
The development of a slide-rail pneumatic node cutting machine applied to two sugarcane varieties

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Abstract To minimize seed node damage during propagation, a slide-rail pneumatic node cutting machine (SPCM) equipped with double concave blades was developed. The results indicated that pneumatic pressure significantly influenced the cutting force, with the average forces ranging from 1,590 to 2,440 N with the pressure increased. Regarding node quality, the machine's double concave blade design achieved an average of 72.22% "good quality nodes," with no severely damaged nodes were observed across all the tests. The bottom stalk position yielded the highest percentage of good quality nodes at 81.11%. The maximum working capacity reached 1,290 nodes per hour for the LK92-11 variety at a pressure of 60.04 N/cm². To preserve the lightweight structure of 42 kg, a pressure of 50.03 N/cm² is recommended for standard operation.

Keywords: Sugarcane node, Seed cutting, Slide blade, Node quality

Introduction

Sugarcane is an important economic crop in Thailand. In the 2024/2025 production year, sugar mills were supplied with 92 million tons, valued at approximately 365,790 million USD (OCSB, 2025). Due to their high sweetness and yield, there are five major sugarcane varieties, UT84-11, K88-92, LK92-11, Khon Kaen 3 (KK3), and DOA Sugarcane Nakhon Sawan 1 (NSUT10-266), which are popular and frequently planted. The KK3 variety has been grown in about 80% of the country's sugarcane-growing area, particularly in the regions of Northeastern and Eastern Thailand (Khumla *et al.*, 2022; Rungmekarat *et al.*, 2026). Such a cultivar is suitable for planting due to its fast growth, high crop production, and drought tolerance. Regarding the LK92-11, this variety has been widely grown in Eastern Thailand's region due to its high yield, drought tolerance, and resistance to red rot and smut

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diseases (Buddiwong *et al.*, 2025). However, continuous cultivation of a single sugarcane variety in all areas can make it susceptible to diseases and pests (Daken, 2020; Kaewkantha, 2020), which affects the amount of sugarcane available for milling and, consequently, sugar production. These effects have led to a campaign that is focused on planting new crops (Daken, 2020) to decrease an occurrence of sugarcane diseases, insects, and other pests (Boodseeaphum and Wongtamee, 2022; Kaewkantha, 2020). In order to supply growers with sufficient sugarcane varieties, propagation, which is carried out by planting sugarcane stalks and billets directly in the sugarcane fields, takes a long time (6-8 months at least). Thus, propagation using bud chips and nodes enables rapid distribution and reduces the requirement for sugarcane seeds by 70-80% per planting area (Jain *et al.*, 2010; Jaiphong *et al.*, 2020; Singh *et al.*, 2020).

To cut sugarcane nodes for propagation, several devices have been developed. For example, hand-cutting utilizing machetes and human power is a simple method. This platform has been applied to suit small-scale farms or areas facing limited access to electrical power (Shrestha *et al.*, 2024; Tangwongkit, 2020). Nevertheless, when having to operate with a large number of sugarcane nodes, this technique is time-consuming and labor-intensive (Killedar *et al.*, 2019). Therefore, electric motors and engines have been applied to drive the cutting system (Elwakeel *et al.*, 2024; Elwakeel *et al.*, 2021). These power sources control the mechanism that slides the blade back and forth to create shear force and thereby, gently cut sugarcane nodes. However, as the cutting speed is increased, the ability to cut sugarcane nodes decreases. The arrangement of sugarcane stalks for cutting sugarcane nodes is discontinuous, thus causing more damage to the sugarcane nodes when directly cut by pressing blades. Whenever double blades are used, the nodes may be injured. Another method is to directly apply an electric motor that drives twin circular saw blades (SASRI, 2015; Wang *et al.*, 2022; Zhou *et al.*, 2020), which reduces the number of damaged or broken sugarcane nodes during the operation. Conversely, the cut tissues become splintered, thus making them more susceptible to being destroyed by pathogens. Moreover, when sugarcane is cut, dust is produced and spreads out, which tends to cause air pollution problems and affects the respiratory health of the operators (Leite *et al.*, 2018; Sakunkoo *et al.*, 2011). Currently, modern agricultural technology is focusing on precision agriculture, utilizing machine vision and deep learning to accurately identify, to efficiently improve, and to precisely cut sugarcane nodes so that bud damage can be minimized (Wang *et al.*, 2022; Zhou *et al.*, 2020). However, automated cutting machine problems consist of slow speeds, poor real-time performance, and expensive maintenance (Shrestha *et al.*, 2024), which is particularly problematic in developing countries due to the need for cost-effectiveness. Some modern cutting machines apply fluid transmission to support the cutting process due to uncomplicated installation and high-power requirements. For example, a

