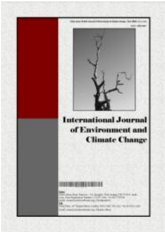

International Journal of Environment and Climate Change

12(11): 2337-2350, 2022; Article no.IJECC.88936
ISSN: 2581-8627
(Past name: British Journal of Environment & Climate Change, Past ISSN: 2231–4784)

Performance Evaluation of Tractor Operated Sugarcane Leaf Stripper through Analysis of Effect of Length, Girth and Number of Buds of Sugarcane

Anurag Patel [aφ*], Sheen Cline Moses [a#], Prashant M. D'souza [a†] and Rana N. Alam [a‡]

[a] *Department of Farm Machinery and Power Engineering, Vaugh Institute of Agricultural Engineering and Technology, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj, U.P., India.*

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJECC/2022/v12i1131229

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/88936

Original Research Article

Received 08 May 2022
Accepted 14 July 2022
Published 10 September 2022

ABSTRACT

In this present research paper analysis of the performance of tractor-operated sugarcane leaf stripper is performed. India is the second-largest producer of sugarcane and Sugarcane is the most prominent cash crop. The sugarcane harvesting process is labour intensive and takes around 850-1000 working man-hours per hectare when sugarcane is harvested manually and de-trashing alone takes 400 man-hours in manual harvesting procedures for removal of tops.

Mechanized leaf stripper is developed and fabricated to prevent labour and accident and the performance of the machine is evaluated on MCO-238, K-269 and R-94184 variety of sugarcane. The data regarding de-topping time and stripping rate are taken and the effect of parameters namely Length of, Girth and number of Buds of the stalk are evaluated. The machine was operated at a roller speed of rpm. The results showed that length and number of buds affect the stripping time significantly and the length of stalk and girth of the stalk has a significant impact on the stripping rate. For stripping rate the most dominant and significant factor was the length of the stalk:

[φ] Ph D. Scholar;
[#] Professor and Head;
[†] Assistant Professor;
[‡] Research Engineer;
**Corresponding author: E-mail: 3679anuragpatel@gmail.com;*

MOC-238 has 62.35% contribution, K-269 has 78.10% contribution and a case of R-94184 has 60.72% contribution. The second significant factors were girth with the contribution of 33.30%, 20.53% and 36.44% contribution in MCO-238, K-269 and R-94184 varieties respectively. The factor, number of buds remained insignificant.

Keywords: Sugarcane; tractor operated; leaf stripper machine.

1. INTRODUCTION

Sugarcane is the main source of Sugar and is considered among the prominent cash crops. India is the second-largest producer of sugarcane after Brazil. As of the 2018 data, the global production of sugarcane stands at 1.91 billion tonnes, with Brazil having a major contribution of 39% and followed by India with 20%. It has a significant contribution to the GDP of the nation [1].

Sugarcane belongs to the species of tall perennial true grass; the family of sugarcane is Graminease, class monocotyledons, subfamily panicoidae, genus *Saccharum* and tribe *Andropogoneae.* In India, the species n*Saccharum officinarum* is most common among the different species of sugarcane due to its high sucrose content. According to data, sugarcane is a labour-intensive crop. In India alone, 5.0 M hectares of land are used for sugarcane cultivation, which accounts for 19.07 percent of global production. Of this amount, 355 MT, or 18 percent of global production, is produced. The productivity of sugarcane in India stands at 78.25 metric tons per hectare which are above the global average productivity of 70.77 metric tons per hectare [2].

In the harvesting of sugarcane, the requirement of more labour force is of major concern, in India mechanized harvesting and leaf striping of sugarcane crops is still very less. The use of a harvesting knife is among the most common manual harvesting techniques being followed in India, manual harvesting is very time-consuming and costly as it takes around 850-1000 man working hours per hectare when sugarcane is harvested manually [3]. Due to more employment opportunities in other sectors, the cultivators of sugarcane feel the brunt of the labour shortage which in turn increases the sufferings and losses in the peak season. Any delay in harvesting has a direct impact on the quality of sugarcane in terms of yield, sugar recovery and juice quality [4-6]. Therefore, keeping given mentioned shortcomings and hardships in sugarcane harvesting there is a need to introduce and promote economic mechanized sugarcane harvesting solutions in India.

2. BACKGROUND

Harvesting of sugarcane at a proper time i.e. at the peak time of maturity by using the appropriate technique is crucial to realize the maximum malleable cane weight. Therefore keeping in view the negative consequences of manual harvesting of sugarcane there is needed to adopt the mechanized solution to the various stages of sugarcane harvesting.

2.1 De-trashing / Leaf Stripping

De-trashing is the process of removal of tops and stripping of leaves. In traditional methods, the dried leaves of sugarcane were burnt in the standing crop and then the stalk is cut manually [7]. Generally, at the time of harvesting the sugarcane stalk comprises 70% stalk for milling, 15% green leaves, 8% cane tops and 7% dry leaves and there is a need to remove leaves and tops before milling.

2.2 Manual De-trashing

In the conventional method, the labour uses a sickle to manually remove the trash and pick up sugarcane stalks one after another. The manual process of trash removal is time-consuming and labour demanding.

2.3 Mechanized Method

In mechanized method de-trashing can be achieved by following process:

a. Removal of leaves by use of compressed air
b. Removal of leaves by centrifugal method
c. Removal of leaves by use of series of rubber belts with groove cuts

In India hand tools are most commonly used in the removal of tops and green leaves, an institution like IISR, OUAT and TNAU have developed some efficient hand tools for de-trashing and these tools are available in the market, de-trashers and the output of the same de-trashers along with the data on the damage done to the stalk is given in the table below: [3].

Fig. 1. Hand tool developed by TNAU

Fig. 2. Hand tool developed by IISR

Table 1. Stripping output and damaged caused to stalk of various developed detrashers

Developed Detrasher	Stripping output, Kgh^{-1}	Damaged caused to stalk, %
IISR detrasher	119.75	6.1
TNAU detrasher	123.25	3.5
OUAT detrasher	117.50	4.3
Hand Operated detrashing	110.60	0.0
IISR mechanical sugarcane detrasher	2400	0.0
IIT Kharagpur detrasher	1210	0.00

2.4 Literature Review

In an experimental study conducted by Sopa Can see under the title "A study of Sugarcane Leaf-Removal during Harvest" the role of mechanized sugarcane leaf-removing tool is evaluated in speeding the harvesting process and reduction in contamination. The LK92-11 type of sugarcane is utilised in the study as feed for machinery. It has a 12-month harvesting period, a density of 9,387 stems, and it can yield up to 14.01 tonnes of sugar cane tops, 1675.2 kg of leaves, and 180 kg of sheath. Small engine-powered leaf remover is used with 4 different materials namely soft wire, tendon string, sling and medium wire. The efficiency of a machine is indicated by the sugarcane leaf removal quantity (by area) and time. It was observed that the quantity of leaves and leaf sheath affects the harvesting rate, also the leaf sheath and leaves are a source of contamination which could bring mud, sand and clay into the final product such as sugar. Using the mechanized method for leaf-removing the harvest time can be reduced from 37h/rai to 11.4h/rai. Also, it was highlighted that the material of the leaf removing blade is a crucial element in managing the efficient harvest whereas the poor material on the blade can lead to tangling and clogging of the rotator dish [8].

