

Disc Ridger Cum Inter-row Cultivator and Fertilizer Applicator for Sweet Potato Production

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Abstract

Mechanization has been the solution to counter issue such as labor shortage and low production rate on field in the agricultural sector. Adaptation of mechanization system have shown to lower the cost of production, improve quality and also reduce the tedious work of labor. Current practice, which seems to contribute high cost in labor since the job requires a lot of man power. MARDI has developed a complete machinery package for sweet potato production from land preparation until harvesting. One of the important activities that require an implementation of machinery aspect is ridge forming. This activity is essential due to the height of the ridge which is one of the important factors that influences the yield. It is believed that the higher the ridge will contribute, to more aeration and thus, produce higher yields. In this manuscript, the authors report on the development and evaluation of the disc ridger. It is believed that this implement is capable to be used as ridge forming as well as inter-row cultivator. This tractor-mounted implement is designed with two units of high quality steel discs which is attached to the frame with disc diameter and thickness of 720 mm and 6 mm respectively. This disc ridger is able to form either a single row or double row planting ridges to suit with the desired planting system for sweet potato. This is due to the location of the discs at the frame which is adjustable. Furthermore, this implement also can be employed as an inter-row cultivator for weeding control of sweet potato planting in the early stages. In addition, this implement also equipped with granular based fertilizer applicator in which 2 application can be performed together which are inter row cultivation and fertilizer application. The recorded average working rate of this implement is 0.27 ha/hr for bed forming and 0.25 ha/hr for inter-row cultivation with fertilizer application. In terms of fertilizer application performance, the average amount of fertilizer to be withdrawn for 50m bed is 1.52kg, which is complied to the agronomist recommendation.

Keywords: Sweet potato, disc ridger, bed forming, inter-row cultivator, fertilizer applicator

Introduction

Nowadays, sweet potato has become one of the major crop planted in Bris soil especially in Kelantan and Terengganu because it has been recommended as an alternative industrial crop to replace the tobacco plantation (Zaharah, 2010). Thus, MARDI has announced quite a lot of sweet potato variety such as Gendut, Telong and Jalomas and VitAto (Zaharah, 2010). As a result, sweet potato plantation in Malaysia is increasing rapidly year by year. Moreover, Vitato plantation is one of the flagship projects of Ministry of Agriculture with collaboration among government agencies such as MARDI, LPP and FAMA. So, the mechanization aspect is essential in order to facilitate the field operation for sweet potato cultivation in Malaysia.

Usually, there are two planting season in a year for sweet potato cultivation especially in Kelantan and Terengganu. The first and second season starts during January until May and July until November

respectively. However, the second season is quite troublesome for the farmers due to heavy rainfalls (Tan S.L, 2006). From the experiment, it is verified that the total yield from the second season is reduced with high percentage of low quality yield (<150g/sweet potato) (Tan S.L, 2006). It is believed that during the heavily rainfall season, the water table is increasing. This situation has led to the growth of roots and tuber development becomes limited.

In order to solve the problems, the raised bed planting system is recommended by the agronomist from MARDI. Furthermore, the use of raised bed planting system is thought to increase the yield and it also helps to prevent the crops from being flooded during monsoon season. Therefore, in mechanization aspect, the use of disc ridger is fit to fulfil the requirement instead of rotor-ridger.

Materials & Methods

The experiment was carried out at a research plot in MARDI Bachok Research Station. The site is characterized by Bris soil with annual precipitation and temperature between 2500-2800 mm and 24°C – 32°C respectively.

The plot was ploughed to a depth of 30cm using rotorvator after decomposed manure was broadcasted at a rate of 8-10 tonne per hectare. Fifteen ridges of 1.2m x 50m x 0.5m (width x length x height) for raised bed and 15 ridges of 1.2m x 50m x 0.3m (width x length x height) for normal bed were made by using disc ridger and rotor-ridger respectively. The arrangement of ridges on field is randomized.

The vine of sweet potato, Anggun variety (Anggun 1, Anggun 2 and Anggun 3) was cut into 0.3m in length as planting materials and mechanically planted using sweet potato transplanter for both ridges type; raised bed and normal bed with single row planting system. Cuttings were spaced 0.25m of intervals between plants. Plants were maintained until harvesting stage at 3^{1/2} months for data collection.

During the data collection, the evaluations recorded were; 1) performance of disc ridger during bed forming, 2) performance of disc ridger during crop management (inter-row cultivation) and 4) effect of ridges system (raised bed and normal bed) to the yield production.

