Design & development of Insect trapper for selected crops in Vidharbha region

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Abstract - *This paper presents a solar-operated insect trapper as an eco-friendly solution for reducing the population of insects, such as mosquitoes and flies, in outdoor areas. The trapper is designed to attract insects with its ultraviolet (UV) light source and capture them, which pulls them into a container where they can be safely disposed of. The trapper is powered by a solar panel, making it self-sufficient and independent of external power sources. The solar panel charges a battery during the day, allowing the trapper to operate continuously throughout the night. The trapper is equipped with a light sensor, which automatically turns on the UV light at dusk and turns it off at dawn, further increasing its energy efficiency. The design and construction of the trapper are straightforward, and its materials are easily accessible, making it a cost-effective option for households and communities. The performance of the trapper was evaluated through field tests, demonstrating its effectiveness in reducing the population of insects in outdoor areas. This type of insect control is a safe alternative to harmful pesticides Overall, the solar-operated insect trapper presents a sustainable and efficient solution for controlling insect populations while minimizing the environmental impact.*

Key Words: **Solar light trap, Insects, Crops, Model**.

1. INTRODUCTION

A solar-operated insect light trap is a device designed to attract and capture insects using a combination of light and solar power. It is an environmentally friendly and energy-efficient way to control insect populations, particularly in agricultural or outdoor settings. The device works by emitting a specific wavelength of light that attracts insects, which then fly into the trap and are captured. The solar panel powers the light source, making it independent of electrical grid systems and reducing the carbon footprint. This type of insect control is a safe alternative to harmful pesticides and can be used for a variety of insects, including mosquitoes, moths, and other flying pests. However, some of these result in monetary losses. The significant pests that infest crops.

In addition, sucking insects include thrips (Scirtothrips dorsalis), aphids (Aphis craccivora), leafhopper/jassids (Empoasca kerri), and mealybugs (Phenacoccus solenopsis) are also damaging crops as pests and vectors of virus diseases. The solar-operated insect light trap is a great solution for those looking to control insect populations while also promoting sustainable practices. In this paper, we present the design, construction, and evaluation of a solar-operated insect trapper, highlighting its efficiency and effectiveness in reducing the population of insects in outdoor areas. The solar-operated insect trapper represents a sustainable and eco-friendly solution for insect control that addresses the environmental and health concern associated with traditional insect control methods.

1.1 Study area

The study was conducted in a farm at Matkazari village, Nagpur district, during winter to the summer season, 2023. Wheat, was sown in 2 acre field. The duration of the crop is around 100 to 160 days. The trials were conducted for 10 days. In the study area,. The experimental field area for each trap was 3600 m2, and the total field area was about 2 acre, and no other field crops were grown surrounding the experimental field. The site was free from existing artificial lighting at least 100 m radius to ensure no influence by other lights. The manual weeding was done one time before the experiment, and no insecticides were applied during the trials.

1.2 Selection of Light

When designing a solar-operated insect trapper, selecting the appropriate light source is crucial to its effectiveness. Here are some factors to consider when selecting the light source for a solar-powered insect trapper: wavelength, Intensity, Energy Efficiency, Durability, and Cost. Also, four different colored Led lights such as ultraviolet, blue, green, and red with different frequencies were tested. The LEDs' colors and wavelengths were selected based on the literature review.

2 LITERATURE REVIEW

According to Rieta Gols and Jeffrey 2023 assumes that insect herbivores play a major role in shaping not only the evolution of plant traits but also in having significant impacts on plant fitness. The primary biotic barrier to the production of vegetables in India is insect infestations. Many of them not only cause direct harm but also serve as viral vectors. diseases. Vegetable crop losses of between 30 and 40 percent have been reported. Vegetable crops are greatly impacted by insect infestations and production loss. But it damage the crops and encured heavy loss to the farmers

.There are number of studies available on different types and application of various methods for insect trapping Recently developed light-emitting diode (LED) technology was applied to standard insect-vector traps to produce a more effective lighting system Cohnstaedt,et al (2008). Recently, there has been an epidemic of gall midge (Asphondylia capparis), which is a minor pest that is progressively becoming a regular problem in chilli, capsicum, and brinjal. Andhra Pradesh and Karnataka, as well as in brinjal. In the state of Chattisgarh. Various species of mealy bugs in cotton, vegetables, and papaya have increased in severity in various sections of the country and have become indicator insects for contemporary ecosystems as a result of modest changes in climate over the last decade. Termites, white grubs, hairy caterpillars, gramme pod borers, and Spodoptera litura are among the national and international polyphagus pests that are becoming more severe and widening their host-horizon (Rai et al.2014).