In a study where large-scale sugarcane leaf stripper was introduced with automatic feed, it was found that advances in harvesting techniques where stripper wheels having leaf stripping bars installed in them are used can reduce the labour intensity without compromising the quality and could prove helpful in using the removed leaves from recycling or reuse point of view [9].

In a study by Sing & Solomon, 2014, "Development of a Sugarcane Detrasher" a powered operated detrasher is used which is composed of a mechanized feeding mechanism, detrashing unit and delivery system. Detrashing unit consists of two counter-rotating rollers, an air blower and comb-shaped attachment. Rollers were made of mild steel, cushioned with a rubber canvas belt having comb-like attachment to increase grip and they have an effective diameter of 300 mm. The working mechanism is such that the air blower pushed the green top and leaves of the cane into the detrashing cavity from where the counter revolving rollers pushed down the leaves, meanwhile, the forward movement of the cane and downward push of leaves through the roller separates the leaves from the cane. The performance of five sugarcane types, CoLk 97147, CoPant 97222, CoSe 95422, LG 96115, and CoLk 84184, was assessed. Three canes at a time were fed through a feeding chute at a 10° angle, and the roller's speed was between 350 and 400 rpm. It was observed that around 1.5 to 6.6% of trash is left on the de-trashed cane and the average machine output comes out to be 2.4 ton/h. Economic analysis showed that the price per tonne of cane was INR 83, which is less expensive than the price of INR 100 per tonne for manual detrashing. Around 17% of the cost of operation and 84% of labour requirements are reduced by the introduction of the mechanized method [10].

In an experimental research study by Ashfaq et al., 2014, "Performance Evaluation of Sugarcane Stripper for Trash Recovery" the performance of sugarcane stripper, designed by Agricultural Mechanization Research Institute (AMRI) Wing, Faisalabad was performed using three varieties; V1 (COL1148), V2 (FH-237) and V3 (MO-240). For the experiment the parameters were; NS1 (250 rpm), NS2 (200 rpm) and NS3 (150 rpm) as sprocket speeds and NB1 (750 rpm), NB2 (1000 rpm) and NB3 (1500 rpm) as three blower speeds. The results of the experiment showed that maximum sugarcane stripping efficiency was achieved at parameters combination of sprocket speed at NS3 (150 rpm) and blower speed of NB3 (1500 rpm). This indicated that at the higher speed of de-trashing drum the stripping efficiency is affected because of the quick passage of canes as a result of the decreased effect of air thrust of a blower and on the other hand higher blower speed has a higher air thrust in passing sugarcane which helps in better removal of leaves. The study also highlighted that due to the unavailability of labour during harvest duration farmers usually avoid performing de-trashing part which reduces their income by around 10% in the sugar industry as the trash can absorb around 30% of the juice during the extraction procedure. Moreover, the mechanized method also decreased the cost to INR 17129/ha from the INR 19200/ha cost of the manual procedure [11].

In the study regarding "Present Mechanization Status in Sugarcane– A Review" by KISHORE, et al., 2017, it is highlighted that area under sugarcane cultivation is significantly huge and the mechanization in harvesting will be beneficial for the farmers who are still using traditional techniques and tools. The study highlighted that major areas of mechanization in sugarcane cultivation are planting, harvesting and de-trashing. Sugarcane de-trashing alone takes 400 man-h in manual harvesting procedures for removal of tops, dry and green leaves, and INR 7500 as cost of operation per hectare. The use of the mechanized solution in de-trashing reduces the harvest time; labour burden and cost of operation, in this way loss of sugar content and contamination in sugarcane harvested crop, can be prevented [3].

Chandravanshi et al., 2021, in their study "De-trashing of sugarcane: A review" took into consideration the losses to sugarcane cultivators due to labour shortage during harvest time. De-trashing and de-topping are crucial procedures in sugarcane cultivation which are labour intensive and account for about 65% of labour requirements in the harvesting season. The study favored the use of the mechanized de-trashing solution to address the highlighted problems. Manual removal of tops and green leaves can lead to labour fatigue as the manual process exerts excessive stress on joints and muscles. For the adaptability of sugarcane de-trasher it was reported that the rupture rates in mechanized de-trashing units are lower in straight canes than the bending sugarcane therefore the impurities in straight sugarcane were larger than in the bending sugarcanes' (Shukla, et al., 2020). Various factors affecting the de-trashing units are the speed of input and output rollers, speed of de-trashing, the distance between input rollers and de-trashing plate, and between output roller and de-trashing plate, and other important factors are arrangement and material of cleaning element [12]. Objective: Study of the various parameter of sugarcane and Performance evaluation of developed machine for remove of leaf on sugarcane crop under actual field condition.

3. METHODOLOGY

In India, a sizable amount of sugarcane is grown as a low-risk cash crop, and about 50 million farmers are involved in the sugarcane and sugar sector directly or indirectly. One of the top producing states for sugarcane is Uttar Pradesh, where the amount of labour required for sugarcane production is greater yet the level of mechanization is relatively low. It is necessary to alter the current manual harvesting practices since labour costs are constantly rising and are currently more expensive than sugar from mechanized overseas sources (Patel, et al., 2018). Farmers' labour-intensive tasks can be reduced by using a mechanical solution throughout the harvesting phase, particularly during sugarcane stripping. Therefore, in an attempt to provide an efficient and economical solution to the problems of sugarcane producers design and development of a stripper for sugarcane stripping is being done at the Division of Farm Machinery and Power Engineering, Vaugh Institute of Agricultural Engineering and Technology, Sam Higginbottom University of Agricultural Technology and Sciences, Prayagraj District of Uttar Pradesh.

