Design and Implementation of MOAT (Moth Attractor Technology): Glue-Tube-Light System with RTC (Real Time Clock) Module

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ABSTRACT

Massive reduction of onion in Kabupaten Probolinggo was caused by Spodoptera exigua attacks. Since 2012, the significant reduction of onion production was up to 19%. One of the farmers group facing the reduction is Sumber Makmur III with total of reduction is up to 61.69%. The culture technique has done by farmers using conventional lamp and net which have many weaknesses from its implementation. Based on this problem, innovative technology MOAT (Moth Attractor Technology) has created as portable moth attractor. It is the innovative solution using lamp, box and glue completed by RTC (Real Time Clock) and having special glue to intensify the effectiveness and efficiency in exterminating the moths. Following methods have done are (1) literature study and observation, (2) designing product, (3) production, (4) device trials, (5) product’s socialization and implementation, and also (6) monitoring and evaluation. The result is MOAT which can effectively attract up to 770 months in a week. It can help the farmers reduce the damage of onion and increase the production up to 11.07 quintal in 180 m² area. Furthermore, it can also increase the income of onion farmers.

I. Introduction

The 2015-2019 National Medium Term Development Plan (RPJMN) in the field of Horticulture has one of the strategic commodity policy directions namely onion development. To support the above scenario, East Java Province as the second largest supplier in Indonesia expanded the land to increase the production of onion. One of the biggest onion producing centre in East Java is Probolinggo with total of land area was 6,306 hectares. The onion production reaches 60,339 tons (Probolinggo District Agriculture Office, 2017) is the main source of income for farmers in the area.

However, the fact shows that the production of onions in 2012-2016 has decreased by 19% (BPS, 2016). One that has decreased is Sumber Makmur III Farmers Group, which is the largest farmer group in Tegalsiwalan District, Probolinggo Regency. The head of the farmer group explained that when plants are in good condition, yields can reach 1.1 tons/180 m². Whereas recently the yield is only around 4.24 quintals/180 m². The decline has an impact on the turnover earned by farmers, because of the small amount of production and the high production costs.

Based on observations and interviews, there are several things that cause the decrease of yields. However, the most pressing issue is the attack of moths which causes a decrease in productivity of onions. In line with the research of Rosenzweig et al. (2001); Haryati et al. (2009) which states that the problem of decreasing in onion production experienced by farmers is due to the increase in moths attack, so that productivity also decreases. Razak et al. (2016) states that the types of moths that are often found and are important moths in onions are Spodoptera exigua. This is because onion is the main host of S. exigua. Moekasan et al. (2012) stated that these moths attack the onion crops.
from the planting phase to the time of harvest. The worst fact is that when severe attacks occur, losses can reach 100% (Udiarto et al., 2005)

The solution used by farmers to solve the problem is controlling the moths using conventional light to attract insects (Nugraheni, 2009). The control in question is by putting lights at certain points in the field. This following picture is a conventional lamp analysis of onion farmers to control S. exigua.

Understanding the loss will be very large if it is not handled in the right way, a relevant solution should be found to reduce the number of farmers losses. The innovative solution is creating a designed tool that can reduce S. exigua attacks on onion plants. The tool named MOAT (Moth Attractor Technology) which is portable moth trapping technology. It is collaborated with a glue tube light system using LED light that can be controlled automatically and using special adhesive glue on the outside of the tool.

II. Methodology

A. Data Collection

Data collection was carried out by means of literature studies, observations, interviews and questionnaires. Based on these activities data collected in the form of an average 180 m² area, with a total of 12 plots of beds. Moths management methods that have been carried out by farmers are not effective and efficient, because using conventional equipment in the form of incandescent lamps so that the risk of short circuiting and moths are trapped slightly. The number of moths captured is also very low, only about 270 moths per week. This is not comparable to the number of S. exigua populations that attack. In addition, the net that is used as an auxiliary lamp has perforated, so it does not maximally eliminate pests.

