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CREATING A BIOPHYSICAL TRAPPING DEVICE BASED ON AN OPTICAL RADIATION SOURCE WITH A LIGHT-EMITTING DIODE

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ABSTRACT

The article addresses the problems of using semiconductor LEDs in the creation of environmentally friendly, high-efficiency, energy-efficient biophysical trapping device and their introduction into agriculture. The use of semiconductor LED lamps that are compatible with the spectrum of solar light in the device is preferred over other methods in that it is effective in combating pest flying insects and does not harm beneficial insects. The proposed device is environmentally friendly compared to chemical and biological methods of pest control. The device consists of an energy-saving circuit, which does not require high energy in use. This prevents inconveniences when used in field conditions, and the efficiency of useful work in the fight against flying insects is higher than other methods.

KEYWORDS: *Semiconductor LED, High Voltage, Circuit, Semiconductor Transistor, Transformer, Conductors, Energy Consumption, Light Spectrum, Power Supply, Solar Photo Element, Battery, Biophysical Trap, Flying Insects, Sexual Pheromone.*

1. INTRODUCTION

It is known that there are more than 80,000 species of pests of agricultural crops, of which more than 10,000 species cause significant economic damage to agricultural crops. According to the United Nations, one-third of crop yields are lost to pests each year. This figure is 50-60% in developing countries and 10-12% in developed countries.

The productivity of agricultural crops, the quality of the harvest increases the efficiency of production, ensures the economic and food security of the country, increases the material well-

being of the population. At present, the use of technologies based on innovative technical solutions that meet modern requirements is a key factor in the development of agriculture.

There are several widely used methods of pest control in the world: chemical, biological and physical. Of these, the method that combines biological and physical methods is the biophysical method, which is technically distinguished by its effectiveness. Currently, extensive research is being conducted on the use of this method, in particular, on various models and mechanisms of its operation. They are a high-voltage grid device based on optical radiation according to their structure and mode of operation [1,2]. The main mechanism that attracts insects in such devices is a source of optical radiation. It is surrounded by a high-voltage net in the form of a net, and the insects that seek the light are destroyed in this net. A common disadvantage of such devices is the extinction of all types of insects, including beneficial insects, the use of a special lamp as a source of optical radiation, ie, such a lamp does not attract large numbers of insects due to limited service life, high energy consumption, slow light wave propagation. Another device [3] has also been developed, a biophysical trapping device for killing harmful flying insects. This device is surrounded on three sides by a transparent wall of the sex pheromone, the fourth side by a high-voltage mesh, and the optical radiation source is mounted on its front. The main disadvantage of the device is that in field conditions, beneficial insects are killed by colliding with a high-voltage net at the expense of wind. Surrounded by a transparent wall on three sides, which reduces the scattering of optical rays in this direction, a special shaped fluorescent lamp was used as the optical radiation lamp. The required 220 V power supply is required for the device to work. This poses a problem in power supply in field conditions. Given the shortcomings of these methods, one of the current challenges is to create an environmentally friendly, inexpensive and highly efficient, energy-efficient biophysical trapping device to protect agricultural crops from various pests, to study its physical mechanisms. The newly developed device by us [4] illuminates the physical nature of the energy-saving biophysical trap device based on an optical source semiconductor LED, free from the above shortcomings.

2. STRUCTURE OF THE DEVICE

Figure 1 illustrates an energy resource-efficient biophysical grip device. According to the structure of the device, the base of the device consists of a cap, a bag for insects and electrical circuit elements. The upper part of the base of the device is in the form of a bath (1), on the surface of which is mounted a fighter device (2) in the form of a high-voltage grid. Beneath it are placed sex pheromones (3). Dead insects fall into the bag (4) through a hole in the bottom of the tub. The bag is located on the closed part of the device base (5). Inside the closed part of the base of the device are the elements of the electrical circuit. The electrical circuit consists of a low-power energy-saving transformer, a switch, a transistor, a conductor. The device cover (6) is fixed to the base by means of threaded rods (8) through the troupe (7). The semiconductor LED lamp (9) is located between the hood and the bath. To supply it with power, electrical conductors pass through the troupe.