Campbell and. Hanula 2007 suggested Malaise traps and colored pan traps for collecting flower visiting insects Harding Jr, et al. (1966) suggested use of blacklight lamps for seasonal abundance of important insect pest species.

For Lepidoptera, Hemiptera, Hymenoptera, Odonata, and Diptera, mercury light was more effective, whereas black light was more effective for Coleoptera, Orthoptera, Isoptera, and Dictyoptera. Coleopterans were shown to be attracted to black light and mercury in a comparable way. When all bug traps were taken into account, the average temperature revealed a substantial association with coleopterans, lepidopterans, and hemipterans.. (Ramamurthy 2010)

This implies that farming methods should be reconsidered for reorientation, and vegetables should be prioritised with proper insect pest management strategies. In this context, the Integrated Pest Management (IPM) system was developed in response to the need for a long-term crop protection strategy in the face of rising pesticide use and the negative effects of pesticide residues on the environment (Rai 2014)

From the above discussion it is clear that still there is a need to design a low cost insect trapping system for agricultural field. For this we have develop an solar based light trap for insect in agriculture field, following are the steps followed in developing this model.

3. DESIGN & FABRICATION OF PROPOSED MODEL

The solar LED insect trap comprises a Solar panel, storage battery, LED array, insect collecting tray, PVC legs, sticky pads. Solar Panel generates electricity during the daytime, stored in a battery, and stored electricity can be exploited to capture trap during the night time. The solar panel was fixed on the head of the battery unit with a steel plate's head. The product can be accessible to farmers. The trapper utilizes Arduino technology for automation and improved functionality. Additionally, sticky pads can be used to enhance the trapper's effectiveness by capturing a greater number of insects in day time. The solar panel's direction can be manually adjusted to follow the sun's movement. Moreover, the trapper features a sensor-based UV light operation that turns on automatically after sunset and turns off during the day. This trapper offers dual efficiency, as it utilizes UV light to attract insects at night and sticky pads during the day to capture insects. The product can be adjustable according to the height of crops. The solar-operated insect trapper consists of a tall pole with an adjustable height of 1250-2000mm. The pole supports a solar panel that can be manually rotated to face the sun for maximum efficiency. The solar panel powers an Arduino-based system that automates the trapper's functionality. At the top of the pole, a UV light is mounted, which attracts insects during the night. Below the UV light, there is a sticky pad that traps insects that fly into it. The sticky pad can be easily replaced when it becomes full. The trapper also features a sensor-based system that automatically turns on the UV light after sunset and turns it off during the day, optimizing its energy use. The trapper is designed to be easily accessible to farmers and gardeners, and its simple design requires minimal maintenance. Additionally, the trapper's efficiency is enhanced by the use of sticky pads, which capture a greater number of insects than traditional traps. Overall, this conceptual solution for a solar-operated insect trapper offers a sustainable and effective way to control pests while minimizing environmental impact and reducing costs.

