DEVELOPMENT OF POLYOXYMETHYLENE (POM) GROUSER FOR HIGH CLEARANCE QUAD TRACK PRIMEMOVER ON PADDY FIELD

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ABSTRACT

The use of crop maintenance machinery for herbicide spraying and spreading fertilizer input has been the current practice for paddy production in Malaysia, especially in large granary areas. Soft soil issue in paddy field have become major problem and prevent the use of heavy machinery for conducting field operations. Current paddy prime movers for crop maintenance operation use rubber wheels that produce high ground contact pressure onto the soil. With high ground contact pressure, the probability of machines sinking into the soil, or bogged down, is higher and can cause the machine to get stuck. This also can result in hardpan damage (Mandang et al., 2000). Recently agriculture prime mover uses steel track which have the issue on road or soil damaged due the grousers material use. Engineering Research Centre in Malaysian Agricultural Research and Development Institute (MARDI) have found an alternative solution for this issue by develop and replacing all the wheels on a standard 12.75kW (17 hp) High Clearance Prime Mover with Polyoxymethylene (POM) grousers equipped on triangular track-based system. Polyoxymethylene or POM was chosen due to its excellent rigidity, impact toughness, abrasion resistance, creep resistance and solvent resistance, hydrolytic stability fatigue endurance, low coefficient of friction light weight. To develop suitable POM grousers, a triangular track-based system has been tested with three different length sizes of rectangular wooden track grousers 13x4x4cm, 15x4x4cm and 18x4x4cm that could be quickly mounted on or removed from D4 track chain, permitting rapid sequential testing on the soft soil area. Field tests have been conducted at MARDI Seberang Perai, Pulau Pinang. The measured parameters were slippage, machine sinkage and soil compaction. The high clearance prime mover obtained slippage of 16.4% using 13cm shoes and 18.2% for 15cm 22.2% for 18cm accordingly and sinkage for all shoes size were less than 30 cm.

Keywords: Quad tracked, Polyoxymethylene (POM), grouser, slippage, sinkage, soil compaction.

INTRODUCTION

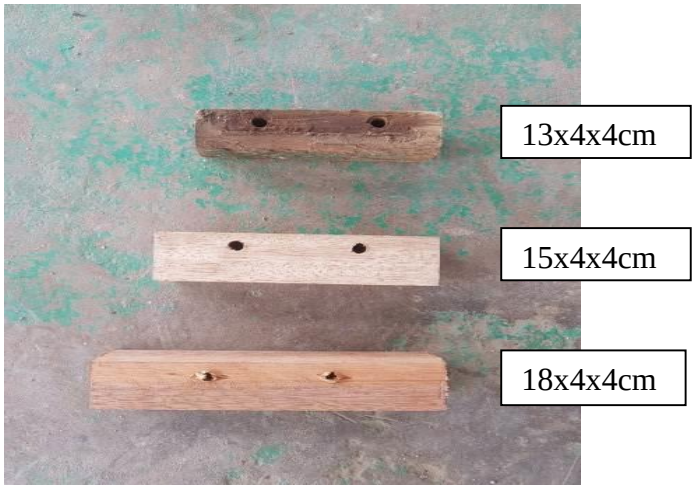
Rubber wheels prime mover that produce high ground contact pressure onto the soil have been use widely for paddy crop maintenance operation. This is the main cause of machines sinking into the soil and bogged down in the field. There are some farmers use the machine equipped a track system with steel triangular track. It will increase the contact area however due to the heavy weight of the steel grousers, this will cause damaged to the hardpan layer. A Polyoxymethylene (POM), also known as acetal, [2] polyacetal, and polyformaldehyde has been chosen as a triangular track grouser to replace the steel or wooden track. The use of this material as a grouser for triangular track is still new however the reason to choose this material is due to it lightweight, excellent rigidity, impact toughness, abrasion resistance, creep resistance and solvent resistance. Good appearance, hydrolytic stability fatigue endurance and low coefficient of friction. Better creep resistance, thermal stability, resistance to bases and processability than homopolymer. Lightweight material is one of the initial steps to reduce hardpan damage. With the same soil contact area using the steel and wooden grousers, the contact pressure, slippage percentage and hardpan damage can be reduced

MATERIALS AND METHODS

Field tests have been conducted at MARDI Seberang Perai, Pulau Pinang. The plot was planted with paddy transplanter machine using MR297 variety. The test was done using three different length sizes of rectangular wooden track grousers 13x4x4cm,

15x4x4cm and 18x4x4cm as seen in Fig 1. That could be quickly mounted on or removed from D4 track chain, permitting rapid sequential testing on the soft soil area.