3.1 Main Components of PTO Operated Sugarcane Stripper

I. Frame: The frame of the machine is designed by keeping in mind the space and required strength. Frame not only supports the other compiled components but also reduces the vibration during the loading of the machine.

II. Feeding chute: The feed chute is ergonomically designed and fabricated on the machine at 10° angle from the horizontal to facilitate easy feeding.

III. Intake roller unit: A combination of two rollers placed one above another makes the intake roller unit. The roller is made up of Mild Steel (MS).

a) Supporting roller: The function of the supporting roller is to support the sugarcane stalk and slide the stalk into the stripping unit.

b) Stripping roller: The stripping roller is spring-loaded having covered with nylon rubber.

IV. PTO attachment: PTO attached is provided on the back side of the machine to power the machine through the tractor.

V. Air Blower: The air blower is placed above the stripping unit. Its function is to blower away the leaves removed by a stripping roller.

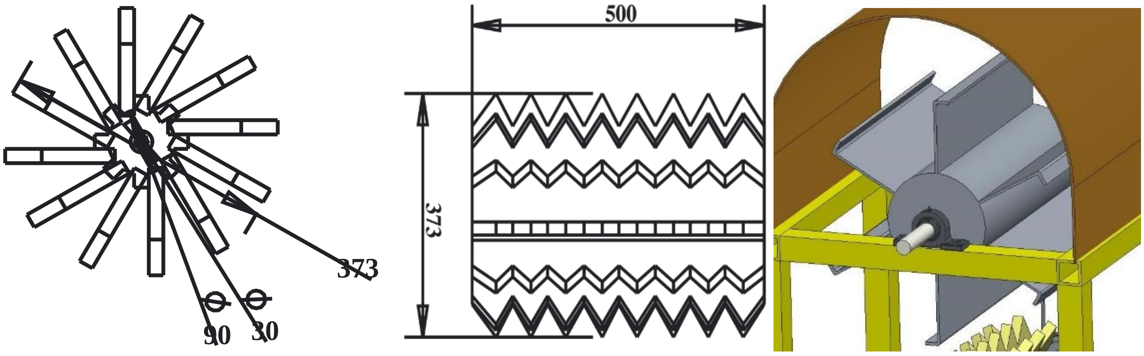

Fig. 3. Leaf stripping rollers, blades and blower assembly

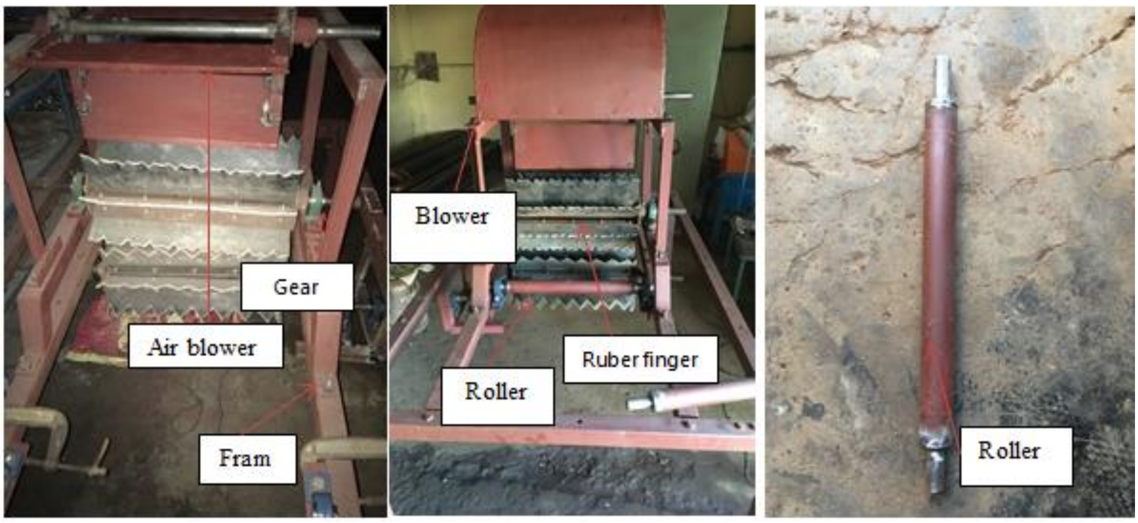

Fig. 4. Various parts of developed sugarcane leaf stripper machine

3.2 Design of Experiment

Robust designing of engineering machines is vital for producing a highly efficient product with economical cost. In designing the effect of parameters involved in the functioning of a machine must be known so that effective machine design can be developed. Taguchi's parameter design is considered among the most effective tool in obtaining a robust design. It provides a systematic approach to optimizing the parameters.

Orthogonal arrays in Taguchi's technique are used to reduce a large number of experiments into less effective experiments to obtain an accurate result for analysis and also save time, money and labour. In the given experiment 3 parameters with 3 levels are selected therefore L9 orthogonal array is used for this investigation.

3.3 Analysis of Variance (ANOVA)

The analysis of variance (ANOVA) is performed to evaluate the significance of each selected factor involved in the stripping process. ANOVA results provide an accurate idea about how far a particular process parameter has influences on the output of experiments and the level of significance of each parameter. Selected input parameters are:

1. Length of Stalk, mm,
2. Girth of Stalk, mm, and
3. No. of buds.

The performance of machine measured over the output:

1. De-topping time, s.
2. Stripping rate, kg/h

3.4 Experimental Procedure for Performance Evaluation

In the experiment to evaluate the performance of the leaf stripper in terms of de-topping time, stripping rate and damage done to the stalk, their varieties of sugarcane are selected; a. MCO-238, b. K-269, c. R-94184. The rpm of the machine roller was set at 400-450 RPM and the blower RPM was set at 520 with an air velocity of 24.3 m/s. all three varieties were fed into the stripping machine and data was collected for de-topping time, stripping rate and damage to stalk as shown in Tables 2, 3, and 4 below:

Table 2. MCO-238 output results

Length, mm	Girth, mm	No. of buds	De-topping time, s	Stripping Rate, kg/h
3005.90	51	24	2.50	1825
3005.90	53	25	2.52	1860
3005.90	54	27	2.55	1870
3009.50	51	25	2.56	1865
3009.50	53	27	2.58	1875
3009.50	54	24	2.55	1885
3048.00	51	27	2.61	1880
3048.00	53	24	2.58	1900
3048.00	54	25	2.60	1920