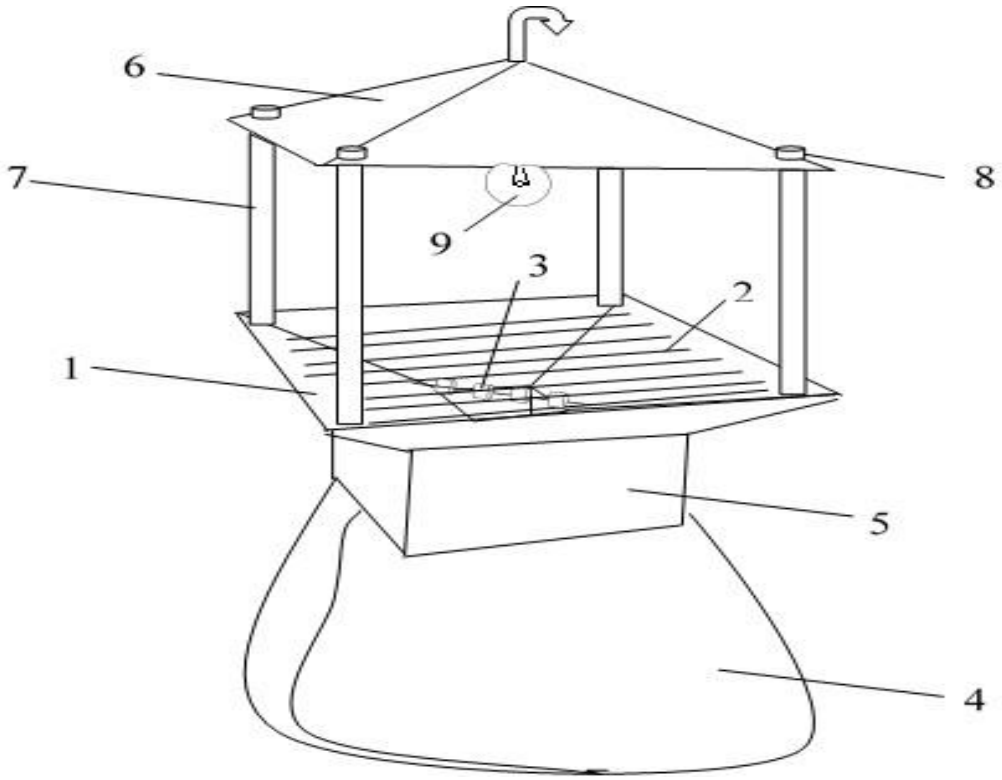

Figure 1. Simplified scheme of energy-saving biophysical trap device.

3. TECHNICAL CHARACTERISTICS OF THE ELECTRICAL CIRCUIT OF THE DEVICE.

Figure 2 shows the electrical block scheme of the device, which consists of an electrical amplifier transistor [5-7], an energy-saving high-voltage transformer, switch-off switches, a semiconductor LED lamp, and conductors.

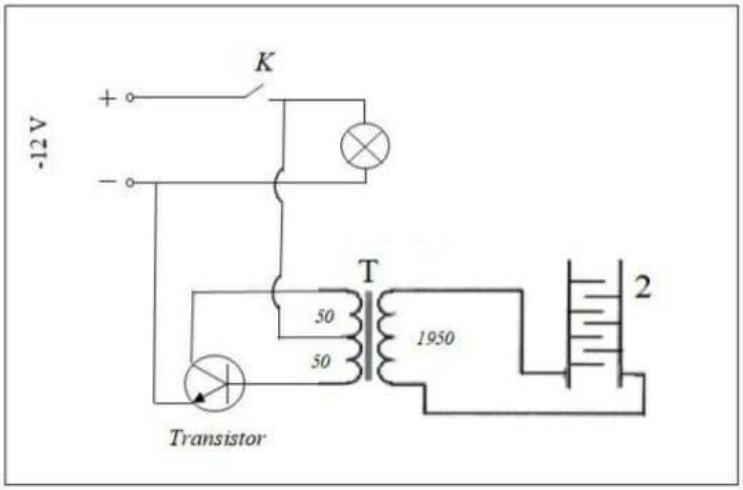

Figure 2. Electrical block scheme of the device.

The transistor converts an alternating 12-volt voltage from the current source into alternating current and transmits it to the transformer.The first winding of the transformer consists of 50 to two windings of copper wire with a cross-sectional area of 50 mm^2. The second winding consists of 1950 copper wire windings with a cross-sectional area of 30 mm^2[8-10]. A high voltage of ~ 3000 volts is generated in the secondary winding of the transformer, which is transmitted to the wire mesh. The range of the device to attract insects ranges from 500 m to a radius of 1000 m. Power supply capacity (duration of operation) 1 day.