hydraulic system can be modified to provide a high cutting force with sugarcane's hard skin (Jaiphong *et al.*, 2020; Singh *et al.*, 2013). However, this system is expensive and unaffordable (Killedar *et al.*, 2019) for conducting propagation. The structure is rather heavy compared to other power sources, which makes it difficult to move it anywhere. In contrast, a pneumatic system machine, which is fitted with an automated precision system, can reach a high speed, and has accurate efficiency when cutting sugarcane nodes. Furthermore, it can be easily transported anywhere (Shrestha *et al.*, 2024). The pneumatic structure is lightweight and low maintenance, as well as is convenient to install. However, compared to a similarly sized hydraulic system it has less power.

Sugarcane buds are sensitive and easily injured. Therefore, protecting any damage during bud cutting is a challenge. Any small scratch on the sugarcane bud can cause damage, which could lead to improper germination and could result in spoilage. When cutting, care must be taken because the sugarcane bud, which protects the sugarcane from a seed to a plant, should not become stressed. The different cutting forces rely upon the physical properties of the sugarcane stalks, depending on the cutting positions at the top, middle, or bottom of the stalk. As the stalk's diameter increases, the cutting forces tend to rise (Samaila *et al.*, 2012). The sugarcane nodes that are directly cut by applying pressure with a single straight sharp knife require two cuts per one sugarcane node, which is time-consuming and leads to excessive pressure force demands. When cut with double straight sharp knives, the seed nodes are damaged by pressing and by lateral forces (Jaiphong *et al.*, 2020; Mahmoud and Abu El-maaty, 2021). To improve node quality, the development of a sugarcane node cutter is mandatory. Therefore, the objective was to develop a slide-rail pneumatic node cutting machine (SPCM) with varied pressures that could be applied to two sugarcane varieties in Thailand.

Materials and methods

The design of SPCM

The design of SPCM was based on the following concepts: having a compact structure and being lightweight in design (overall dimensions: 68 cm wide × 160 cm long × 120 cm high; total weight: 42 kg). The operating mechanism, which was simplified, is low maintenance, is able to be easily transported, and requires only for one person to operate. The machine has the following important components (Figure 1). The sugarcane stalk beam supports the sugarcane stalks. The sliding support helps to slide the sugarcane stalks into the sugarcane node cutting system. The pneumatic cylinder (Bore 80 mm × Stroke 150 mm) holds the sugarcane node cutting blade. The pneumatic cylinder size was selected based on cutting force data reported by

Jaiphong *et al.* (2020), which were measured by a universal testing machine (Instron: Table Model 3400 Series). The sliding blade cutter (commercially available blade; concave edge radius 180 mm $\times$ blade thickness 2.5 mm, blade angle 10 degrees per side) is a double-blade type, which is able to slide back and forth to cut the sugarcane nodes. The adapted blades are specifically designed to manually cut sugarcane and can be sourced locally. The blade was cut from a handle and drilled at both ends to fit between the shafts of the sliding rail and the pneumatic cylinder. The sugarcane nodes are cut 40 mm long (Singh *et al.*, 2020). The sugarcane node receiving hole supports the node after it has been cut. The internode receiving hole accepts the internode by dropping it inside. An air regulator with filter controls the pressure itself. The footswitch controls the operation of the pneumatic cylinder. In addition, a 5 HP, 890 l/min air compressor from Puma Industrial Co., Ltd. (Thailand) serves as the air supply source.