<table>
<thead>
<tr>
<th>Number</th>
<th>Weakness Analysis</th>
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<tbody>
<tr>
<td>1</td>
<td>The use of cable with a long size and protruding at risk of peeling and electrical short circuit. In addition, the cost becomes more expensive because it requires a long cable. Farmers must monitor frequently, because the lights are on with the control switch.</td>
</tr>
<tr>
<td>2</td>
<td>An open circuit has the risk of shorting when it rains. Using AC electricity, so it is likely that farmers are electrocuted.</td>
</tr>
<tr>
<td>3</td>
<td>There is a distance between the lamp and the tube so that the moth can escape after being trapped.</td>
</tr>
<tr>
<td>4</td>
<td>The lights have a color that doesn't make moths interested.</td>
</tr>
<tr>
<td>5</td>
<td>The tub only contains water so the moths that come cannot be trapped effectively and die.</td>
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</table>
B. Design of Tools

This design phase aims to get the right design and mechanism of the tool, so that this tool can function properly and remain in accordance with the study of literature and observation data. There is also an electronic mechanism starting from input, process, and output show in Figure 2.

The designing process of MOAT consists of 3 stages: the selection of electronic components, designing and manufacturing of tools, and combining the glue. The selection of electronic components was done to choose what materials and equipment components will be used in the electronic system. This has done to make sure that the selected items are the best items to guarantee the effectiveness of product’s work. And then, it continued by assembling components by designing RTC (Real Time Clock), microcontroller, mini USB 5V charger module and boost converter.

After the selection of electronic components is complete, the process continues with designing the tool. Beginning with drawing designs on CAD (Computer Aided Design) applications. The tube is designed in yellow so that the LED lights can emit yellow light. This is intended to attract pests because S. exigua is included in insects that can only absorb yellow and red pigments (Sihombing 2013). Then proceed with compiling all the components in the special box that has been provided. The last step is to pair the hangers on the top of the tool.

The activity continued with combining adhesive glue on MOAT. This adhesive glue contains glumon and pheromones from the researcher’s own combination. This glue is applied to the plastic that has been glued to the outside of the tube. The purpose of making this glue is to pull moths to stick and get trapped so that moths will be dying.

C. Implementation and Device Trial

The tool’s testing phase is carried out directly in the Sumber Makmur III Farmer Group land. The trial was carried out on a 180 m² area of onion. Installation of equipment starts at 6:00 p.m. to 12:00 p.m. by installing 5 devices at the points specified. The installation distance of the equipment during the trial ranges from 5-10 meters. The tool used is the MOAT with yellow light, which is coated with plastic coated with a special adhesive glue that has 30% pheromone content as a puller of S. exigua. Figure 3 show of the tools placement on the land during the implementation and trial activities.

III. Results and discussion

A. Effectiveness Study of MOAT Implementation and Its Implications for Increasing Production of Onion

The implementation of the MOAT as a portable S. exigua moth attractor completed by glue-tube-light system uses special glue which aims to attract moth’s attention so that cannot attack the onion plant. The lamp used emits a constant yellow light, while the tube used is plastic waterproof tube as the lamp’s protector. In addition, the outer part is covered with plastic coated with special glue. This glue contains 30% pheromone as S. exigua moth attractant. Haryati (2009) explained that pheromones are chemicals originating from the endoktrin gland to function as attraction of moth such as S. exigua. Special glue on MOAT works to make it sticky so that the moth dies and cannot fly to attack the onion plant. The following is the MOAT framework designed for the prevention of S. exigua partner groups show in Figure 4.

![Fig. 3.MOAT Placement in Farmer’s Land](image-url)
Besides using a glue-tube-light system, MOAT (Moth Attractor Technology) is also completed with RTC (Real Time Clock) module. RTC is a circuit that serves to keep the lights on in a predetermined state. The time to turn on the lights will be set at 18.00-24.00. This was done because the authors considered the most efficient and effective time to catch S. exigua and overcome moth attacks.