Table 3. K-269 output results

Length, mm	Girth, mm	No. of buds	De-topping time, s	Stripping rate, kg/h
2623.60	47	22	2.42	1835
2623.60	49	24	2.49	1855
2623.60	51	27	2.53	1865
2743.20	47	24	2.53	1866
2743.20	49	27	2.57	1876
2743.20	51	22	2.51	1883
2876.30	47	27	2.6	1885
2876.30	49	22	2.54	1897
2876.30	51	24	2.57	1905

Table 4. R-94184 output results

Length, mm	Girth, mm	No. of buds	De-topping time, s	Stripping rate, kg/h
2935.20	49	23	2.47	1855
2935.20	50	24	2.50	1870
2935.20	52	27	2.54	1882
3267.30	49	24	2.62	1875
3267.30	50	27	2.67	1890
3267.30	52	23	2.57	1895
3392.70	49	27	2.71	1887
3392.70	50	23	2.67	1905
3392.70	52	24	2.66	1925

3.5 Analysis of MCO-238

ANOVA for De-topping time (95% confidence level)

Table 5. Analysis for de-topping time (MCO-238)

Source	DF	Seq SS	Adj SS	Adj MS	F	P	% Contribute
Length, mm	2	0.008089	0.008089	0.004044	364.00	0.003	78.6179
Girth, mm	2	0.000156	0.000156	0.000078	7.00	0.125	1.5161
No. of buds	2	0.002022	0.002022	0.001011	91.00	0.011	19.6520
Residual Error	2	0.000022	0.000022	0.000011			
Total	8	0.010289					

Table 6. De-topping time (95% confidence level)

Level	Length, mm	Girth, mm	No. of buds
1	2.523	2.557	2.543
2	2.563	2.560	2.560
3	2.597	2.567	2.580
Delta	0.073	0.010	0.037
Rank	1	3	2

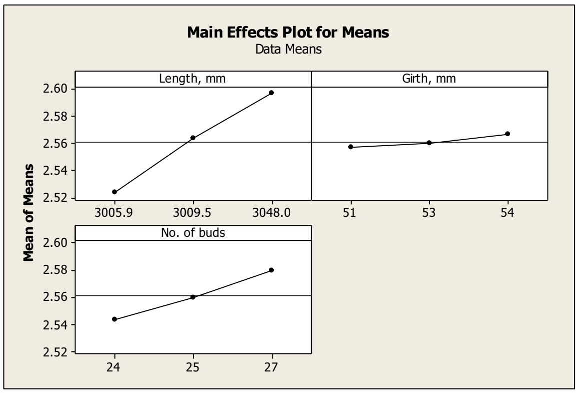

Fig. 5. Main effects plot for means of length, girth and number of buds on de-topping time

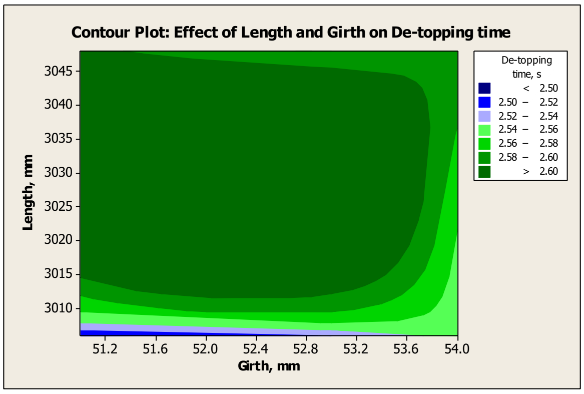

Fig. 6. Effect of length and girth on de-topping time

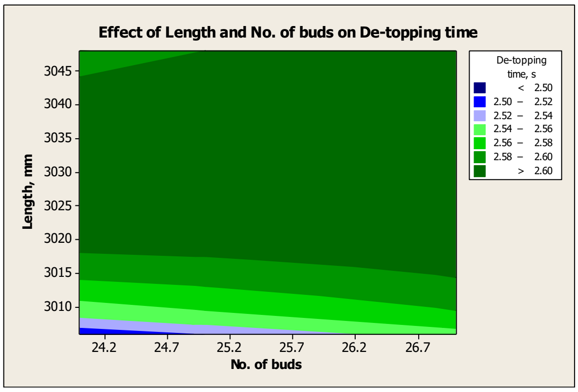

Fig. 7. Effect of length and number of buds on de-topping time

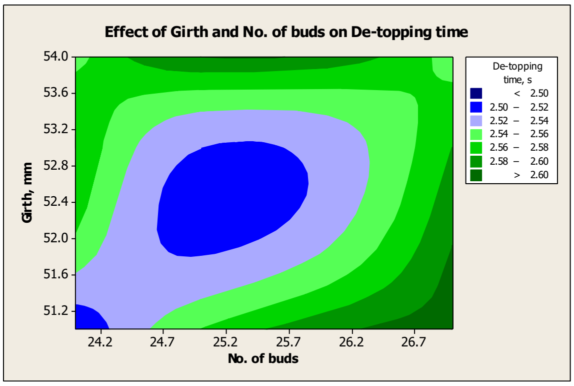

Fig. 8. Effect of girth and number of buds on de-topping time

4. RESULTS OF ANOVA

ANOVA test was performed using MINITAB software, the relative importance of the sugarcane stalk physical parameter is shown in Table 5. As per the ANOVA table, the length of the stalk is the most dominant parameter with 78.62% contribution in affecting the de-topping time, followed by No. of buds with 19.65% contribution. The contribution of girth of the stalk has no significance in the test as per the "P" value (125>.05). Mean effect plots for means in Fig. 5 for each factor show how the de-topping time changes with factor, length and number of buds have a dominant effect and the same trend has been shown in response Table for mean given in Table 6. The contour plots in Figs. 6 to 8 also provide the same picture.

As per the ANOVA Table 7, the length of the stalk is the most significant (P-value: 011<.05) and dominant parameter with 62.35% contribution in affecting the stripping rate, followed by girth with 33.30% contribution. The contribution of No. of buds has no significance in a test as per the "P" value (.159>.05). The mean effect plot for mean in Fig. 9 showed that length of stalk and girth has a dominant effect on the stripping rate and the same trend has been shown by response Table for mean in Table 8. The contour plots in Figs. 10-12 also provide the same picture.

4.1 Analysis of K-269

As per the ANOVA Table 9, the length of the stalk is the most significant (P-value: 005<.05) and dominant parameter with 55.73% contribution in affecting the de-topping time for the K-269 variety, followed by the number of buds with 39.58 % contribution. The contribution of girth has no significance in the test as per the "P" value (.34>.05). As per mean effect plots for means in Fig. 13, length and number of buds have a more dominant effect on the de-topping time and the same trend has been shown by response Table for mean in Table 10. The contour plots in Figs. 14 to 16 also provide the same picture.

