DESIGN AND PERFORMANCE TEST OF SEEDLING MACHINE

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ABSTRACT

A good paddy seedling is very supportive for mechanical rice planting by rice transplanter. This research aims to design and make a mechanically seedling machines. This machine consists of three hoppers containing the nursery media, each consisting of soil, seed and fertilizer placed in a tray. The machine testing was done to determine the success of design by comparing the design condition to its actual form. The actual of soil thickness, seed and fertilizer were achieved with an accuracy of 94.4%, 83.4% and 55.5% from the planned target. The total thickness of the material for the whole paddy seedling was obtained by 2.97 cm from the target thickness of 3 cm or 99% accuracy. The average capacity of seedling with this machine is 10 seconds/tray or 6 trays / min with an average power requirement for 247.5 watts of operation.

Key words: Machine, soil, seed, fertilizer, tray.

http://www.iaeme.com/IJME/issues.asp?JType=IJMET&VType=8&IType=9

1. INTRODUCTION

When farmers are seedling the seeds in open land, the seeds that grow will then be transferred to the planting area when the age reaches one to two months. Paddy leaves are usually cut into pieces and the roots will be damaged when conventionally transferred, which in turn leads to the slow growth of seedlings. On the other hand, when farmers use seedlings with a tray system, the seeds are transferred when they are about 10 days old. In tray system, seeds can germinate on flat surfaces such as banana leaves or plastic sheets [1]. The damage level of seedlings roots and leaves when transferred to the seed-land can be minimized and the development of seedlings can be more rapid. Tray system shortens the seedling time and seed selection, so the tray system is well suited for plants with short growth durations.

After the paddy is sowed, the seedlings will be transferred from the seed-land to the planting-land. This stage is called transplanting stage. Transplanting is generally done manually, i.e. Seedlings planted one by one into the soil. However, at this time it has been created a planting transfer machine using a machine called a rice transplanter that adopts the
workings of human fingers in planting the seeds on the land [2]. To support the rice transplanter performance, it is necessary to provide good paddy seeds. This can be done with a dry tray nursery system which uses a box / tray that serves as paddy seedlings container where it will be transferred. The paddy seedlings which can be used on rice transplanter have special shapes and structures, with united and roll able seed root. The objective of this research is to design and make a mechanical paddy seedling machine with a dry condition tray system that produces seeds with good rooting to support planting by using rice transplanter.

2. MATERIALS & EXPERIMENTAL PROCEDURES

2.1. Materials
This research is started on March 2017. Design plan and machines testing is done in the Laboratory of Engineering and Bio-system of Agricultural Engineering, Universitas Sumatera Utara. While the machines making are done in the Agricultural Engineering Workshop, Faculty of Agriculture, Universitas Sumatera Utara.

The main materials used in this research are soil, paddy seed and organic fertilizer. The machines used in this research are wattmeter, tachometer, digital scales, stopwatch, meters. The power source to drive this machine is 2 HP electric motor with 70 gearbox as rotation reducer, while the designing plan equipment is a set of computer with supporting software such as Microsoft office and Solidworks software 2011.

2.2. Methods
2.2.1. Determination of Machine Dimensions
The size of the tray / box for nursery is adjusted to the space where the seeds area on the transplanter i.e. 58 cm long and 28 cm wide [3]. The size of the box width is the size of the conveyor belt width on the designed machine. The hoppers used are as many as 3 pieces to place soil, seeds and organic fertilizer that has the same size i.e. 28.6 cm long, 20.6 cm wide and 45.7 cm high with 1 mm plate thickness. The distance between the end of the hopper is 4 cm so that the overall length of the hopper becomes 69.4 cm, the belt conveyor length is 112 cm and width is 40 cm. Machine frame is made by using iron elbow with length is 112 cm, width is 50.6 cm and height is 70 cm. The overall machine dimension is 112 cm in length, 66.4 cm in width and 120.4 cm in height. The overall machine drawing is presented in Figure 1.

![Figure 1 Designing machine dimensions](image-url)
2.2.2. Design Plan

Machines are designed with the following working mechanisms. In the hopper 1 filled with organic fertilizer mixed with soil with a ratio of 1:1.[4] Hopper 2 filled with paddy seed and hopper 3 filled with powdered dry soil. Tray / box placed on the conveyor belt then the electric motor is turned on. Each hopper will drop the soil, paddy seed and fertilizer by rotating alloys along with the rationing of the shaft and fall directly on the box carried by the conveyor belt. Preceded by the soil that fell into the box with soil thickness of 2.5 cm [5] then the seeds were dropped to the soil surface in the box and then covered by a mixed of soil and fertilizer. The next step, water is sprayed manually. The soil, seed and fertilizer metering device systems are presented in Figure 2

![Figure 2 Soil, seed and fertilizer rationing mechanism](image)

2.2.3. Machine Testing

Machines testing is done to determine the overall machine performance, the parameters in the test are:

- The time required for the process of falling the soil, seed and fertilizer
- The average thickness of the soil that falls into the box
- Density of seeds that fall into the box
- Average power used for a single nursery process
- Percentage of seed-growing potency
3. RESULTS AND DISCUSSION
3.1. Mechanical Seedling Machine
The seedling machine which made has met the criteria of the planned mechanism. Each component, both structural and functional components work in accordance with their respective functions. The seedling machine that has been made is presented in Figure 3.
This machine works to drop the soil, seed and fertilizer according to the planned needs. Each hopper is filled with soil, paddy seed and fertilizer, then the tray is placed on the belt conveyor. Electromotor is switched on, the shaft rotates and the rotational speed (rpm) is reduced by gearbox 70 times lower. The power and rotation of the gearbox shaft is transmitted to the conveyor shaft and rationing shaft. Soil, seed and fertilizer rationing shaft will drop the soil, seed and fertilizer while the conveyor shaft will move the conveyor belt to carry the tray. The tray will move under the hopper through every rationing and will drop the soil, paddy seed and fertilizer to the tray with the condition to be achieved that is 2.5 cm soil thickness, 0.3 cm seed thickness and 0.2 cm fertilizer thickness [6]. To achieve those conditions, is done by adding a grader component (shaping machine) which the distance is adjust-able.

3.2. Seedling Machine Testing

The test is performed to determine the machine design accuracy which made against the planned parameters. The parameters test results is presented in Tables 1, 2 and 3.

<table>
<thead>
<tr>
<th>Repetition</th>
<th>Rationing rotor rotation (rpm)</th>
<th>Rationing time (second)</th>
<th>Soil Thickness (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>20</td>
<td>9.30</td>
<td>2.36</td>
</tr>
<tr>
<td>2</td>
<td>20</td>
<td>9.15</td>
<td>2.42</td>
</tr>
<tr>
<td>3</td>
<td>20</td>
<td>9.22</td>
<td>2.30</td>
</tr>
<tr>
<td>Average</td>
<td>20</td>
<td>9.22</td>
<td>2.36</td>
</tr>
</tbody>
</table>

The results obtained in the soil allotment process showed that the soil thickness in the tray is in accordance with the recommended thickness of 2-3 cm. While the planned thickness is 2.5 cm, the result of the soil allotment can be stated as accurate (94.4% accuracy) although there is still deviation of 5.6%.

<table>
<thead>
<tr>
<th>Repetition</th>
<th>Rationing rotor rotation (rpm)</th>
<th>Rationing time (second)</th>
<th>Soil Thickness (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5</td>
<td>9.20</td>
<td>0.25</td>
</tr>
<tr>
<td>2</td>
<td>5</td>
<td>9.12</td>
<td>0.25</td>
</tr>
<tr>
<td>3</td>
<td>5</td>
<td>9.20</td>
<td>0.25</td>
</tr>
<tr>
<td>Average</td>
<td>5</td>
<td>9.17</td>
<td>0.25</td>
</tr>
</tbody>
</table>
The results obtained in the process of paddy seeds rationing showed that the seeds thickness that fell on the tray had not been exactly with the planned thickness of 0.3 cm. The deviation is 16.6% or the accuracy is 83.4%, still considered in accordance with the target to be achieved.

<table>
<thead>
<tr>
<th>Repetition</th>
<th>Rationing rotor rotation (rpm)</th>
<th>Rationing time (second)</th>
<th>Soil Thickness (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>11.5</td>
<td>9.15</td>
<td>0.36</td>
</tr>
<tr>
<td>2</td>
<td>11.5</td>
<td>9.47</td>
<td>0.36</td>
</tr>
<tr>
<td>3</td>
<td>11.5</td>
<td>9.31</td>
<td>0.36</td>
</tr>
<tr>
<td>Average</td>
<td>11.5</td>
<td>9.31</td>
<td>0.36</td>
</tr>
</tbody>
</table>

The results obtained in the fertilizer allotment process showed that the fertilizer thickness that fell on the tray was not in accordance with the recommended thickness of 0.2 cm from the thickness of 0.36 cm. The deviation is 44.45% with 55.55% accuracy. From the total material thickness for the whole paddy seedling, it is obtained at 2.97 cm, then the seedling machine can be expressed in accordance with the planned thickness of 3 cm with 1% deviation or 99% accuracy. The average capacity of seedling with this machine is 10 seconds / tray or 6 trays / minute with percentage of material scattered is 5.2%. The average power requirement for operation is 247.5 watts and seed density is 3-4 seeds / cm².

4. CONCLUSIONS
From the achievement targets, the thickness of each material has not reached the target. But the overall material thickness is good, i.e. 99%. The average capacity of seedling with this machine is 10 seconds / tray or 6 trays / minute with the average power requirement for operation is 247.5 watts. This mechanical seedling machine can be operated easily even though there are still improvements to minimize scattered materials.

ACKNOWLEDGEMENT
Thanks to the Universitas Sumatera Utara Research Institute for funding provided for research under the TALENTA research contract for year 2017 Number: 5338 / UN5.1.R / PPM / 2017 dated May 22, 2017.

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