4. THE WORKING PRINCIPLE OF THE DEVICE.

The device consists of a low-power energy-saving electrical circuit, the power supply voltage required for the operation of the device is constant 12 V. Batteries with such a parameter can be used to operate the device. It is not necessary to bring the battery to the mains to recharge, it is possible to recharge the battery during sunny days of the day using solar panels while standing in the field. In the device, an energy-saving low-power light bulb with a high luminous flux is placed under the cover of the device. The optical radiation lamp attracts insects. In ancient times, local farmers widely used the color of fire to collect insects, which was done by lighting a fire. Flame color has the property of dissipating heat as well as light. It has attracted a large number of insects under natural conditions. With this in mind, the underside of the cap of this device will be red and the surface of the tub will be yellow. Due to the fact that the lamp is located between the two surfaces, the light returning from them is mixed with the light of the lamp and diffuses in the form of a flame color. This attracts a large number of insects. This allows the identification of all types of insects in the area. A high-voltage net designed to kill insects is mounted horizontally on the surface of the bath-shaped kit, along with the base of the device. Beneath the destructive device in the form of a high-voltage grid mounted on the surface of the bath is a sex pheromone, which acts as a trap. Its essence is that the pheromone separator under high voltage attracts the main pest insect, as a result of which the pest insects that seek it are destroyed in a high-voltage net barrier. Another important aspect of the device is the vertical placement of the semiconductor optical radiation lamp, the high-voltage mesh and the pheromones. It is known that pheromones attract insects by spreading odors. The infrared light in the color of the flame, which is seen above, that is, returning from two surfaces and diffused by mixing with the light of the lamp, enhances the odor-scattering property of the pheromone. The odor rises to the top through a high voltage mesh. This is amplified in the range of the optical voltage lamp as well as the high voltage mesh and increases the attractiveness of the insects. Insects that seek out the odor-spreading pheromone are destroyed in a high-voltage net. Dead insects fall into the bag through the crack. Does not harm beneficial insects. Their destruction is prevented. The area of influence of one device ranges from 500 m^2 to 1 hectare.

It should be noted that pheromones in the device can be used for any type of insect. This, in turn, allows the device to be used in any area of agricultural crops in the fight against pests.

The efficiency of the device is determined by the intensity of the optical source attracting a large number of flying insects. The light sensitivity of flying insects corresponds to the wavelength range ~460–650 nm [11]. It is important to select suitable light sources that take into account the distribution of light intensity in the environment at a certain wavelength, as well as the increase or decrease of the light power effect when propagating in the environment.

Known light sources include incandescent lamps, fluorescent lamps, and semiconductor LED types. They differ from each other in lighting intensity, performance efficiency, power consumption, operating time, and the fact that they emit a certain wavelength. At present, semiconductor LEDs are mainly used in manufacturing, industry and the national economy. Semiconductor LEDs differ from other types of lighting in quality and light distribution ability, low power consumption, long service life, ability to emit different light spectra, control the emitted light power, high durability, environmental and fire safety [12, 17-19]. Depending on the type of semiconductor LED, the wavelength of the light emitted can range from 0.4 μm to 1 μm [13, 18]. Another important aspect of semiconductor LEDs is that the illumination does not change even when the operating voltage drops below the required voltage.

RESEARCH METHOD

In addition to the parameters listed above, in order to increase the efficiency of the device when choosing an optical source for a fishing lighting device, it must meet requirements such as lighting efficiency, light wavelength propagation in the environment and attracting large numbers of insects. Therefore, lamps with the same luminous flux of 1200 lumens [14] were selected as the source of optical radiation for the study. Determining the wavelength of light in the air is one of the most important scientific and technical problems in research. Figure 3 illustrates a simplified scheme of the research method.

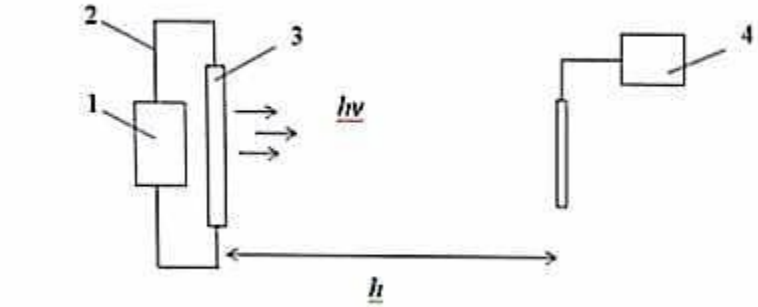

Figure 3. Simplified scheme of the research method. 1 - light source, 2 - light source, 3 - light source, 4 - luximeter, h - distance from the lamp to the luximeter.