Table 7. Analysis for stripping rate (MCO-238)

Source	DF	Seq SS	Adj SS	Adj MS	F	P	% Contribute
Length, mm	2	3505.56	3505.56	1752.78	90.14	0.011	62.3518
Girth, mm	2	1872.22	1872.22	936.11	48.14	0.020	33.3003
No. of buds	2	205.56	205.56	102.78	5.29	0.159	03.6562
Residual Error	2	38.89	38.89	19.44			
Total	8	5622.22					

Table 8. Stripping rate (95% confidence level)

Level	Length, mm	Girth, mm	No. of buds
1	1852	1875	1870
2	1875	1878	1882
3	1900	1892	1875
Delta	48	35	12
Rank	1	2	3

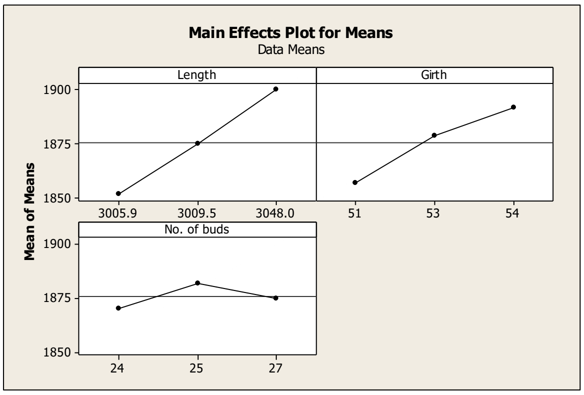

Fig. 9. Main effects plot for means of length, girth and number of buds on stripping rate

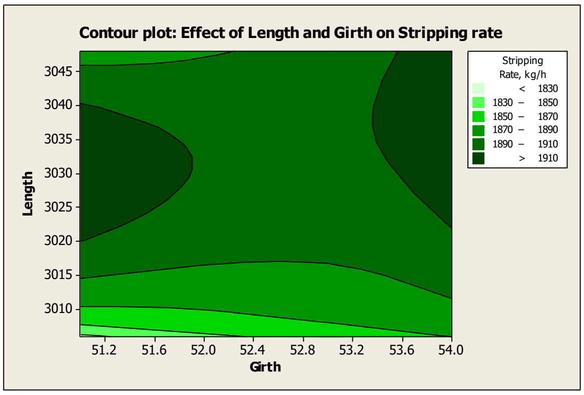

Fig. 10. Effect of length and girth on stripping rate

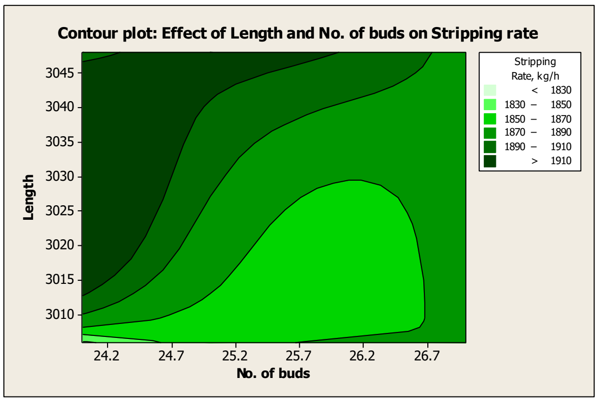

Fig. 11. Effect of length and number of buds on stripping rate

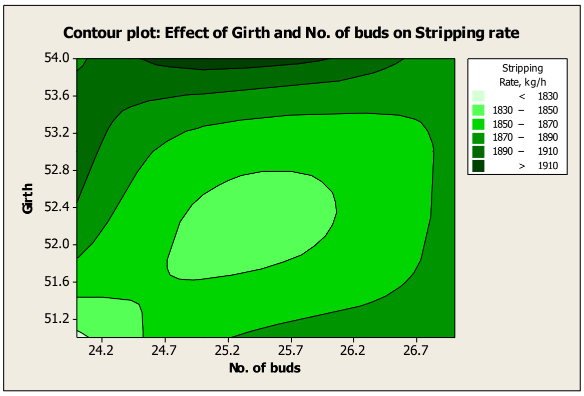

Fig. 12. Effect of girth and number of buds on stripping rate

Table 9. Analysis for de-topping time (K-269)

Source	DF	Seq SS	Adj SS	Adj MS	F	P	% Contribute
Length, mm	2	0.012422	0.012422	0.006211	34.94	0.028	55.7315
Girth, mm	2	0.000689	0.000689	0.000344	1.94	0.340	03.0912
No. of buds	2	0.008822	0.008822	0.004411	24.81	0.039	39.5800
Residual Error	2	0.000356	0.000356	0.000178			
Total	8	0.022289					

Table 10. De-topping time (95% confidence level)

Level	Length, mm	Girth, mm	No. of buds
1	2.480	2.517	2.490
2	2.537	2.533	2.530
3	2.570	2.537	2.567
Delta	0.090	0.020	0.077
Rank	1	3	2

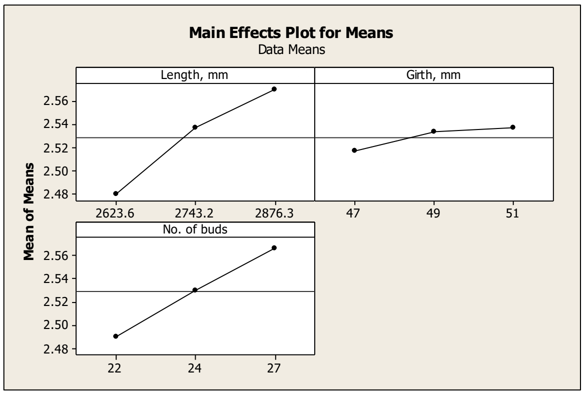

Fig. 13. Main effects plot for means of length, girth and number of buds on de-topping time

