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DEVELOPMENT OF POWER OPERATED SUGARCANE SINGLE EYE BUD CUTTER FOR TRAY AND POLYBAG SEEDLINGS

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ABSTRACT

The increasing adoption of single-bud sugarcane setts for tray nursery transplantation has highlighted the need for efficient and precise bud preparation methods. Traditional manual bud cutting is labor intensive, time consuming & prone to inconsistencies that can affect germination and overall crop performance. Also, it causes human fatigue. A power operated sugarcane bud cutter offers a practical solution by ensuring uniform bud removal, reducing physical strain on workers and significantly improving operational speed. Mechanical bud cutting enhances accuracy, minimizes damage to buds and optimizes the size and quality of setts required for tray nurseries. This leads to improved sprouting rates, Additionally, the machine supports largescale timely nursery preparation, making it indispensable for modern sugarcane cultivation practices aiming for higher productivity and resource efficiency. A small scale portable machines can facilitate affordability to individual farmers for preparation of their own seedling tray nursery & can also be affordable for micro, small and medium scale nurseries that wish to enter into sugarcane seedlings tray nursery making business. In market, either big sized expensive machineries or on another end manually operated sugarcane bud cutting machines are available. The power operated machines in the market are not equipped with safety precautions Hence, a small sized, yet power operated machine, that is equipped with safety precautions is a need of hours. Keeping this in view a research work was undertaken on development of sugarcane single eye bud cutting machine for seedling tray nursery preparation. The developed single eye sugarcane bud cutter delivers average output capacity of 865 buds/hr. The efficiency of a machine was observed to be 98.41 per cent.

***Keyword*:** Sugarcane, Transplanting, Sugarcane Nursery, Single eye bud, Seedlings, Sugarcane tray nursery

Introduction

Sugarcane (*Saccharum officinarum*) is considered as main source of sugar production in India and many countries in the world. Area under sugarcane cultivation in India was 59.81 Lakh ha. and production was 434.79 million tons in the year 2022-23. There are two methods of planting sugarcane. The traditional one which includes direct planting sugarcane sets having 3 or 2 or 1 buds and the other one which recently got acceleration is transplantation method. The application of transplanting technique to replace traditional planting of sugarcane saves up to two months of crop production season (Drees, 2005)

The transplanting method has been utilized in several countries for reducing the sugarcane production season. The benefits of transplanting have led increase in usage of sugarcane seedlings. Sugarcane seedling planting in the nursery is done using the single buds, the sugarcane buds it means excised axillary buds from cane stalks. Traditional tools used for bud chipping of

sugarcane are unsafe, messy, having minimum production and the risk of injury is also too high (Ragupathy *et al*., 2017)

As a need of hour various sugarcane bud cutting machines are available in the mark*et al*l over the world. Majority of them are large in size and costlier and hence difficult to afford for common farmers as well as micro, small & medium scale nursery owners. Also, the risk of injury is high in them.

Material and Methods

Main Frame: The main frame is made up of 2×2-inch mild steel square pipes. Two pipes of length 462.5 mm and two pipes of length 487.5 mm were connected to each other by welding process. The main frame was formed which have dimensions 462.5×487.5 mm. In middle portion 2×2 mm square pipe was welded have length 387.5 mm for support to all frame.

Electric Motor: The 1050-watt electric motor with speed 1200 revolutions per minute was selected. The motor run on AC Supply.

Blades: Two blades were taken made up of stainless steel, having diameter 125 mm and thickness 0.9 mm. The blades were having 40 teeth's each.

Shaft: The shaft was made up of EN24 material which is having high tensile strength. This shaft was made custom on lathe machine. The developed bud cutting machine requires 2 easily replaceable shafts according to required size of buds to farmers and nursery owners. When small size buds are required the shaft having length 36 mm can be used and when long size buds are required the shaft having 75 mm length can be used.

V-Shape Grooves: These grooves were prepared from MS angles. Length of left side groove kept to be 150 mm. and the length of right sided grooves was kept to be 100 mm. The grooves were supported and fixed on C shaped channel by welding process.

Spring: The helical coil spring which was made of stainless steel having length 125 mm, inner diameter 35 mm and outer diameter 37.5 mm was used.

Handle: Hollow rectangular pipe made up of MS having length 412.5 mm was used for making handle.

Speed Controller: The electronic speed regulator controls the speed of shaft on which the blades have been placed. With the help of controller, we can vary the rotating speed of shaft and consequently the rotating blades. When we want to speed up the cutting process we can increase the speed and vice-versa.

Blade safety cover: This was made of MS sheet of thickness 16 gauge**.** The length is 450 mm and width 50 mm.