The studies were carried out in the process of changing the distance from the optical radiation source to the luximeter in the range h=50 ÷ 600 cm. The resulting light intensity was measured using a luximeter brand LX1330B.The LX1330B luximeter receiver sensor type silicon photodiode filter is made of selenium semiconductor material and has a large light measuring range. The experiment was performed several times between 6pm and 4am and the results were found to be consistent.

RESULTS AND THE MECHANISM OF INTERPRETING THEM

Figure 3 illustrates the dependence of the luminous intensity of optical sources on h. We can observe the different distribution of light rays from optical radiation sources in the air. In all cases, it was found that the luminosity decreases exponentially with increasing distance from the

optical radiation source to the luximeter. The value of light intensity in an incandescent lamp takes smaller values in all cases than in a fluorescent lamp and a semiconductor LED. We can see that the luminous power of a semiconductor LED is higher in all cases than that of a fluorescent lamp and an incandescent lamp. This is because the flux of white light emitted from a semiconductor LED source is close to the spectrum of sunlight and has a wide spectrum range [15, 16, 18], it propagates in light spectra of different wavelengths.

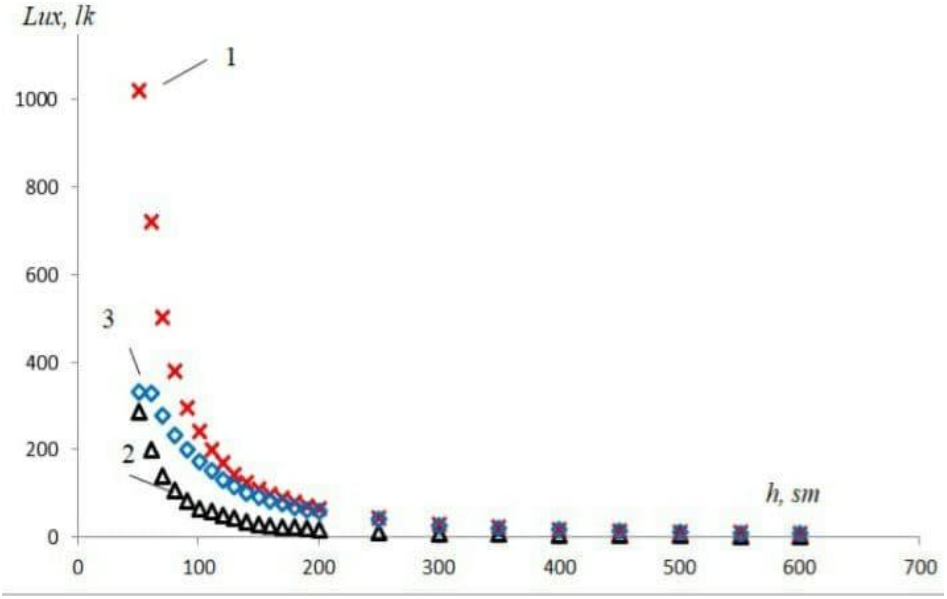

Figure 4. Dependence of optical source light power on h. 1 - LED, 2 - incandescent lamp, 3 - fluorescent.

The use of semiconductor LEDs in comparison with incandescent lamps and fluorescent lamps in the development and implementation of biophysical trapping devices against agricultural pests indicates that they attract large numbers of flying insects and are the preferred source of optical radiation with a wide wavelength of propagation in the air.

RESULTS OF THE EXPERIMENT

Preliminary research results were used against cotton plant pest flying insects. The experiment was conducted between 00^{00} and 4 p.m., and found that 62 caterpillars were caught in more than 1,000 biophysical traps, and no beneficial insects were harmed.

CONCLUSION

In summary, such a modern improved physico-technical solution of a biophysical grip device based on a semiconductor LED lamp has not been recorded in the literature to date. The device is energy efficient and effective in combating agricultural pests, plays an important role in increasing the productivity of agricultural crops, the quality of products.

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