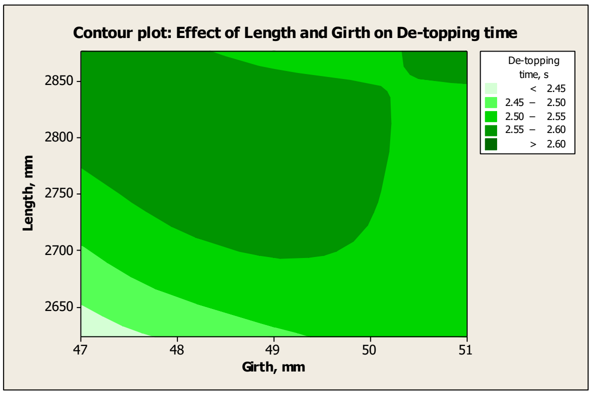

Fig. 14. Effect of length and girth on de-topping time

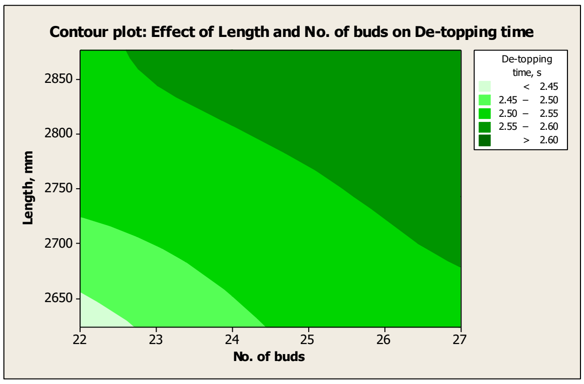

Fig. 15. Effect of length and number of buds on de-topping time

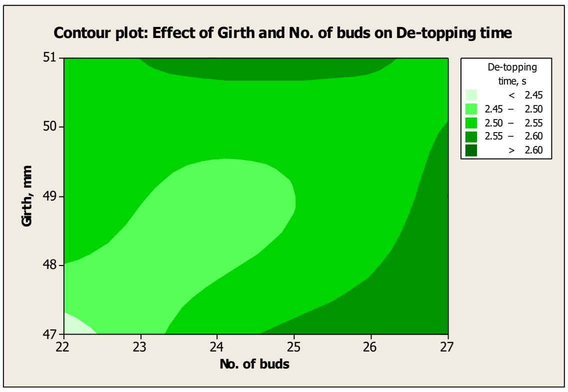

Fig. 16. Effect of girth and number of buds on de-topping time

Table 11. Analysis for stripping rate (K-269)

Source	DF	Seq SS	Adj SS	Adj MS	F	P	% Contribute
Length, mm	2	2907.56	2907.56	1453.78	120.04	0.008	78.0995
Girth, mm	2	764.22	764.22	382.11	31.55	0.031	20.5276
No. of buds	2	26.89	26.89	13.44	1.11	0.474	0.7222
Residual Error	2	24.22	24.22	12.11			
Total	8	3722.89					

Table 12. Stripping rate (95% confidence level)

Level	Length, mm	Girth, mm	No. of buds
1	1852	1862	1872
2	1875	1876	1875
3	1896	1884	1875
Delta	44	22	4
Rank	1	2	3

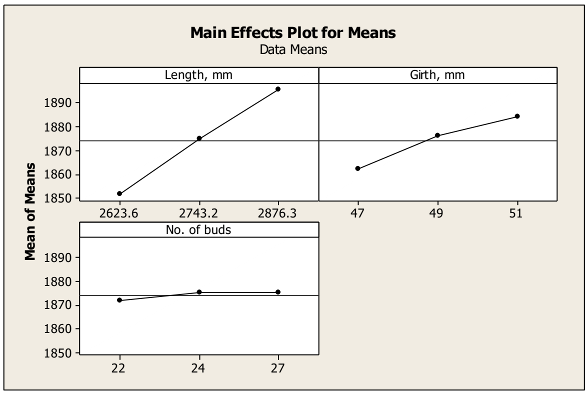

Fig. 17. Main effects plot for means of length, girth and number of buds on Stripping rate

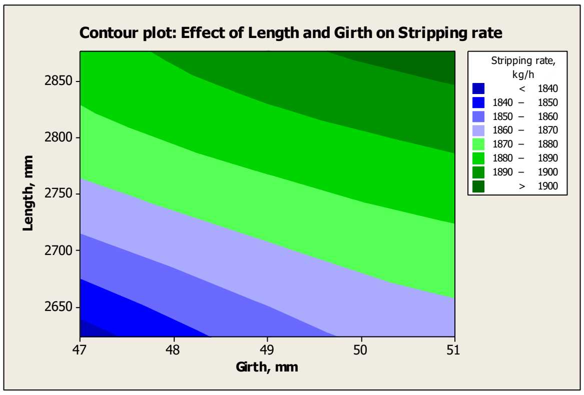

Fig. 18. Effect of length and girth on stripping rate

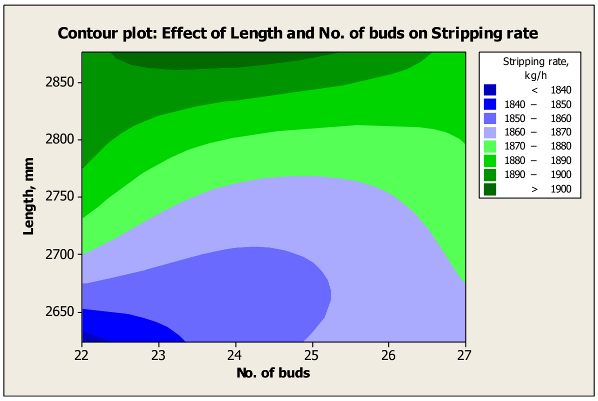

Fig. 19. Effect of length and number of buds on stripping rate

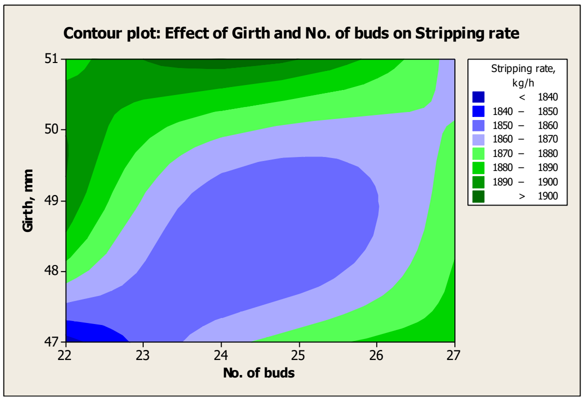

Fig. 20. Effect of girth and number of buds on stripping rate

As per the ANOVA Table 11, the length of the stalk is the most significant (P-value: 008<.05) and dominant parameter with 78.1 % contribution in affecting the stripping rate, followed by girth with 20.5% contribution. The contribution of number of buds has no significance in a test as per the "P" value (.474>.05). The mean effect plot for means in Fig. 17, showed that length of stalk and girth has a dominant effect on the stripping rate and the same trend has been shown by response Table for Mean in Table 12. The contour plots in Figs. 18-20 also provide the same picture.