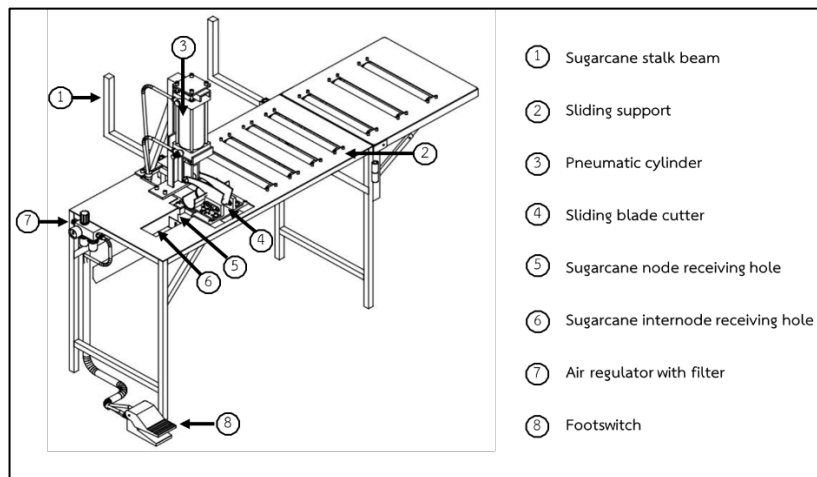


Figure 1. The components of SPCM

The design of the cutting force measurements for SPCM

Electronic devices were installed to measure the cutting force (Figure 2). A pressure transducer (Kyowa: PG-10KU) detects the air pressure to measure the force applied to cut sugarcane nodes. A displacement transducer (Tokyo Sokki Kenkyujo: DP-1000C) measures the distance of the movement of the sugarcane node cutter blade. A compact recorder (Kyowa: EDS-400A) amplifies the signal of the sensor and transducer to collect the operating data. A monitor displays the cutting data of the tested sugarcane nodes. The pneumatic pressure was set for cutting sugarcane nodes at three different levels: 40.03, 50.03, and 60.04 N/cm², respectively. Thirty replications per sample were tested, totaling 540 sugarcane node samples.