Figure 1. rectangular wooden track grousers 13x4x4cm, 15x4x4cm and 18x4x4cm



A standard 12.75kW (17 hp) High Clearance Prime Mover tractor with 4-wheel drive (4WD) was used for this experiment. This high clearance was chosen for its suitability and technical aspects to work in domestic paddy fields.

Figure 2. High Clearance Prime Mover tractor with triangular track

Each of the high clearance prime mover wheels had been replace by a triangular track and each track is similar in design and weight which estimated 300kg each, as seen in Fig 2. The triangular track system consists of a driver sprocket at the top edge, with two idlers located at the two other edges of it and a set of rollers are located between the two idlers.

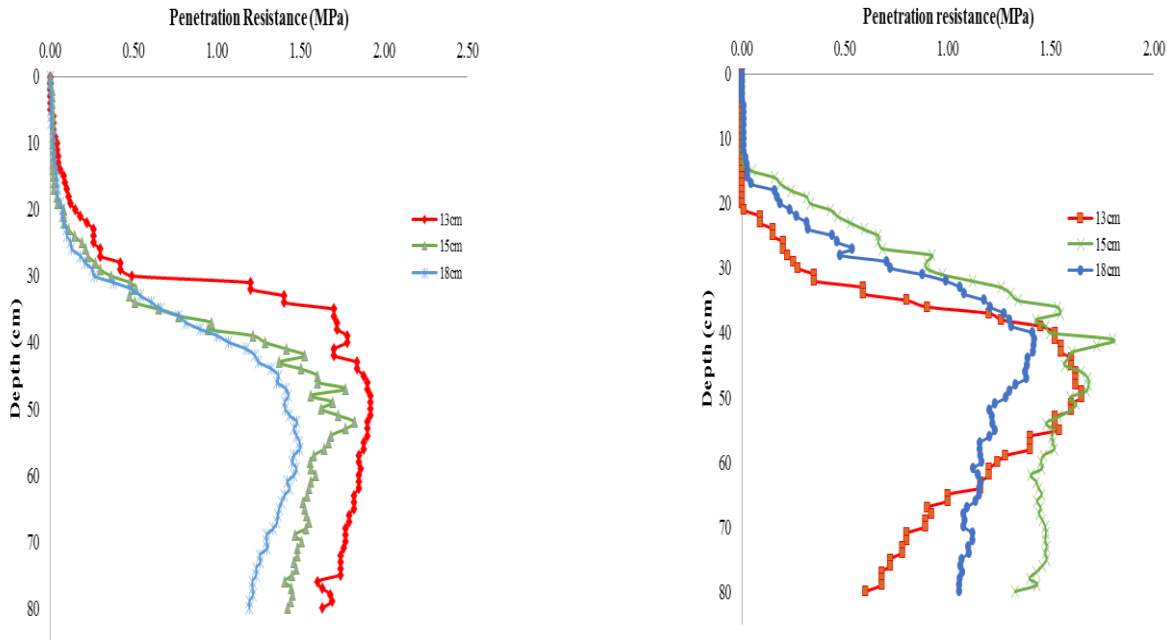
Figure 3. Machine performance data

Soil conditions were evaluated by the bulk density on a dry basis and the soil penetration. The parameters were taken before and after the passage of the for each different grouser sizes with three replicates for each sampling area. The soil strength was measured up to 80 cm depth using a soil cone penetrometer with a base area of 323 mm2 (ASAE. 1999). The machine performance was evaluated by slippage, crop damage and soil failure as seen in Fig 3. The parameters were taken during machine operation on road and in field.