4.2 Analysis of R-94184

As per the ANOVA Table13, the length of the stalk is the most significant (P-value: 009<.05) and dominant parameter with 84.52% contribution in affecting the de-topping time for the R-94184 variety, followed by the number of buds with 13.30 % contribution. The contribution of girth has no significance in a test as per the "P" value (.339>.05). As per mean effect plots for means in Fig. 21, length and number of buds have a more dominant effect on the de-topping time and the same trend has been shown by response Table for mean in Table 14. The contour plots in Figs. 22 to 24 also provide the same picture.

As per the ANOVA Table 15, the Length of the Stalk is the most significant (P-value: 008<.05) and dominant parameter with 60.72 % contribution in affecting the Stripping rate, followed by girth with 36.44 % contribution. The contribution of number of buds has no significance in a test as per the "P" value (.574>.05). The mean effect plot for means in Fig. 25, showed that length of stalk and girth has a dominant effect on the stripping rate and the same trend has been shown by Response Table for Mean in Table 16. The contour plots in Figs. 26-28 also provide the same picture.

Table 13. Analysis of De-topping time (R-94184)

Source	DF	Seq SS	Adj SS	Adj MS	F	P	% Contribute
Length, mm	2	0.048422	0.048422	0.024211	114.68	0.009	84.5223
Girth, mm	2	0.000822	0.000822	0.000411	1.95	0.339	01.4348
No. of buds	2	0.007622	0.007622	0.003811	18.05	0.052	13.3044
Residual Error	2	0.000422	0.000422	0.000211			
Total	8	0.057289					

Table 14. De-topping time (95% confidence level)

Level	Length, mm	Girth, mm	No. of buds
1	2.503	2.600	2.570
2	2.620	2.613	2.593
3	2.680	2.590	2.640
Delta	0.177	0.023	0.070
Rank	1	3	2

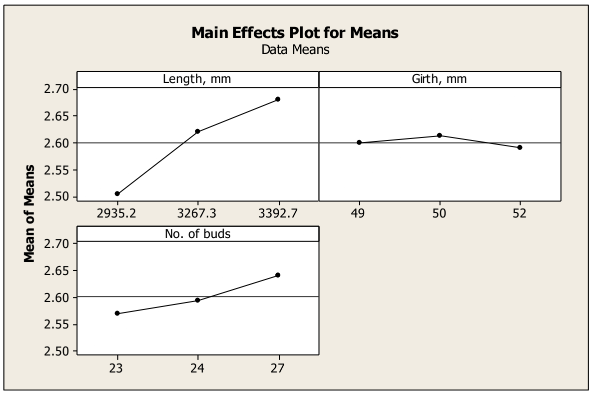

Fig. 21. Main effects plot for means of length, girth and number of buds on de-topping time

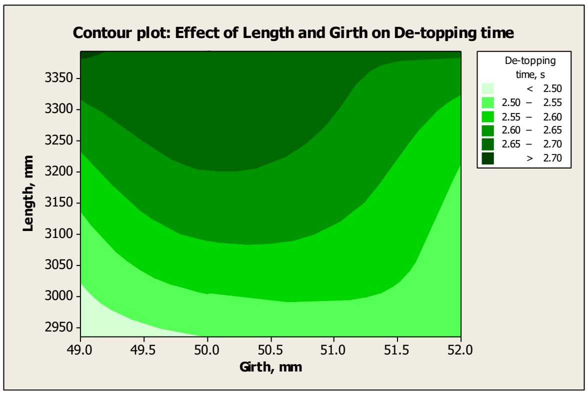

Fig. 22. Effect of length and girth on de-topping time

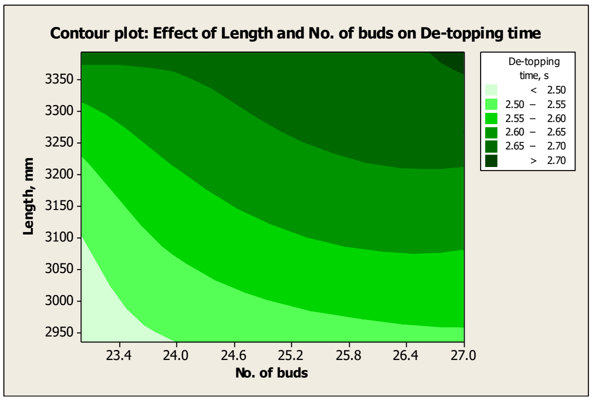

Fig. 23. Effect of length and number of buds on de-topping time

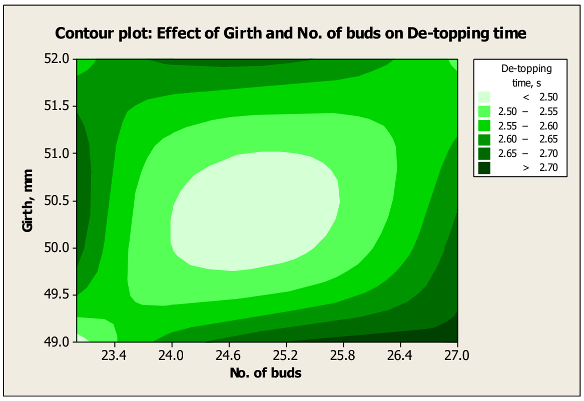

Fig. 24. Effect of girth and number of buds on de-topping time

Table 15. Analysis for stripping rate (R-94184)

Source	DF	Seq SS	Adj SS	Adj MS	F	P	% Contribute
Length, mm	2	2017.56	2017.56	1008.78	37.21	0.026	60.7170
Girth, mm	2	1210.89	1210.89	605.44	22.33	0.043	36.4408
No. of buds	2	40.22	40.22	20.11	0.74	0.574	01.2103
Residual Error	2	54.22	54.22	27.11			
Total	8	3322.89					

Table 16. Stripping rate (95% confidence level)

Level	Length, mm	Girth, mm	No. of buds
1	1869	1872	1885
2	1887	1888	1890
3	1906	1901	1886
Delta	37	28	5
Rank	1	2	3