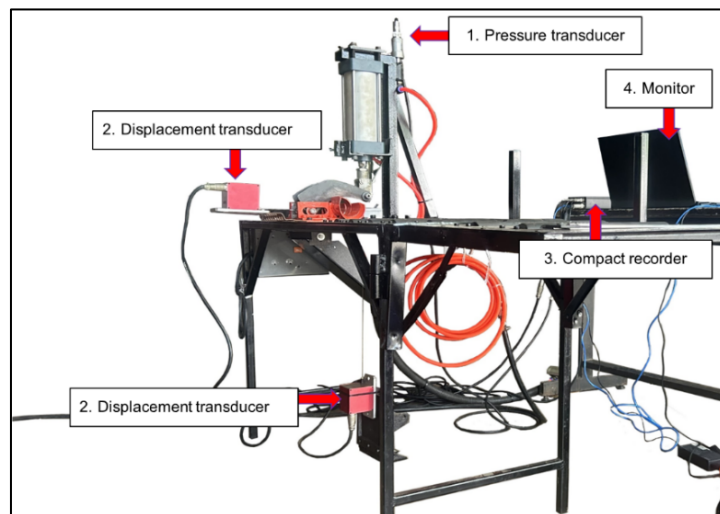


Figure 2. The setting of the instruments used to measure the cutting forces

The performance test of SPCM

Preparing two sugarcane varieties to cut sugarcane nodes

Two varieties of 8-month-old sugarcane (KK3 and LK92-11) were prepared. Both varieties had been grown in the Kamphaeng Saen District of Nakhon Pathom Province. The physical characteristics of sugarcane stalks were studied, and then stalks were divided into three main positions: the top of the sugarcane (the position of the 3rd–4th sugarcane nodes from the natural breaking point of the sugarcane), the middle of the sugarcane stalk, and the bottom of the sugarcane stalk (the position of the between 3rd and 4th sugarcane nodes from the base of the sugarcane stalk). At each position, the diameter of the sugarcane node, the distance of sugarcane internode, the number of nodes per sugarcane stalk (buds per stalk), and the length of sugarcane stalk were all measured, with 35 replications each.

The quality of cut sugarcane nodes

The cutting-edge qualities of the sugarcane nodes were obtained from cutting the sugarcane at the top, middle, and bottom stalk positions of the two sugarcane varieties. The air pressure measurements used to cut the sugarcane nodes were at three levels: 40.03, 50.03, and 60.04 N/cm². Samples of 540 nodes (30 nodes × 3 positions × 3 levels of pressure × 2 varieties) were measured to determine the cutting-edge qualities. The cutting-edge qualities of sugarcane nodes were classified by following the methods derived from Elwakeel *et al.* (2024), Elwakeel *et al.* (2021), and Kroes (1996). Each sample of the cut-node qualities was evaluated by cooperating 2-3 inspectors (Whiteing and Kingston, 2008). The node qualities of the sugarcane stalks were classified into five categories (Figure 3).

1) Good nodes: The nodes were able to be cut without cracks and damage. The sugarcane node is damaged less than any other type.

2) Split nodes: The nodes were cracked or bruised on the edges more than the complete sugarcane node (Good node), but less than the characteristics of other types.

3) Cracked nodes: The nodes were cracked and separated at the cutting-edge. The edges of the cracks were 5-10 mm long.

4) Damaged nodes: The nodes were cracked or had cracks longer than 10-20 mm.

5) Severely damaged nodes: The nodes were cracked longer than 20 mm. The sugarcane nodes were broken.



Figure 3. The classification of the sugarcane node qualities

Testing the cutting performance

The capacity testing of SPCM was divided into three levels of tested pneumatic pressure: 40.03, 50.03, and 60.04 N/cm². According to the level of the pressure tested, three replications of sugarcane nodes were cut using specific pneumatic pressure to each pneumatic pressure level by cutting 100 sugarcane nodes per time period (Equation 1).

$$\text{Sugarcane node cutting rate} = \frac{\text{Number of sugarcane nodes cut}}{\text{Time period of cutting}} \quad (1)$$

Statistical analysis

To determine the differences between the various cutting conditions, statistical analyses were used to analyze significant levels and to compare the factors related to the SPCM's varying forces for cutting sugarcane nodes. The analyses were conducted as detailed below:

- The physical characteristics of sugarcane varieties prior to cutting

One way ANOVA was performed to compare the physical characteristics of the two sugarcane varieties, such as stalk diameter, length, and buds per stalk.

- The forces for cutting the sugarcane nodes

Two-way ANOVA was performed on both sugarcane varieties in order to determine the cutting forces that the different pneumatic pressures could have on the sugarcane node positions.

- The sugarcane node quality

The chi-square test was used. However, if the counts in any of the cells was lower than five, Fisher's exact test was used instead. The test was used to compare the two sugarcane varieties with regard to the quality of the sugarcane nodes at the different stalk positions (the bottom, middle, and the top) under the varying pneumatic cutter pressures.

- The sugarcane node cutter capacity

Two-way ANOVA was performed to compare the cutting rates at the different pneumatic pressures.

All statistical analyses were performed in R version 4.5.1 (R Core Team, 2025). A P -value < 0.05 was considered significant. If significant differences were found among treatments after an ANOVA, post-hoc comparisons, such as Duncan's Multiple Range Test, were applied.