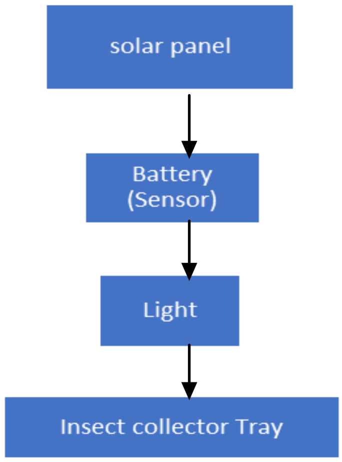

Fig -1: Conceptual drawing of solar insect trapper

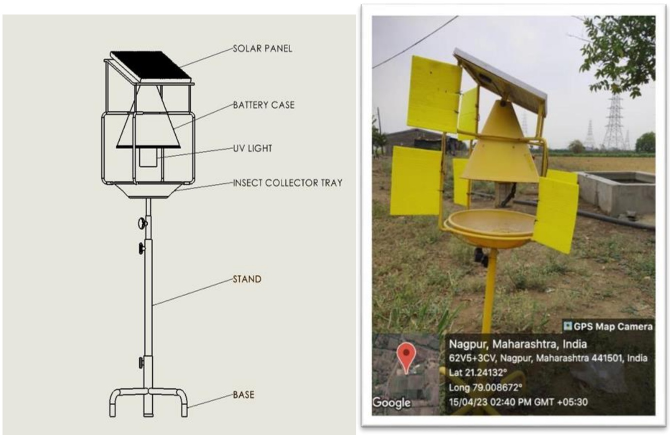

Fig -2: Design of the model

4. MATERIALS USED & PURPOSE

Table 1 gives details of material used for the model

Table -1: Material used

Plastic container	For trapping insects
LED or fluorescent light source	To emit light
Solar panel	For powering the light source
Rechargeable battery	For storing solar energy
Insect attractant	To attract insects
Sticky Pads	To prevent the escape of trapped insects.

5. SUITABILITY OF TRAPPER IN FOLLOWING CROPS

5.1 WHEAT

1. **UV Light Traps**: UV light traps use ultraviolet light to attract insects, which are then captured in a container or net. These traps are effective for many types of insects, including *aphids*, which are a common pest in wheat fields.

2. **Pheromone Traps**: Pheromone traps use chemical attractants to lure insects into the trap. These traps are effective for certain types of insects, such as *armyworms and cutworms*, which can damage wheat crops in India.

3. **Sticky Traps**: Sticky traps use glue or adhesive to capture insects that come into contact with the trap. These traps are effective for a wide range of insects, including *thrips and leafhoppers*, which can damage wheat crops.

4. **Combination Traps**: Combination traps use a combination of different techniques, such as UV light and pheromones, to attract and capture insects. These traps are effective for a wide range of insect pests in wheat fields.

5. **Mobile Traps**: Mobile solar insect traps are mounted on a wheeled cart or trailer, making it easy to move them around the wheat field as needed. These traps are particularly useful for monitoring insect populations and identifying hotspots of pest activity.

5.2 COTTON

1. **UV Light Traps**: UV light traps use ultraviolet light to attract insects, which are then captured in a container. These traps are effective for many types of insects, including *moths and beetles*, which are common pests in cotton fields.

2. **Pheromone Traps**: Pheromone traps use chemical attractants to lure insects into the trap. These traps are effective for certain types of insects, such as *bollworms and pink bollworms*, which are major cotton pests in India.

3. **Sticky Traps**: Sticky traps use glue or adhesive to capture insects that come into contact with the trap. These traps are effective for a wide range of insects, including *whiteflies and thrips*, which can damage cotton crops.

4. **Combination Traps**: Combination traps use a combination of different techniques, such as UV light and pheromones, to attract and capture insects. These traps are effective for a wide range of insect pests in cotton fields.

5. **Mobile Traps**: Mobile solar insect traps are mounted on a wheeled cart or trailer, making it easy to move them around the cotton field as needed. These traps are particularly useful for monitoring insect populations and identifying hotspots of pest activity.

5.3 BANANA

1. **Pheromone traps**: Pheromone traps use chemical attractants to lure insects into the trap. These traps are effective for certain types of insects, such as banana *weevils and fruit flies*, which can damage banana crops in India.

2. **Sticky traps:** Yellow sticky traps use glue or adhesive to capture insects that come into contact with the trap. These traps are effective for a wide range of insects, including *thrips and aphids*, which can damage banana crops.

3. **UV light traps**: UV light traps use ultraviolet light to attract insects, which are then captured in a container or net. These traps are effective for many types of insects, including *fruit flies and whiteflies*, which can damage banana crops.

4. **Combination traps**: Combination traps use a combination of different techniques, such as pheromones and yellow sticky traps, to attract and capture insects. These traps are effective for a wide range of insect pests in banana fields.

5.4 CAULIFLOWER

1. **Pheromone traps:** Pheromone traps use chemical attractants to lure insects into the trap. These traps are effective for certain types of insects, such as *diamondback moths and cabbage loopers*, which can damage cauliflower crops in India.

