

STUDY ON PERFORMANCE OF TRIPLE ROWS SWEET POTATO TRANSPLANTER MACHINE

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ABSTRACT

Sweet potatoes are a cash crop that also contributes to the country's agro-food output. Meanwhile, vine cuttings are the most common seedling in sweet potato cultivation in Malaysia. Most farmers nowadays plant sweet potatoes manually which takes a lot of effort and time. However, a few farmers have utilized a single-row sweet potato planter. However, the utilization of this machine is still insufficient to meet the needs of sweet potato production. As a result of research and enhancements from current planters, MARDI has developed a three-row sweet potato planter. The purpose of this study was to put the developed planter to the test. The developed planter is made up of two main parts: the main frame and three sets of planter pieces. Each planter unit includes a seedling tray, gripper, furrow opener, soil compactor, and operator's seat. This study was carried out at MARDI Bachok

in Kelantan. During the study, data such as operation time, tractor speed, travel slip, and crop distance were collected. According to the study's findings, the work capacity for the manual method, single-row planter, and three-row planter is 0.048 hectare/hour, 0.16 hectare/hour, and 0.31 hectare/hour, respectively. That is, the three-row planter outperforms the manual approach by 84.5% and the single-row planter by 48.3%. This is because this planter can plant sweet potatoes in three rows at the same time for a single path. As a result, the adoption of this three-row sweet potato planter may have a positive impact on the use of mechanization for the country's sweet potato production.

Keywords: Sweet potato, planter, field efficiency

INTRODUCTION

Sweet potatoes are classified as cash crops or short-term crops, yielding returns during a span of 3 to 6 months. Cash crops further enhance the country's agro-food production, following rice, fruits, and vegetables (Ruwaida et al. 2020). In 2021, Malaysia produced 53,614 metric tons of sweet potatoes, cultivated across a total area of 3,129 hectares. Perak, Kelantan, and Selangor were the top sweet potato producing states in 2021, with production volumes of 33,476 metric tons, 10,946 metric tons, and 3,458 metric tons, respectively. In Kelantan, sweet potato production primarily occurred in the BRIS land area in Bachok, resulting in a yield of 8,995 metric tons. This accounted for 16.7% of the overall sweet potato production in 2021 (DOA. 2022).

The cultivation of sweet potatoes in BRIS land is conducted using a semi-mechanized approach. Land preparation procedures are mechanized, whereas the subsequent operation is performed manually (Md. Akhir et al. 2014). According to Birhanu et al. (2016), vine cutting is the preferred planting material for sweet potato production due to its speed and ease of acquisition compared to mini tubers. Furthermore, the estimated number of cuttings needed per hectare for planting was roughly 33,000 (Anuar et al. 2020).

Nowadays, there is a large range of vegetable planters available in the market. However, globally, semi-automatic transplanting technology has been widely embraced (Liu et al. 2021). Essentially, these semi-automatic transplanting operate based on the process in which the operator places the vine cutting into the clamping component. Subsequently, this clamp will move down after being moved by the driven wheel along with the movement of the tractor to insert it into the soil. The planting mechanism was designed to open and close the clamping component after planting in order to prevent the seedlings from being dislodged during forward movement. Following that, the vine section that has been planted is compressed using a compactor roller.

Currently, farmers rely on conventional techniques for planting sweet potatoes due to a lack of available sweet potato planting machines. This manual procedure necessitates a workforce of up to ten individuals capable of accomplishing the planting task within a duration of four hours per hectare. At the moment, the sweet potato planting machine in use was a single-row vegetable transplanter machine manufactured by Checchi & Magli (Checchi & Magli. 2023). This machine requires the presence of two workers to function at a productivity rate of 6 hours per acre.

Nevertheless, the utilization of current machinery remains suboptimal as a result of workers limitations and a brief planting duration. Hence, in order to address this matter, it is vital to enhance the functionality of the current machine in order to improve its operational efficiency. The aim of this study was to assess and compare the performance of both the original and improved sweet potato transplanter machines in the field.

MATERIALS AND METHODS

Experimental site

The experiment was conducted in a research plot located in the MARDI Bachok Research Station in Kelantan. The site exhibits BRIS soil composition and experiences an annual precipitation of 2500-2800 mm with temperatures ranging from 24°C – 32°C.

The study was carried out in two plots of 100 meters in length and 50 meters in width, with each plot covering an area of 0.5 hectares. In order to facilitate the land preparation for the study, the plot was tilled to a depth of 30 cm using a rototiller implement. This was accomplished following the application of decomposed manure at a rate of 8-10 tons per hectare. The elevated bed's ridges, measuring 1.3 meters in width, 50 meters in length, and 0.5 meters in height, were created using a disc ridger.

Description of machine

The first machine was a single row sweet potato transplanter as shown in figure 1(a). This machine, a vegetable transplanter model called Foxdrive, was imported from Italy under the Checchi & Magli name. The second machine is essentially an identical machine from the same brand as the first machine. However, this machine has undergone modifications and improvements to incorporate three rows, as shown in figure 1(b). The modification involved expanding the main frame structure of this machine to allow for the installation of three planter units. Table 1 displays comprehensive comparative data regarding the specs of these two machines. The height of these two machines can be adjusted based on the specific type and height of the bed used. However, in this particular case, the height of the machine has been modified to 110 centimeters to accommodate a bed that was 50 centimeters height.