Results

The physical characteristics of the sugarcane

In total, the 210 node samples, which had been obtained from the top, middle and bottom stalks, were measured thrice. The physical characteristics indicated significant differences (P -value < 0.05) between the two sugarcane varieties (KK3 and LK92-11) (Table 1). The LK92-11 variety displayed significantly greater stalk length (2.10 ± 0.28 m) and higher numbers of nodes per stalk (17.68 ± 2.12 nodes) compared to those of the KK3 variety. Regarding the node diameters, the LK92-11 variety had exhibited larger dimensions across all measured positions (top, middle, and bottom), significantly exceeding the KK3 variety. The KK3 variety produced a higher internode distance at each position than the LK92-11 variety but this was not significant (P -value ≥ 0.05).

Table 1. The descriptive statistics of the physical characteristics of the sugarcane varieties

Items		KK3 (Mean $\pm$ SD)	LK92-11 (Mean $\pm$ SD)
Stalk length (m)		1.52 ± 0.22^a	2.10 ± 0.28^b
Nodes per stalk		13.37 ± 2.47^a	17.68 ± 2.12^b
Position of the node diameter (mm)	Top	29.69 ± 2.64^a	32.36 ± 2.71^b
	Middle	29.68 ± 2.16^a	32.39 ± 2.43^b
	Bottom	30.38 ± 2.04^a	33.73 ± 2.81^b
Position of the internode distance (cm)	Top	9.07 ± 2.20^a	8.65 ± 1.39^a
	Middle	10.70 ± 1.40^a	9.57 ± 2.11^a
	Bottom	10.32 ± 2.44^a	10.30 ± 1.94^a

Means with the same row followed by the same letter were not significantly different at P -value < 0.05 .

The sugarcane node cutting force

The forces used for cutting the sugarcane node positions of the two varieties (KK3 and LK92-11) were measured using three pneumatic pressure levels: 40.03, 50.03, and 60.04 N/cm², respectively. The study indicated that pneumatic pressure was the primary factor that had influenced cutting force. An increase in pressure from 40.03 to 60.04 N/cm² had led to a significant increase in cutting force between the two sugarcane varieties and among the node positions within the varieties (P -value < 0.05). With respect to the top position of the KK3 variety with a pressure of 60.04 N/cm², the maximum cutting force was observed at $2,485.85 \pm 155.68$ N. Similarly, under the previous same pressure, the LK92-11 reached its peak cutting force at the middle node position at $2,425.23 \pm 140.77$ N. Additionally, for both varieties, a pressure of 40.03 N/cm² provided an average cutting force ranging from 1,590 to 1,670 N. When the pressure was increased to 50.03 N/cm², the average cutting force had ranged from 1,890 to 1,900 N, increasing approximately 14–19% compared to the force at 40.03 N/cm². Furthermore, testing at 60.04 N/cm² showed that the average cutting force had ranged from 2,380 to 2,440 N, representing an increase of 47–49% relative to the pressure of 40.03 N/cm² (Table 2 and Figure 4).

Table 2. The impact of cutting forces on sugarcane varieties at different pneumatic pressures and node positions

Varieties	Pressures (N/cm ²)	Node positions	Cutting forces (N) (Mean $\pm$ SD)
KK3	40.03	Top	$1,515.65 \pm 76.03^a$
		Middle	$1,594.32 \pm 76.71^{ab}$
		Bottom	$1,666.62 \pm 80.54^{bc}$
	50.03	Top	$1,833.39 \pm 94.67^d$
		Middle	$1,945.22 \pm 80.05^e$
		Bottom	$1,922.76 \pm 88.78^{def}$
	60.04	Top	$2,485.85 \pm 155.68^g$
		Middle	$2,362.15 \pm 139.60^h$
		Bottom	$2,464.47 \pm 125.96^{gi}$
LK92-11	40.03	Top	$1,670.64 \pm 69.36^{bcj}$
		Middle	$1,647.59 \pm 72.99^{bcjk}$
		Bottom	$1,670.84 \pm 74.07^{bcjk}$
	50.03	Top	$1,889.41 \pm 97.32^{defl}$
		Middle	$1,888.23 \pm 72.99^{deflm}$
		Bottom	$1,891.86 \pm 85.64^{defm}$
	60.04	Top	$2,298.88 \pm 148.92^h$
		Middle	$2,425.23 \pm 140.77^{ghin}$
		Bottom	$2,408.06 \pm 135.28^{ghin}$