2. **Sticky traps**: Sticky traps use glue or adhesive to capture insects that come into contact with the trap. These traps are effective for a wide range of insects, including *flea beetles and thrips*, which can damage cauliflower crops.

3. **Light traps:** Light traps use artificial light to attract insects, which are then captured in a container or net. These traps are effective for many types of insects, including *moths and beetles*, which can damage cauliflower crops.

4. **Combination traps**: Combination traps use a combination of different techniques, such as pheromones and sticky traps, to attract and insects. These traps are effective for a wide range of insect pests in cauliflower fields.

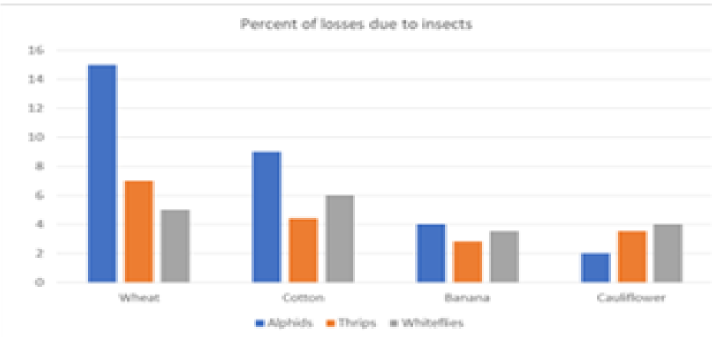

Chart -1: Variation in crops caused by insects.

6. RESULTS

The model is installed in a farm for testing. The testing is done in early morning, afternoon, evening, midnight. Also sticky pads are used for more efficiency .The results shows the percentage of insect trap.

FOR COTTON FIELDS-
Percentage of insects trapped = No. of insects trapped / Total no. of insects * 100

FOR COTTON FIELD –

- Total no. of insects captured = 90 = Early morning + afternoon + evening + midnight + pad
- No. of insects trapped in Early morning = 36 = 36/90 * 100 =40.
- No. of insects trapped in afternoon = 28 = 28/90 * 100 =31.11.
- No. of insects trapped in evening = 54 = 54/90 * 100 = 60.

FOR WHEAT FIELDS –

- Total no. of insects captured = 90 = Early morning + afternoon + evening + midnight + pad
- No. of insects trapped in Early morning = 43 = 43/90 * 100 = 47.77
- No. of insects trapped in afternoon = 23 = 23/90 * 100 = 25.55
- No. of insects trapped in evening = 49 = 49/90 * 100 = 54.44 No. of insects trapped in midnight = 30 = 30/90 * 100 = 33.33