Glass: Toughened glass of size 50 × 40 mm was fitted on blade safety cover.

Auxiliary handle: It is made up of rubber having Length 125 mm and outer diameter 30 mm.

Waste material collector: It is made up of MS sheet of thickness 16 gauge and size 250 ×100 ×50 mm.

Bag holding frame: The frame to hold bag to collect cut buds was made up square MS pipes of 25 × 25 mm. Size of the frame was 350 × 337.5 mm. Two hooks were welded to frame for holding the bag.

Adjustable Legs: Height adjustable legs are provided so that machine can be operated both by seating on the floor as well as by seating on the chair. Inner side legs are made of 37.5 × 37.5 mm square pipes and the outer side legs are made of 50×50 mm square pipes.

Others: The instruments used for the research work were Vernier caliper, stopwatch, power meter measuring scale, etc.

Table 1 : Material used for fabrication of Machine.

Sr. No.	Particulars	Material	Specifications	Units
1	Electric Motor	--	1050 Watts	01
2	Shaft	EN24	36mm, 1.5" & 3"	02
3	Toughened Glass	Glass	5×5"	01
4	Auxiliary handle	Plastic	5×2	01
5	Blade	Stainless Steel	5" with 40 teeth	02
6	Square pipe, Angle, C Channel, rectangular Pipe	Mild Steel	2×2" square pipe, 1×2"rectangular pipe	01
7	Plywood	Wood	18 mm	02
8	Wire	Copper	5 Meter	01
9	Screws	M.S.	2"	20
10	Bushing	Rubber	2×2	16
11	Nut and Bolts	M. S.	10×50 mm	14
12	Color	Oil Paint	Green & Yellow	01
13	Speed controller	Plastic, Silicon	--	01
14	Spring	Stainless steel	1.5×5"	01

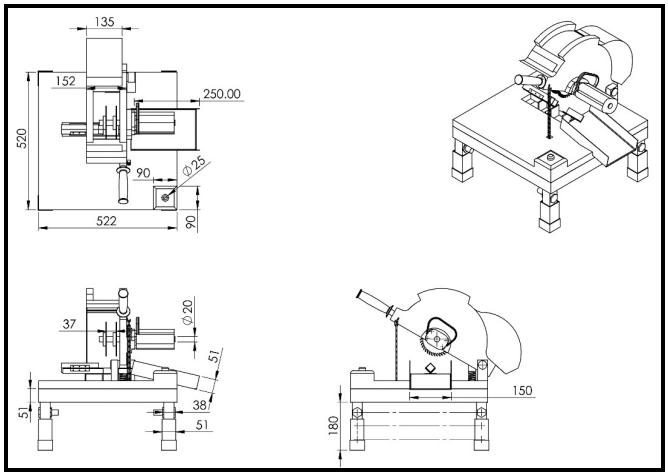

Fig. 1: CAD design of electric power operated sugarcane bud cutter with ground seating