Means with the same column followed by the same letter were not significantly different at P -value < 0.05.

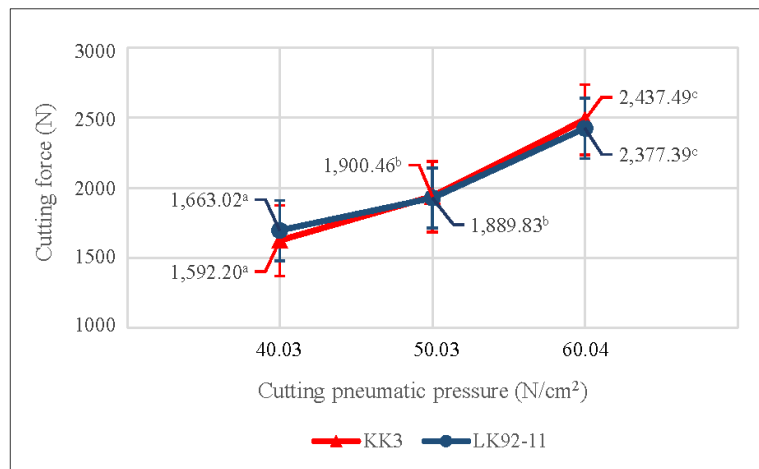


Figure 4. The impact on cutting forces by using different pneumatic cutting pressures with the sugarcane varieties

Means with the same line and sign followed by the same letter were not significantly different at P -value < 0.05 .

The quality of the cut sugarcane nodes

The overall qualities of both varieties of sugarcane nodes impacted the three cutting pressures (Table 3). The classification at the good node quality level had shown an average of 72.22%, while the criterion of the split node quality level had exhibited an average of 17.41%. The criterion of the cracked node quality level had had an average of 8.89%, while the criterion of the damaged node quality level had exhibited an average of 1.48%. Meanwhile, the criterion of the quality level of the severely damaged nodes did not appear from the operation of the sugarcane node cutter. When comparing the quality of the cuts node between the two varieties, the results were not found to be statistically significant (P -value = 0.575). Additionally, the cut node qualities at the three cutting pressure levels were not determined to be significantly different (P -value = 0.102). However, the quality range of the good nodes tended to increase with higher cutting pressure. When the three node positions were compared, the results were significantly different (P -value < 0.001). The bottom node position of the sugarcane stalk had shown a higher quality level of good nodes than the middle and top positions.

The working capacity of the sugarcane node cutter

The performance of the sugarcane node cutter was evaluated as shown in Figure 5. Overall, the average amount of cutting capacity per hour for sugarcane buds had ranged from 1,048 to 1,068; 1,127 to 1,209; and 1,217 to 1,290, corresponding to each of the pressure levels. Additionally, the cutting rate showed a positive relationship with the applied pressures for each variety. The sugarcane node cutting rate at the pressure level of 40.03 N/cm² for the

LK92-11 (1,068 nodes per hour) and the KK3 (1,048 nodes per hour) were not determined to be significantly different (P -value > 0.05). At a pressure of 60.04 N/cm², both varieties showed significantly higher rates (P -value < 0.05), with the KK3 producing 1,217 nodes per hour and the LK92-11 producing 1,290 nodes per hour. These rates represented the highest rates observed across all pressure levels as shown in Figure 5.

