PERFORMANCE EVALUATION OF A ROOT BALL PEDESTRIAN TYPE TRANSPLANTER ON GINGER PLANTING

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ABSTRACT

This article reports on the performance evaluation of a pedestrian type transplanter on ginger planting. The experiments were conducted on mineral soil at the Engineering Research Center Plot in MARDI Serdang, Selangor. The shortage of labours was a main problem thus the need for mechanization arises. Conventional method of ginger planting was using manual hand to plant the seeds into soil. To overcome this issue, a root ball pedestrian type transplanter was introduced and tested. When tested on a planting bed, the equipment functioned admirably. The results of the performance test revealed that the planting rate was 88% for the machine. On average, the machine required 10 hours to complete planting ginger in 1 hectare while manual planting took about 13.5 hours to complete the planting process based on 2 men operating respectively. Results from the experiment indicated that the field efficiency was 95.65% and machine required 20man.hr/ha whereas human planting required 27man.hr/ha. This result indicated that labour usage reduced by 26% compared to the conventional method. For future research, it would be good to analyse on the ginger growth performance and yield based on the machine used.

Keywords: *ginger planting; transplanter; machine performance; field efficiency; ginger planter*

INTRODUCTION

Ginger (Zingiber officinale) is a flowering plant whose rhizome, often known as ginger root or ginger, is frequently used as a spice and a folk remedy. In Malaysia, ginger was planted on 822 ha area and produced of 8,719 MT productions in 2021 (Jabatan Pertanian Malaysia, 2022). Ginger was planted commercially in Bentong, Keningau and Tambunan. The most popular varieties of ginger planted by farmers were Bentong, Bara, China and Indonesia.

Malaysia has imported ginger mainly from China to support demand at local market. Based on statistic in 2021, self-sufficiency ratio (SSR) of ginger was at 14.6 % and import dependency ratio (IDR) of 86.5 % (Department of Statistic Malaysia, 2022). This figure showed dependency on imported ginger was very high.

Jabatan Pertanian Malaysia stated that labor cost for 1 hectare ginger planting was RM108,000.00 based on 3 years' period (Jabatan Pertanian Malaysia, 2022). This cost contributed to highest production cost of ginger compare to the other cost. This indicated that mechanization was required to tackle this issue. In addition to a reduced reliance on normal inputs and labor, mechanization technique leads to increased productivity, higher income, and a higher standard of living when gingers are grown on a large scale.

There were many researches involving mechanization on ginger planting. One of them was a power-operated tiny ginger planter that would be ideal for India's northeast and be lightweight, affordable, and portable. The ginger planter is made comprised of a chain and bucket-style metering system. A semi-circular bucket-type metering system's effectiveness was tested at 0.75 km/h forward speed (Patel, T.et.al, 2021).

Manoranjan Kumar and Akhilesh Bariha (2023), have developed a planter consist of components which were the main frame, the seed metering device, the seed hopper, the ground wheel, the furrow opener, the ridger, the power transmission unit, and the operator seat.

MARDI has adopted a Yanmar root ball pedestrian type transplanter in cabbage planting during 2019 to 2020. According to the findings of the performance test, the field efficiency on the planting bed was 91.36% (Mohd Fazly M.et.al,2020). Due to the availability of this machine in MARDI, a test was carried out on ginger planting to see the suitability and performance of the machine on mineral soil at Engineering Research Center, MARDI Serdang, Selangor.

METHODOLOGY

MACHINE DESCRIPTION

The experiment was carried out on mineral soil at Engineering Research Center Plot in MARDI Serdang, Selangor. A machine called root ball pedestrian type transplanter was used in this experiment. A compact, semi-automated, lightweight (155 kg), self-propelled transplanter, as shown in Figure 1. The equipment works with root balls seedlings. The air-cooled petrol engine, power transmission system, hydraulic system, sensor roller, planting shoe, covering wheels, handlebar, handle assembly featuring multiple control levers, rotating pot deliver system, the two aligned seedling racks, and farm wheels are all included in the transplanter's components list. The root ball seedlings are manually fed from the rack into the rotating pot deliver system, which serves as the foundation for how the transplanter works. Eight pots are present altogether. One plate with an outlet is placed below the pots to enable the seedlings to be dropped into the spinning planting shoe. The planting shoe helps seedlings be transplanted on the planting bed standing upright. To prevent seedlings from being pulled off while moving ahead, The planting shoe operation has been developed to open as well as close the holding part after planting. The role of the covering wheels is to cover the seedlings that have been sown with soil to keep them standing erect. A planting depth control lever can be regulated in increments of up to 15, with a 5 mm difference between each level. The height of the vehicle body is controlled by the hydraulic auto-tracking system. The parallel horizontal link mechanism adjusts the front and rear vehicle body heights to maintain a stable planting depth and position. The system can be positioned at an angle of up to 10 degrees. The transplanter is equipped with a sensor roller that can determine the planting bed's top and allow planting on ridges. The appropriate ridge height is less than 300 mm. The planting ridge width is adjustable between 500 and 1070 mm. The plant spacing gauge on the transplanter ranges from 200 mm to 500 mm.