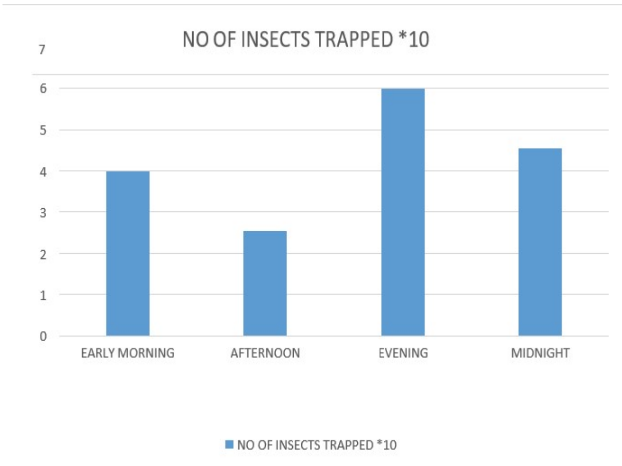

Chart -2: Quantity of insects in a day

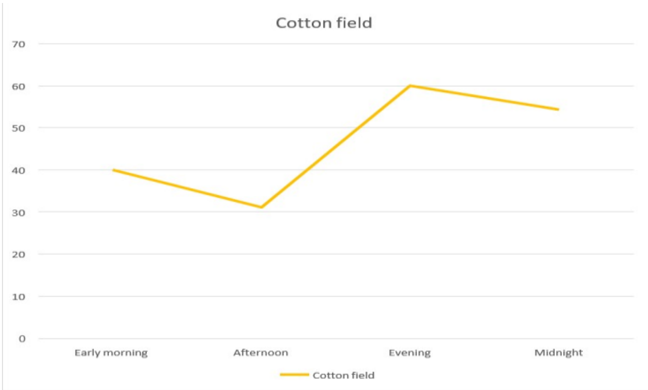

Chart -3: Testing of Cotton crop

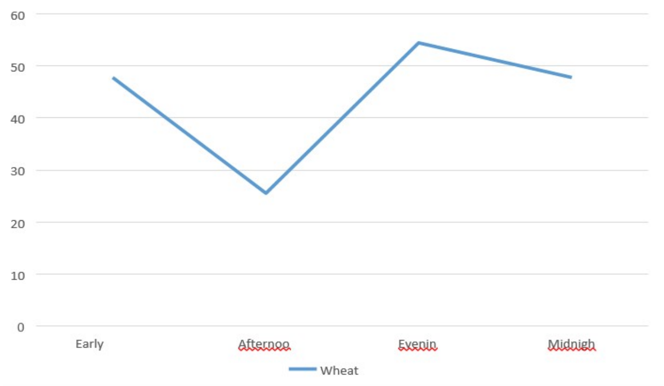

Chart -4: Testing of Wheat crop

Automatic solar insect light trap they use UV lights that are energy-efficient and have a longer lifespan compared to the incandescent or fluorescent bulbs used in traditional traps. This reduces the frequency of replacements and energy consumption, ultimately resulting in lower operating costs.

Secondly, automatic solar insect light traps come equipped with sensors that can detect changes in light conditions, allowing them to adjust light intensity and duration according to the current circumstances. This feature conserves energy while ensuring optimal operation during both day and night.

Thirdly, automatic solar insect light traps use solar panels to charge their batteries, eliminating the need for electricity and decreasing operating costs. They can function continuously without increasing energy bills or requiring frequent battery replacements.

Fourthly, automatic solar insect light traps are constructed with durable materials withstand harsh environmental conditions, making them weather-resistant. As a result, they can be used in various outdoor settings, even in areas with extreme weather conditions.

Lastly, automatic solar insect light traps require minimal maintenance, reducing labor costs while ensuring long-term effectiveness. This makes them a cost- effective and efficient pest control solution in both residential and commercial settings.

7. CONCLUSION

Solar-operated insect trappers are an effective and eco-friendly method of controlling insects without the use of harmful chemicals or electricity. These devices use solar energy to power the light source that attracts insects, and then trap them inside a container where they can be safely disposed of. One of the major advantages of solar-operated insect trappers is that they are self-sufficient and can operate in remote areas without access to electricity. Additionally, they do not emit any harmful chemicals or pollutants into the environment, making them a safe and sustainable alternative to traditional insect control methods. However, it is important to note that solar-operated insect trappers are not a complete solution for insect control and should be used in conjunction with other methods, such as proper sanitation and hygiene practices, to effectively control insect populations. Overall, solar-operated insect trappers are a promising technology that can help reduce the negative impact of insect populations on human health and the environment.

Moreover, its robust and weather-resistant construction necessitates low maintenance, making it a reliable and long-lasting solution for pest control in both residential and commercial settings. The development of an automated solar insect light trap offers several advantages in the field of entomology and pest management. Here are some key points to consider:

Enhanced Efficiency: The automated solar insect light trap utilizes solar power to operate, eliminating the need for external power sources and reducing operational costs. This allows for continuous and prolonged monitoring of insect populations without interruptions.

Increased Accuracy: The trap's automated features, such as programmed on/off cycles and light intensity control, ensure consistent and standardized trapping conditions. This leads to more accurate data collection, enabling researchers to study insect behavior, population dynamics, and pest outbreaks with greater precision.

Time and Labor Savings: The automation of trapping processes reduces the need for manual intervention and constant monitoring. Researchers can allocate their time and resources more efficiently, focusing on data analysis and interpretation rather than routine trap maintenance.

Remote Monitoring: Automated solar insect light traps can be equipped with remote monitoring and data transmission capabilities. This allows researchers to access real- time data from multiple trap locations, facilitating the tracking of insect populations over larger geographic areas and providing valuable insights into regional pest dynamics.

Environmentally Friendly: The utilization of solar power in the trap's operation aligns with sustainable and eco-friendly practices.

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