Table 3. The impact of the node positions and the different cutting pressures on the quality of the sugarcane nodes

On the quality of the sugarcane nodes							
Items	Sugarcane node quality (Observed counts (%))					Chi-squared <i>P</i> -values	
	Good	Split	Cracked	Damaged	Totals		
Varieties	KK3	194	47	23	6	270	<i>P</i> -value = 0.575
		(71.85%)	(17.41%)	(8.52%)	(2.22%)	(100.00%)	
	LK92-11	195	47	26	2	270	
		(72.22%)	(17.41%)	(9.63%)	(0.74%)	(100.00%)	
Total	390	94	48	8	540		
		(72.22%)	(17.41%)	(8.89%)	(1.48%)	(100.00%)	
Node Positions	Top	105	46	22	7	180	<i>P</i> -value < 0.001
		(58.33%)	(25.56%)	(12.22%)	(3.89%)	(100.00%)	
	Middle	138	35	6	1	180	
		(76.67%)	(19.44%)	(3.33%)	(0.56%)	(100.00%)	
	Bottom	146	13	21	0	180	
		(81.11%)	(7.22%)	(11.67%)	(0.00%)	(100.00%)	
Total	390	94	48	8	540		
		(72.22%)	(17.41%)	(8.89%)	(1.48%)	(100.00%)	
Pressure (N/cm ²)	40.03	121	40	17	2	180	<i>P</i> -value = 0.102
		(67.22%)	(22.22%)	(9.44%)	(1.11%)	(100.00%)	
	50.03	125	30	21	4	180	
		(69.44%)	(16.67%)	(11.67%)	(2.22%)	(100.00%)	
	60.04	143	24	11	2	180	
		(79.45%)	(13.33%)	(6.11%)	(1.11%)	(100.00%)	
Total	390	94	48	8	540		
		(72.22%)	(17.41%)	(8.89%)	(1.48%)	(100.00%)	

Chi-squared P -values were estimated from Fisher's exact test given that the observed counts for some cells were lower than five.

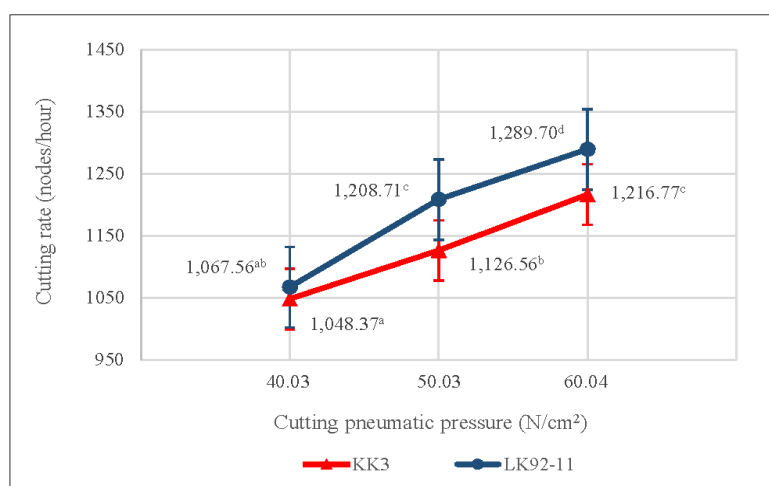


Figure 5. The different pneumatic pressures for the sugarcane cutting rates Means with the same line and sign followed by the same letter were not significantly different at P -value < 0.05 .