Calculation voltage amount and battery power are explained as follows:

1) Calculation of voltage to charge the battery.

   a) Formula
   \[ V_{bat} = V_o - (R_l \times I_b) \]  \hspace{1cm} (1)

   Description:
   \( V_{bat} \) = Battery Voltage (Volt)
   \( V_o \) = Internal Battery Voltage (Volt)
   \( R_l \) = Internal Obstacle (Ohm)
   \( I_b \) = Battery Current (Ampere)

   \[ r_d = \frac{E-V}{I} \]  \hspace{1cm} (2)

   Description:
   \( r_d \) = Internal Obstacle (Ohm)
   \( E \) = Battery Voltage Source (Volt)
   \( V \) = External Voltage (Volt)
   \( I \) = Electric Current in Circuit (Ampere)

   b) Calculation

   \( I_b \) = power per battery 6800 mAh
   = 6800 mAh / 3600 second = 1.88 A

   \[ r_d = \frac{E-V}{I} = \frac{4.2 - 2.7}{1.88} = 0.26 \text{ ohm} \]

   \[ V_o = V_{bat} + (R_l \times I_b) \]
   = 4.2 + (0.26 x 1.88)
   = 4.2 + 0.564
   = 4.764 Volt

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Because using 3 batteries, then:
\[ V_0 = 4,764 \times 3 \]
\[ = 14,292 \text{ Volt} \]

2) Calculation of time to charge the battery.

\( T_1 = \left( \frac{C}{I} \right) + \phi_1 \)  \hspace{1cm} (3)

- \( I \) = Charging current (A)
- \( C \) = Capacity (Ah)
- \( T_1 \) = Desired time (Jam)
- \( \phi_1 \) = % De-efficiency

\( \phi_1 = 30\% \)

\( T_1 = \left( \frac{20.4}{0.85} \right) + \left( \frac{20}{100} \right) \)
\[ = 3.12 \text{ hours} \]

The number of moths that are trapped by MOAT is bigger because moths are easily attracted to the yellow LED light. This is because \( S. \text{exigu}a \) is classified as an insect, and has only two types of visual pigments, which are pigments that absorb yellow and green, and red light and ultraviolet light (Meyer in Sihombing, 2013). Because of this, MOAT is able to trap moths up to 3 times bigger than the tools that have been used by farmers.

The intensity reduction of \( S. \text{exigu}a \) attacks on onions has implications in increasing farmer’s productivity. Yields increase significantly after using MOAT. Before using MOAT, the yield was only around 4.24 quintals. After using MOAT, onions production reaches 11.07 quintals. The increased yields affect the farmers’ income that reaches Rp. 18.700,000,-

B. Comparative Analysis Between MOAT Implementation and Conventional Farmer’s Tools

The innovation of the portable moth attractor MOAT is superior compared to the tools that have been used by the onion farmers before. Here are the advantages of MOAT compared to conventional farmers’ tools:

Table 2 show of effectiveness analysis and comparative of MOAT and conventional farmers’ tools after the trial on farmer’s land.

<table>
<thead>
<tr>
<th>No.</th>
<th>Parameter</th>
<th>Conventional</th>
<th>MOAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Energy usage</td>
<td>12 hours</td>
<td>7 hours</td>
</tr>
<tr>
<td>2.</td>
<td>Operational Cost (per 180 m²)</td>
<td>Rp. 1,760,000,-</td>
<td>Rp. 884,500,-</td>
</tr>
<tr>
<td>3.</td>
<td>Total of trapped moth (per week)</td>
<td>± 270 moths</td>
<td>± 770 moths</td>
</tr>
<tr>
<td>4.</td>
<td>Production total (per 180 m²)</td>
<td>4.24 quintals</td>
<td>11.07 quintals</td>
</tr>
<tr>
<td>5.</td>
<td>Farmers’ Income</td>
<td>Rp. 7,784,000,-</td>
<td>Rp. 18,700,000,-</td>
</tr>
</tbody>
</table>