RESULTS AND DISCUSSION

The results of testing triangular track-based system with three different length sizes of rectangular wooden track grousers 13x4x4cm,15x4x4cm and 18x4x4cm in terms of soil compaction is shown in Fig xxx. For 13cm grouser length size, the soil compaction before disturbance was 0.49MPa, however after disturbance, it drops 44.8% to 0.27MPa for 30cm which cause a maximum damaged in the hardpan layer and soil pattern change. While the soil compaction was increased to 50.5% and 60.3% for 15cm and 18cm grouser length size. The soil compaction was from 0.48MPa to 0.97MPa and 0.26MPa to 0.72MPa accordingly in 30cm soil depth. This situation shows that 15cm and 18cm grouser's size have low contact pressure that preserve the hardpan layer

Figure. 4. Soil compaction before and after passage for shoes size 13cm, 15cm and 18cm

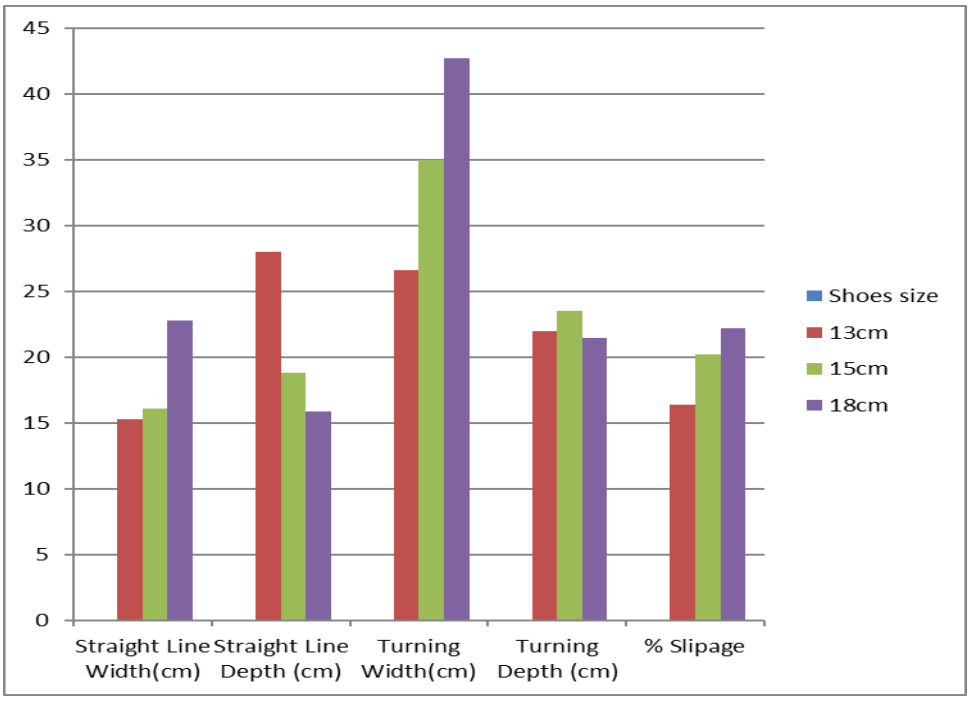


Machine performance test results shown in Table 1 and Fig 5. From the results, found that 13cm have a better performance compare to the others, but due to the high contact pressure and cause the hardpan damage. Therefore, 15cm grouser length size was chosen as a model to develop a POM (Polyoxymethylene) grousers for the triangular track on the High Clearance machine due to it low contact pressure, low in soil and crop failure and acceptable slippage percentage. While 18cm have a very low contact pressure but it is not suitable due to it high percentage crop damage, soil failure during turning and high slippage percentage.

Table 1: Machine performance test results

	Operation Passage		*Turning*		*Slipage*
Shoes size	Straight Line Width(cm)	Straight Line Depth (cm)	Turning Width(cm)	Turning Depth (cm)	% Slipage
13cm	15.3	28	26.6	22	16.4
15cm	16.1	18.8	35	23.5	20.2
18cm	22.8	15.9	42.75	21.5	22.2

Fig 5. High clearance with triangular wooden grousers track performance test results



CONCLUSIONS

A four-triangular track equipped with three different grouser length size was evaluated to observe the effects on soil compaction and the machine performance during field operation. This study to find the best size of wooden grousers as model for developing a new POM (Polyoxymethylene) grousers. The study concluded that:

- Soil compaction was increase 50.5% for 15cm and 60.3% for 18cm grouser
- 15cm grouser was chosen as a model to develop a POM (Polyoxymethylene) grousers for the triangular track on the High Clearance machine due to it low contact pressure, low in soil and crop failure and acceptable slippage percentage.
- 15cm grouser did not damage the soil hardpan layer

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