Discussion

This study hypothesized that SPCM could produce higher-quality sugarcane nodes. To the best of our knowledge, this slide rail pneumatic cutter machine was first developed by the researchers. The sliding rail blade system operates by driving the air pressure in a shearing motion, uniquely cutting sugarcane stalks at the nodes. The cuts made to the sugarcane stalks are fresh and are free from splinters or shreds. The cutter's lightweight structure (42 kg) makes it easy to transport to other locations. The machine is suitable for both small-scale and commercial node varieties. In contrast, other machines cut directly onto the stalks, thereby increasing the cutting forces and the risk of damaging the nodes (Jaiphong *et al.*, 2020; Mahmoud and Abu El-maaty, 2021), especially when using dual blades and lateral force compression. Twin-blade circular saw cutters cause the cut tissue to splinter into small pieces (SASRI, 2015), making it unsuitable for planting and marketable sugarcane nodes. Furthermore, these small fragments can cause respiratory problems for the operators (Leite *et al.*, 2018; Sakunkoo *et al.*, 2011).

The mechanical efficiency and the factors affecting cutting force

The main factors influencing the cutting force were found the pneumatic pressure and the physical characteristics of the sugarcane, which in accordance with the following relationship. Pressure was one of the primary factors influencing the cutting force, which is consistent with the equation $P = F/A$. The position of the sugarcane node also affected the cutting force due to the hardness of the sugarcane rind as the node ages (Singh *et al.*, 2013). Furthermore, the diameter of the sugarcane node is also related to the cutting force. With nodes that have larger diameters, a higher cutting force is required (Samaila *et al.*, 2012).

The fact that increased air pressure was needed to cut the sugarcane nodes demonstrated that the efficiency of a pneumatic sliding-type cutting device depends upon optimizing the power setting so that it can match the resistance of the sugarcane tissue. To ensure that sufficient cuts can be made through even the hardest nodes, the appropriate air pressure needs to be adjusted within a range from 50.03 to 60.04 N/cm². This is consistent with previous studies by Elwakeel *et al.* (2024) and Jaiphong *et al.* (2020). However, when tests were performed using an air pressure of 60.04 N/cm², the cutter's structure vibrated due to the high cutting force. Hence, choosing an air pressure of 50.03 N/cm² is a better option in order to protect the machine's assembly from any damage that could be caused by the increased cutting force. Whenever, a hard section of sugarcane stalk needs to be cut, especially at the bottom position of a stalk, the air pressure should be set to 60.04 N/cm². Utilizing an adjustable pneumatic pressure technique preserves the machine's lifespan.

Cutting capacity and quality of node cuts

The performance of SPCM demonstrated advantages in both the quantitative and qualitative aspects. The physical characteristics of the LK92-11, especially a higher node number per sugarcane stalk, had significantly affected the overall cutting quantity compared with the KK3. Additionally, increasing the pressure from 40.03 to 60.04 N/cm² had resulted in a significant increase in the cutting force of 47–49%. This increased force had directly contributed to an increase in the maximum cutting rate for LK92-11. Interestingly, in this study, severely damaged nodes were not found using SPCM. The results indicated that the concave blade designed for shearing (180 mm radius) can effectively distribute the cutting force compared to the direct pressing method used by other cane node cutters (Jaiphong *et al.*, 2020; Mahmoud and Abu El-maaty, 2021).

The higher cutting rates and the quality of node cuts are the major factors to be considered for commercial cane node manufacturers. To achieve the highest cane bud cutting rate without compromising the quality of the cut nodes, an air pressure of 60.04 N/cm² should be used. Meanwhile, the highest cutting rate (1,290 nodes per hour) could still be run and would provide a high percentage of good quality nodes (79.45%).

As reported by Elwakeel *et al.* (2024), the machine achieves a higher operating rate due to its design and dual-operator requirement. Furthermore, the similar twin-head cutting design of the cutting heads suggests that sugarcane node damage could occur, reflecting the outcomes (Jaiphong *et al.*, 2020; Mahmoud and Abu El-maaty, 2021). Conversely, even though the SPCM operates at a slower cutting rate, its lightweight structure enhances mobility. The SPCM design, which utilizes a unique double concave blade, represents a novel advancement in agricultural machinery that enhances node quality and eliminates any severe damage. This machine produces fresh, high-quality cuts that are suitable for commercial planting.

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Conflicts of interest

The authors declare that there were no conflicts of interest.

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