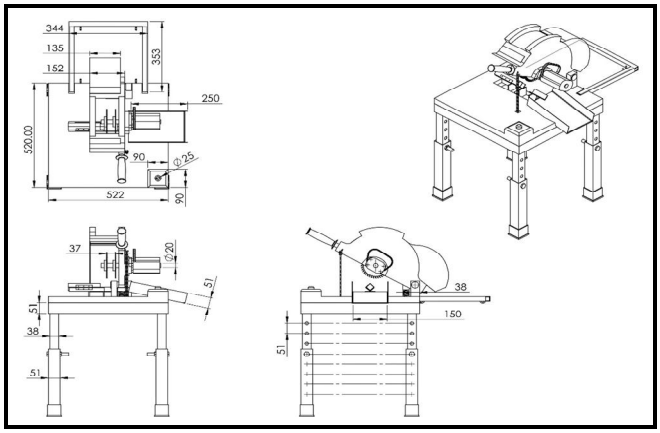

Fig. 2: Electric power operated sugarcane bud cutter with chair seating

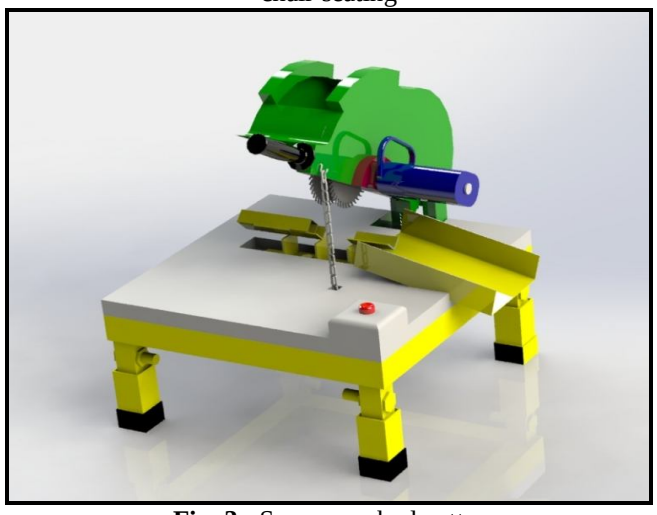

Fig. 3 : Sugarcane bud cutter

Measurements

The developed prototype of the sugarcane bud cutting machine was tested considering the measurements related to prototype performance to realize the purpose of this research

Percentage of Damaged buds (Nbd)

The damaged buds mean mechanical damage to the bud scar due to the cutting process. Decrease in the number of damaged buds indicates an increase in the percentage of cutting efficiency. The percentage of the damage was calculated by counting the damaged buds and relative to the actual number of buds that had been cut.

$$Nbd = \frac{Nbd}{Nbactual}$$

Where, Nbd= Number of damaged buds

Nbactual= Total no. of buds' cut

Cutting Efficiency

Cutting efficiency refers to number of healthy cut buds relative to the total actual number of cut buds.

$$\eta c\ \% = \frac{Nbactu - Nbd}{Nbactu}$$

Where,

ηc = Cutting efficiency

Machine Productivity (Q, Nb/h)

Machine productivity was estimated by using the following equation

$$Q = \frac{Nbactual}{t}$$

Where,

Nbactual = Actual no. of buds cut in time t (hr.)

Result and Discussion

Capacity of developed bud cutting machine

The developed sugarcane bud cutting machine was tested to check its capacity, which is given in table -2

Table 2 : Capacity of developed bud cutting machine

Sr. No.	1	2	3	4	5	Average
Time of operation of machine (min)	60	60	60	60	60	60
Total Number of buds cut	840	780	900	930	905	865

The cutting capacity of the machine varies with girth & length of internodes of sugarcane as every sugarcane could not be of the same girth and intermodal distance. It is observed that, the capacity of machine varies from 780 buds/hr to 930 buds/hr whereas the average bud cutting capacity found out to be 865 buds/hr.

Damaged buds (%)

Mechanical damage to the buds may occur by the cutting blades due to wrong feeding from the laborer. Increasing the operational speed of machine, might increase the percentage of damaged buds. During the process of cutting it is observed that some buds gets damaged. The details of damaged buds have been given in the table -3.

Table 3 : Damaged buds (%)

Sr. No.	Particulars	Test -1	Test -2	Test -3	Test -4	Test -5	Average
1	No. of buds cut/hr	840	780	900	930	905	865
2	Damaged buds (%)	1.19	1.02	1.77	2.04	1.87	1.57

Efficiency of machine:

It is observed that the cutting efficiency of machine varies with the operational speed of the machine. The details are given in table-4.

Table 4 : Efficiency of machine:

Number of buds cut/hr	840	780	900	930	905
Number of Damaged buds	10	08	16	19	17
Cutting efficiency (%)	98.8	98.97	98.22	97.95	98.12

The cutting efficiency of developed machine varies from 97.95% for rate of bud cut 930 buds/hr to 98.97 for rate of bud cut 780 buds/hr. The average efficiency of the machine was found to be 98.41%.

Effect of cutting rate on cutting efficiency (η_c)

The increase in cutting rate decreases the cutting efficiency. The highest cutting efficiency was observed to be 98.23% when the theoretical cutting rate was kept to be 20 buds/min and the lowest cutting efficiency was observed to be 92.18% when the theoretical cutting rate 30 buds/min.

Table 4: Effect of cutting rate on cutting efficiency (η_c)

Cutting Rate (buds/min)	20	25	30
Cutting Efficiency (%)	98.43	94.57	92.18

Fig. 4 : Length of bud cut 1.472 inches

Fig. 5: Length of bud cut 1.537 inches

Conclusion

Based on the results obtained, two different size buds can be cut with this machine, one is 37.5 mm (1.5 inches) average length for tray nursery and the other is 75 mm (3 inches) average length for polythene bags nursery. The average output capacity of machine was observed to be 865 buds/hr. The efficiency of machine was observed to be 98.41 per cent. This machine is having small size and hence it is portable, having low price, it is easy to operate as it can be operated by seating on the ground as well as by seating on chair, having simple construction, low in power consumption and hence it is suitable for individual farmers as well as for sugarcane nursery owners.

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