Figure 1: Root ball pedestrian type transplanter

FIELD PERFORMANCE TEST

The root ball pedestrian type transplanter was tested by MARDI at Engineering Research Center Plot, MARDI Serdang. The test plot was mineral soil with flat land gradient from 0 to 3 degrees. The ginger variety Bentong was planted in the test plot as shown in Figure 2 at 25cm distance between crops and 1.5m between rows. The seedlings were planted on the planting bed with total of 7 rows (5 rows using machine, 2 rows using manual) as shown in Figure 3. While the machine was being used in the field, observations were made and data was gathered. Total time for machine breakdowns or machine handling faults, total time for turning at row ends, and total time for planting seedlings were all recorded for every row for the entire plot.

Figure 2: Variety of Bentong Ginger

Figure 3: Test plot at Engineering Research Center MARDI

Figure 4 shows the conventional method of ginger planting by using bare hand.

Figure 4: Ginger planting manually

Figure 5 shows the ginger planting by using machine.

Figure 5: Ginger planting by using machine

MACHINE PERFORMANCE EVALUATION

The theoretical, effective field capacities and field efficiency of the machine were evaluated. The experiment on the mineral soil type was conducted multiple times. The machine was tested against the conventional approach (manual planting). The theoretical field capacity can be determined without considering losses time.

(Equation 1).

$$TFC = W \times S \quad (1)$$

Where,

TFC= theoretical field capacity, W = the width between-row spacing (m), S= the average forward speed (m/s).
In order to determine the effective field capacity (Equation 2), time losses during operation such as row turning, mishandling, and machine breakdown were taken into account.

$$EFC = W \times S \times FE = TFC \times FE \quad (2)$$

Where,
EFC= effective field capacity is the work rate obtained for the entire plot while taking into account the overall time required for operation,

FE= The implement's field efficiency in exact conditions. The FE is the ratio between the effective field capacity and the theoretical field capacity.

EFC and theoretical field capacity, TFC (Equation 3). Field efficiency is typically represented in a percent.

$$FE = \frac{EFC}{TFC} x\ 100\% \quad (3)$$

RESULTS AND DISCUSSION

MACHINE PERFORMANCE EVALUATION

Table 1 showed the result of machine planting efficiency was averagely at 88%. This result was calculated based on the percentage between actual planted seeds and theory planted ginger seeds based on the distance for each rows.

Table 1: Machine planting efficiency

Row	Theory planted ginger seeds	Actual planted ginger seeds	Efficiency (%)
1	200	175	77.78
2	129	129	100
3	144	129	100
4	169	149	78.83
5	178	161	82.56
Average			**88%**

By considering 66 rows and 100m length for 1 hectare, total time required for the machine to plant the ginger was 10.24 hr while the manual planting required 13.49 hr respectively. Both processes used two-man power to complete all the jobs. Theoretically, 9.79 hr was required for the machine to complete the planting process without considering turning and machine breakdown.

$$Theoretical\ field\ capacity = \frac{1\ ha}{9.79\ hr}$$

The result showed that the theoretical field capacity for this transplanter was 0.102 ha/hr.

The effective field capacity was calculated as below:

$$Effective\ field\ capacity = \frac{1\ ha}{10.24\ hr}$$

The result showed that the effective field capacity for this transplanter was 0.098 ha/hr. The field efficiency for this harvester was calculated as below:

$$Field\ efficiency = \frac{0.098\ ha/hr}{0.102\ ha/hr} x\ 100\%$$

The result showed that the field efficiency was about 95.65% and the machine required 20man.hr/ha while manual planting required 27man.hr/ha. This result indicated that labour usage reduced by 26% compared to the conventional method.

CONCLUSION

The root ball pedestrian type transplanter showed good planting efficiency and field efficiency. The adoption of mechanization in ginger planting also indicated that labour usage was reduced by 26% compared to manual planting. This would reduce labour cost and labour shortage problem in agriculture sector. However, for future research, it would be good to analyse on the ginger growth performance and yield based on the machine used and comparison between machine and conventional method.

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