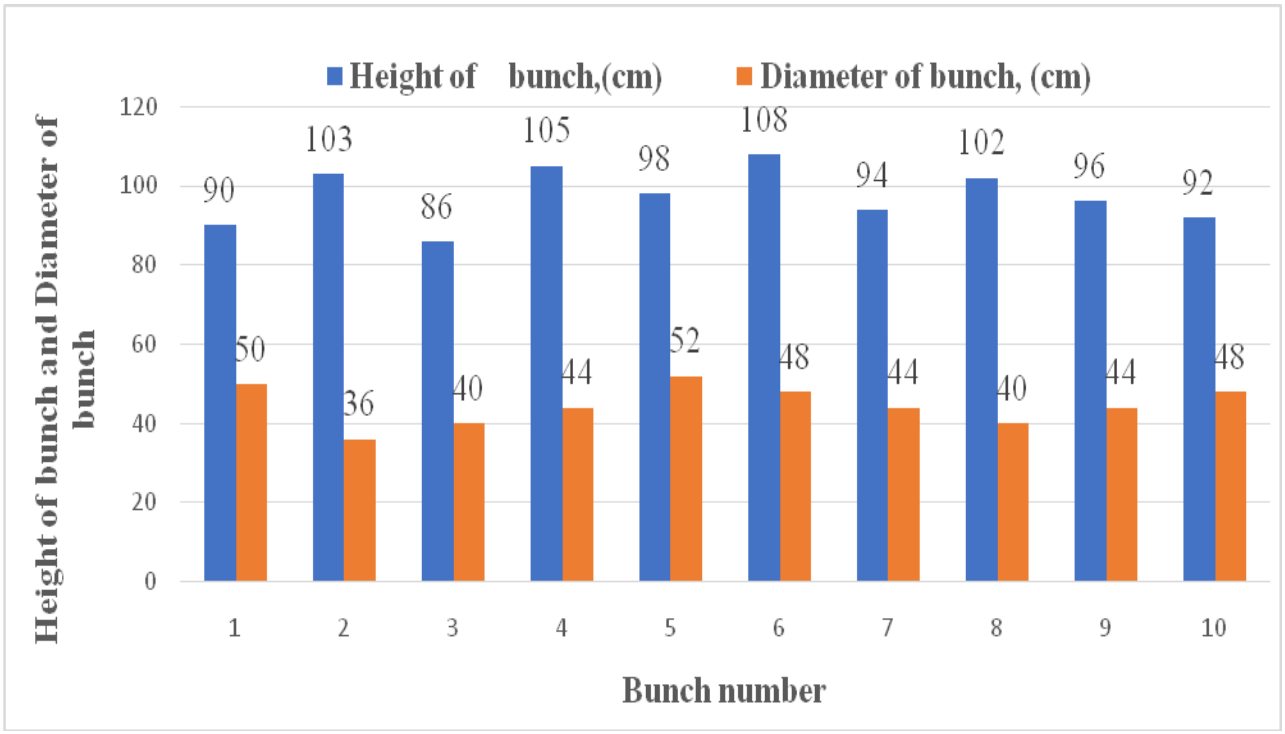


Fig.7 Performance result of developed tool

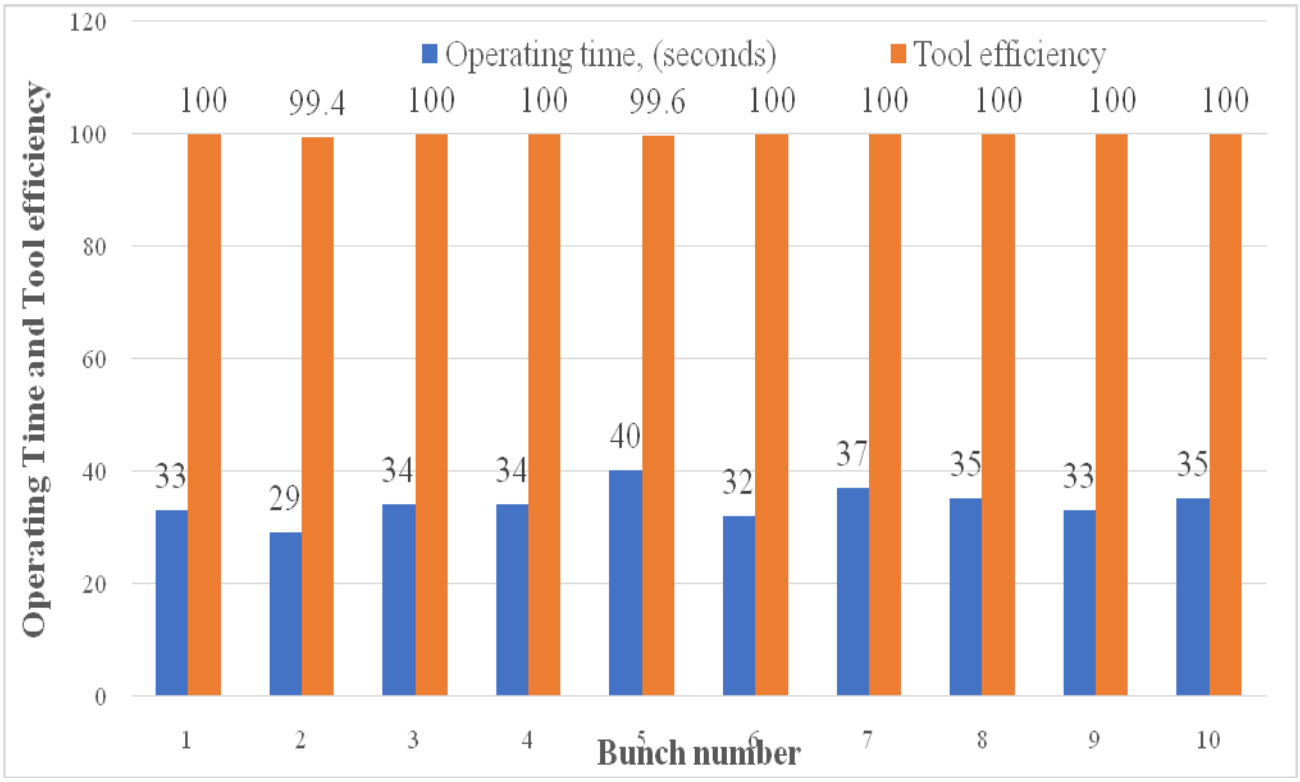


Fig.8 Performance of developed tool

The results of performance evaluation of developed tool are elaborate below.

The average diameter of bunch of K-9 variety was observed to be 44.6 cm.

The average height of bunch of K-9 variety was measured 97.4 cm.

The average number of combs in a bunch of K-9 variety was observed to be in between 7 – 8.

The developed tool was easy to use and does not require highly skilled labor and did not resulted in unnecessary damages and scratches to bananas.

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How to cite this article:

Ghatge J. S., S. B. Patil, P. R. Sable and Mehetre S. A. 2018. Development and Performance Evaluation of Banana Comb Cutting Tool. *Int.J.Curr.Microbiol.App.Sci.* 7(06): 2550-2557.
doi: https://doi.org/10.20546/ijcmas.2018.706.301