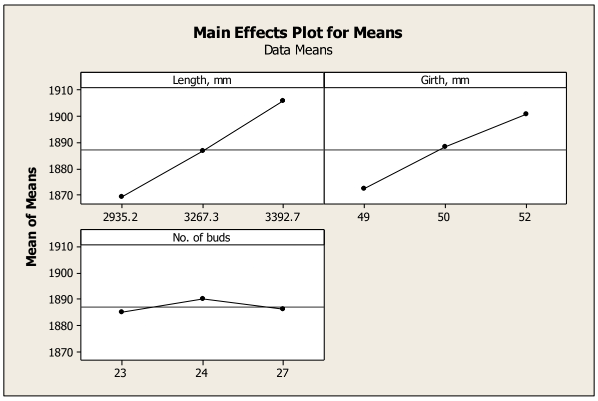

Fig. 25. Main effects plot for means of length, girth and number of buds on stripping rate

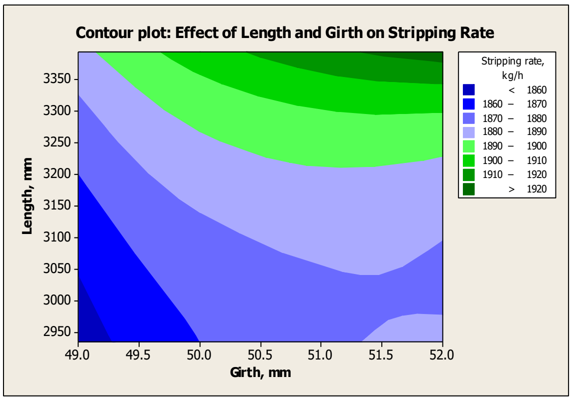

Fig. 26. Effect of length and girth on stripping rate

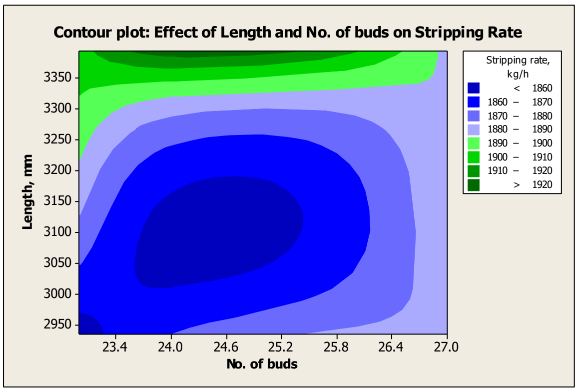

Fig. 27. Effect of length and number of buds on stripping rate

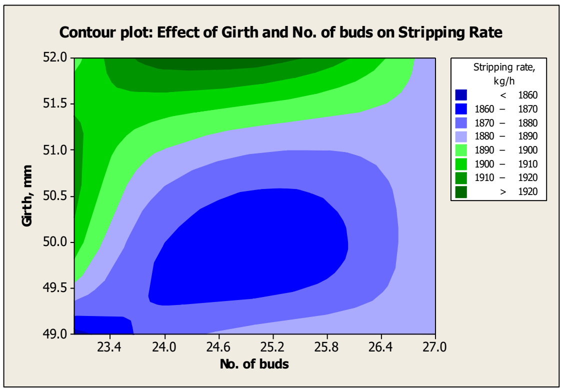

Fig. 28. Effect of girth and number of buds on stripping rate

5. DISCUSSION

In the experiment to evaluate the performance of the leaf stripper in terms of de-topping time, stripping rate and damage done to stalk, on varieties: a. MCO-238, b. K-269, c. R-94184. Following were the outcomes:

1. For de-topping time in the case of all three varieties (MCO-238, K-269, and R-94184), length is the most significant factor with the contribution of 78.62%, 55.73% and 84.52% respectively. The second significant dominant factor was number of buds with 19.65%, 39.58% and 13.30 % contribution. In all three cases, girth has no significant contribution and effect.
2. For stripping rate the most dominant and significant factor was the length of the stalk: MOC-238 has 62.35 % contribution, K-269 has 78.10% contribution and a case of R-94184 has 60.72% contribution. The second significant factors were girth with the contribution of 33.30%, 20.53% and 36.44% contribution in MCO-238, K-269 and R-94184 varieties respectively. The factor, number of buds remained insignificant.

6. CONCLUSION

From the results of the experiment and then analyzed through Taguchi's technique it has been concluded that while using PTO operated sugarcane leaf stripping machine; the length and number of buds affect the stripping time significantly, length of stalk and girth of the stalk has a significant impact on the stripping rate and lastly, the damage on the stalk is connected with girth and number of buds. These factors have a significant role in the performance of the machine and hence can help in efficient designing and fabricating.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. FAOSTAT. Sugarcane production in 2018, Crops/Regions/World list/Production Quantity (pick lists); 2019. [Online] Available:https://www.fao.org/faostat/en/#data/QC \
[Accessed 02 February 2022].
2. Statista Research Department. Annual yield of sugarcane in India from financial year 2014 to 2020, with an estimate for 2021,. [Online]; 2020. Available:https://www.statista.com/statistics/764345/india-yield-of-sugarcane/
[Accessed 02 April 2022].
3. Kishore N, et al. Present mechanization status in sugarcane – A review. International Journal of Agriculture Sciences. 2017;9(22):4247-4253.
4. Anurag P, Rajkishor S, Prabhakar S, Seen CM. Performance evaluation of self propelled reaper binder for harvesting of wheat crop. International J. Current Microbiology Applied Science. 2018; 7(12):896-906.
5. Clemenson CL, Hansen A. Pilot study of manual sugarcane harvesting using biomechanical analysis. J Agric Saf Health. 2008;14(3):309-320.
6. Prabhakar S, Subhasis N, Pramanand S, Anurag P, Himanshu T. Field test analysis of straw reaper combine for optimized operating condition to improve the performance. Current Journal of Applied Science and Technology. 2020;39(8):77-86.
7. Dawson L, Boopathy R. Use of post-harvest sugarcane residue for ethanol production. Bioresource Technology. 2007; 98(9):1695-1699.
8. Cansee S. A Study of sugarcane leaf-removal machinery during harvest. American J. of Engineering and Applied Sciences. 2010;3(1):186-188.
9. Lin J, Yan W, Lin J. The large-scale sugarcane stripper with automatic feeding. Research Journal of Applied Sciences, Engineering and Technology. 2012; 4(14):2183-2185.
10. Singh A, Solomon S. Development of a sugarcane detrasher. Sugar Tech. 2014;17(2):189-194.
Available:10.1007/s12355-014-0306-5
11. Ashfaq S, Ghafoor A, Ahmad M, Yaqub Q. Performance evaluation of sugarcane stripper for trash recovery. International Journal of Renewable Energy Research. 2014;4(4):992-997.
12. Chandravanshi A, Verma A, Roy D. De-trashing of sugarcane: A review. The Pharma Innovation Journal. 2021;10(2): 01-10.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/88936