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Table 3. Advantages of MOAT compared to conventional tools

<table>
<thead>
<tr>
<th>Lamp and Net</th>
<th>MOAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC (Alternating Current) energy resource is less economic if it is implemented in big scale.</td>
<td>Operational cost is cheaper because it uses DC electrical source that has small voltage.</td>
</tr>
<tr>
<td>Parallel circuit caused parallel short circuit in the lamp</td>
<td>Each lamp has its own electric circuit and it is easy to be monitored when the short circuit occur.</td>
</tr>
<tr>
<td>The trapped moths are still capable to go because there is no special glue.</td>
<td>The tool is covered by plastic with special glue outside, and it makes the moth trapped and die.</td>
</tr>
<tr>
<td>AC electricity allows farmers to be electrocuted if there is a cable that is peeling off and there is a rainy season.</td>
<td>Using safe-energy battery, and DC energy which is safe.</td>
</tr>
<tr>
<td>Using conventional lamp with shorter working time and it is not eco-friendly.</td>
<td>Using special LED lamp which has longer working time, safe energy, and eco-friendly.</td>
</tr>
<tr>
<td>There is no time control device to turn on the lamp so that the loss energy often occur.</td>
<td>Complete with RTC that manage lamp’s working time, and adjust its function in the right time.</td>
</tr>
<tr>
<td>Only trap the moth by 270 in a week.</td>
<td>Trapping up to 770 moths in a week.</td>
</tr>
<tr>
<td>Farmers having trouble in moving the lamp because the cable limits its space.</td>
<td>Having high mobility because the portable system makes it easy to be moved.</td>
</tr>
<tr>
<td>There is no special glue that effectively makes the moths are sticky</td>
<td>Collaborating special glue with pheromones as effectively and economically moth attractor</td>
</tr>
</tbody>
</table>

Fig. 5. MOAT Working Mechanism

C. MOAT Working Mechanism

MOAT is able to work for approximately 7 hours in dealing with moths. Figure 5 showed chart of how MOAT works.

The lamp can be turned on by pressing the ON button so that it can emit a yellow light that will attract the attention of S. exigua. After the moths are attracted, it will stick to the outside of the tool that has been coated with special glue. Moths that have been trapped in the outer layer of the tool cannot escape and will be dying and cannot attack the onion. After that, if the outer layer is full, the farmer can remove the plastic and replace it with new plastic and glue. If the battery runs out, farmers can charge easily because of the charger module in the tool box.

D. Principles of MOAT Operational Development

The 2015-2019 National Medium Term Development Plan (RPJMN) implemented by the government aims to increase agricultural productivity in this case onions so that Indonesia can become the main country for exporting it. Supporting the details of the strategy that will be implemented, the MOAT will contribute directly to overcome moths and increase yields so that Indonesia can become a leading exporter of onions in the future.

The MOAT also has its development potential in terms of design, form, and control system that will be tailored to market needs. Development potential that can be done are as follows:

1. Adding solar panels to the appliance so that the device does not need to be charged.
2. Adding SIM I-800 as a remote control component via SMS. This component serves to facilitate farmers in controlling the equipment so that they can monitor from a distance and do not need to come to the location.
3. Extending MOAT to be used in the horticulture sector and other food sectors.

IV. Conclusion

MOAT is the only one sophisticated technology which is more effective compare to the conventional tool that currently implemented by farmers. The effectiveness of MOAT shows that the number of caught S. exigua has reached 770 for one week. The moths trapped cannot attack the onion, and will be die because its glue. This allows a reduction in the risk of onion’s yield.
Production increased to 11.07 quintals with revenue turnover that can be obtained by Rp. 18,700,000,00.

References