Figure 1. (a) Single row sweet potato transplanter, (b) Triple rows sweet potato transplanter



The transplanter was comprised of two primary components: the main frame and the planter unit. The main frame features a 3-point hinge and an elongated horizontal bar that functions to provide support for the planter unit. The planter unit comprises a seedling tray, gripper, furrow opener, soil compactor, driven wheel, and operator's seat. Both transplanters apply a similar clamping mechanism to plant sweet potato vine cuttings. The planting operation was carried out with the operator positioned in a chair, facing away from the tractor. Next, the operator will sequentially place each vine cutting into the gripper. As the tractor advances, the driven wheel will lower the gripper component, causing it to embed some of the vine cutting into the soil. The gripper will automatically open and disengage the vine cutting that has been planted.

Table 1. Comparison of single and triple rows sweet potato transplanter specifications.

	Single row	Triple rows
Length (centimeter)	175	220
Width (centimeter)	160	310
Height (centimeter)	96 - 118	106 - 124
Planter Unit	1	3
Distance between Planter (centimeter)	Nil	130

The purpose of the field study was to assess the efficacy of each transplanter in planting vine cuttings on the prepared beds. Each transplanter will plant sweet potatoes on a plot measuring 0.5 hectares, consisting of 65 beds, each with a length of 50 meters. The time of planting for every single row was recorded. Furthermore, the spacing between crops in row was measured. The single row transplanter testing requires a minimum of two people, whereas the triple row transplanter testing necessitates a minimum of four people.

RESULT AND DISCUSSION

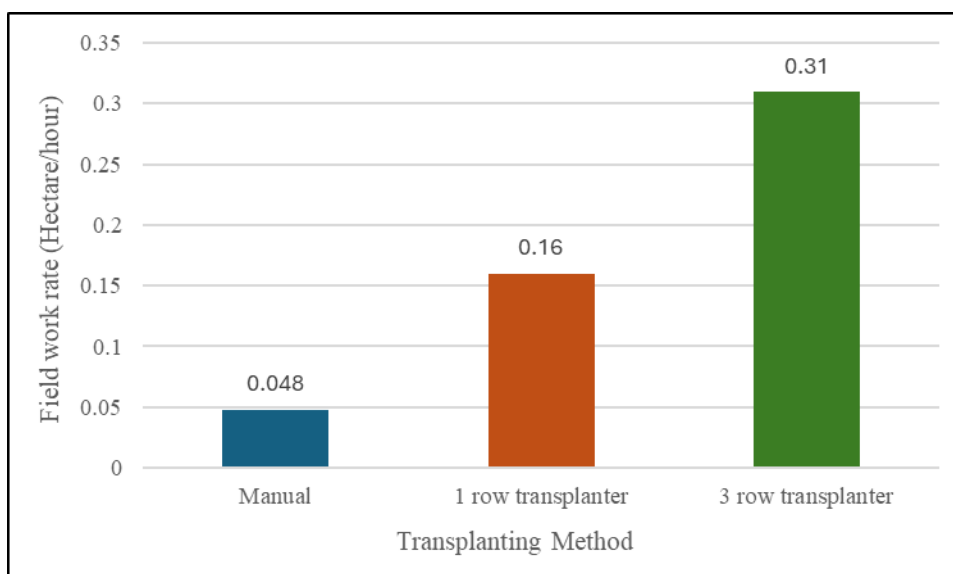
The machine parameters and performance evaluation test during sweet potato transplanting by using single and triple transplanter were recorded as shown in table 2. In this study, the prime mover is a FIAT tractor with a 70-horsepower engine. Furthermore, for both transplanting methods, a total of 16,500 vine cuttings with a bed's height setting of 0.50 m were used. For performance evaluation, the average speed of the transplanter consistent speed of 1.3 km/hour is observed for both methods. While the average transplanting for each path with a distance of 50 m was almost the same with a difference of 0.01 minutes. However, the average time for all 63 beds differs significantly, with the triple row taking 198.81 percent less time than the single row.

Table 2. Machine parameter and performance evaluation during transplanting.

Item	Data	
	Machine Parameters	
Prime Mover	FIAT, 70 Horsepower	FIAT, 70 Horsepower
Implements	Single row	Triple rows
Numbers of vine cutting	16,500	16,500
Height of bed (meter)	0.5	0.5
	Performance Evaluation	
Average Speed (km/hour)	1.3	1.3
Average transplanting time per path (1.3meter x 50meter) (minute)	2.40	2.41
Total transplanting for the whole plot (63 beds) (minute)	151.2	50.6

The machine’s working rate was calculated based on working area and average time taken for transplanting for each transplanting method as shown in Figure 2. This means that the rate of transplanting sweet potatoes using manual methods is around 0.048 hectares per hour. Manual techniques often entail individuals planting sweet potato vine cutting slips by hand. When compared to mechanized processes, this method is likely to be slower. In the meantime, a single row transplanter can cover 0.16 hectares in one hour. Single row transplanters are semi-automated planting machines that are attached to tractors. This figure suggests that a triple row mechanical transplanter can cover around 0.31 hectares per hour. Triple-row transplanters are more efficient than single-row transplanters because they can plant three rows at once, reducing the time required to cover an area. Furthermore, this figure shows that a triple row transplanter can cover around 0.31 hectares in an hour. Triple row transplanters are more efficient than single row transplanters because they can plant three rows at once, reducing the time required to cover an area.

Figure 2. Field work rate for each transplanting methods



CONCLUSION

Overall, this upgraded transplanter works effectively for planting sweet potato vine cuttings. In fact, the performance was superior to the manual method and the single row transplanter, with 84.5 percent and 48.3 percent, respectively. As a result, the implementation of this triple row sweet potato transplanter may have a good impact on the country's sweet potato production's usage of mechanization.

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