Table 1: Machine parameter and performance evaluation during bed forming

Item	Data	
Machine Parameters		
Prime Mover	FIAT, 70Hp	FIAT, 70Hp
Implements	Locally fabricated disc ridger	Rotor-ridger
RPM	-	540 (PTO)
Height of bed	0.5-0.6 m	0.3 - 0.35 m
Performance Evaluation		
Average bed forming time per bed (1.2m x 50m)	1.32 min	1.25 min
Total bed forming time for the whole plot (30 beds)	39.6 min	37.5 min
Field work rate	0.27 ha/hr	0.29 ha/hr

Results & Discussions

The performance evaluation test during bed forming by using locally fabricated disc ridger and existing rotor-ridger were recorded as shown in Table 1. The machine's working rate was calculated based on working area and average time taken for the bed forming per bed. From the data collected, it shows that the time taken for the bed forming activity for both implements do not show a significant difference. Generally, it takes about 3-4 hours of operation per hectare for both implements. However, the working rate of bed forming by using disc ridger is slightly

higher because of the factor of traction. It is because; more power of tractor is needed to pull the soils in order to make the raised bed.

In order to make a good quality of bed by using disc ridger, the best soils moisture content at Bris soil is at 20-30 %. At this moisture content, the quality of the beds is neat and firm, thus the risk of the soils at the bed to collapse is low. Therefore, the irrigation system to irrigate the required area is needed to increase the soils moisture content during the dry season.

Table 2: Performance evaluation of disc ridger during inter-row cultivation for sweet potato

Item	Performance Evaluation
Average time per bed	1.46 min
Total inter-row cultivation time for the whole plot (30 beds)	43.8 min
Field work rate	0.25 ha/hr

The weeding control is essential for many crops in the early stages of planting. In sweet potato planting, the weeding control especially at the furrow is important especially during 1st week until 4th week after planting. Hence, the employment of mechanical weeding is needed since the price of weedicide is

high. As a versatile implement, the disc ridger also can be used as an inter-row cultivator for weeding control of sweet potato planting in the early stages. Through the experiment, the machine's working rate during inter-row cultivation is recorded at 0.25 ha/hr.

Table 3: Effect of bed system on the total yield of sweet potato

Item	Data					
	Sweet Potato Variety					
	Anggun 1		Anggun 2		Anggun 3	
Type of bed	Raised Bed	Normal Bed	Raised Bed	Normal Bed	Raised Bed	Normal Bed
Average yield per bed	161.25 Kg	79.3 Kg	126.2 Kg	105 Kg	159.2 Kg	148 Kg
Total yield per hectare	26.87 MT	13.22 MT	21.03 MT	17.5 MT	26.53 MT	24.67 MT

In terms of yield, the overall yield of sweet potato shows that the raised bed planting system gives a higher yield compared to normal bed for all sweet potatoes, (Anggun 1, Anggun 2 and Anggun 3) variety. As stated in the literature, it is proven that the

height of the ridge is one of the important factors that influence the yield. Table 3 shows that the yield is increased by using raised bed planting system as the other factor that affecting the total yield such as crop management is constant.

Table 4: Performance evaluation of NPK fertilizer applicator for sweet potato

Item	Performance Evaluation
Average time per bed	1.46 min
Average of NPK fertilizer amount per bed (50m)	1.53 kg
Total inter-row cultivation time for the whole plot (30 beds)	43.8 min
Field work rate	0.25 ha/hr

As for fertilizer application during first fertilization stage (NPK) at week 3, this implement shows a promising performance as the rate of total fertilizer per bed can be adjustable. As recommended by the agronomist, the total fertilizer applied for each plant is 0.0075g or 1.5kg for each sweet potato bed (50m long). Table 4 shows the performance of implement during fertilizer application. In terms of tractor speed and working rate, the tuning is similar with bed forming. But the power take off (PTO) speed is set at 1200 rpm to control the amount of NPK fertilizer to be withdrawn according to the agronomist recommendation.

Conclusion

The performance evaluation of disc ridger for raised bed forming, and combined operation which are inter-row cultivation and fertilizer application had showed the general work rate at 0.27 ha/hr and 0.25 ha/hr

respectively. Since MARDI had recommended the single row with raised bed planting system for sweet potato planting, the use of disc ridger plays an important part especially during bed forming, inter-row cultivation and fertilizer application operation.

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