Designing of light traps, monitoring, and also pests control on its basis

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Abstract. The following article is given data about the construction of light-traps working on a semi-automatized or autonomic regime, and also about carrying out the monitoring of identification of the phase of pests’ development and control them with the given light-traps. Given light-trap was created on the basis of the latest achievements of science with the help of semiconducting materials. The device constructed from semi-conducted light-diodes, relay of twilight, and solar batteries assembled of silicium, which is concerned as a typical semiconducting material, and also from accumulating batteries. It is shown that the given method of conducting monitorings and pests’ control is ecologically healthy, hands down to use, and easy in transportation. The method allows getting objective information about kind and sex type, date and dynamics of flying out, egg-laying formation, and fertility of many kinds of agricultural pests and trapping pests with little waste of time and resources.

1. Introduction
Raising the yields of crops is an important task in agriculture. This, in turn, is connected with the provision of food security in the country.

Currently, on average, agriculture annually loses up to 40% of the yield as a result of pests, diseases, and weeds. Therefore, protecting the crop from agricultural pests and diseases is of great practical importance for the successful growing of plant production.

In the system of plant protection against pests, four main methods are distinguished: agrotechnical, mechanical, biological, and chemical. The role of these methods in the overall complex of pest control measures changed significantly at various stages of scientific and technological progress [1]. The work [1, 20] are also highlighted the disadvantages of existing methods from the point of view of their environmental friendliness and laboriousness.

In the work [2, 19], are given existing methods for protecting gardens from pests and diseases that provide partial preservation of the crop. Favorable conditions for their development and growth, the resistance of plants to diseases and damages by pests during seasonable agricultural activities are shown.

On this basis, we, the specialists and scientists of the agricultural sector, have to find the best ways and methods to control agricultural pests. Only after this, it is possible to increase the yield of farmlands.

Thereby, in agriculture, more and more attention is paid to the introduction of electrical technologies with an appropriate set of equipment. Electrical technologies allow to make a sharp turn
of agricultural production to a new level with higher qualitative and quantitative indicators and with minimal economic costs [3, 18].

In the biosphere, many insects affect a person, his life, and labor. This influence can be both positive (pollination of flowering plants, the extermination of insect pests), and negative (destruction of crops, harvesting crops, etc.). As a result, insects are divided into useful and pests [4]. Therefore, it is important to analyze existing methods to control agricultural pests or to develop new methods. Based on the results of the analysis, it is necessary to find the best methods to control agricultural pests.

It is possible to show electrophysical methods that are the most effective and eco-friendly.

In the latter days, agricultural experts and scientists have been offering other pest control methods. For example, the most perspective is considered an integrated plant protection method, including the biological and electrophysical methods of monitoring and extermination of insects and butterflies.

Farmers have been facing the problem of passing to pest control from the chemical method (polluting the environment) to biological (environmentally friendly) and physical methods for a long time.

The work [5, 17] is devoted to the urgent issue of protecting berries from pests by eco-friendly biological preparations.

The main task of protecting plants from pests and diseases is the complete elimination or reduction of crop losses to economically imperceptible sizes through the use of integrated plant protection systems that are safe for a person and his environment.

Integrated plant protection is the most promising way to solve the problem. The set of rational methods used on the basis of information about the species, population size, and ratios of harmful and useful insects in the array of agricultural land, in the development phase, periods of the harmfulness of insects, etc. The quality of monitoring the number and type of pests is determined by conducting integrated plant protection, which includes chemical and electrophysical methods.

Let us consider the method of electrophysical control of pests, which include electric light traps more detailed [6, 16].

Trapping, that is, the attractiveness of a light trap depends on the type and power and spectrum of radiation by the installed lamp, as well as agrometeorological conditions (humidity and temperature of the air, wind, air pressure, etc.).

The constructions of electric light traps are extremely diverse, this includes the light source, electricity, and catching mechanism. The principle of their action is that insects approaching the light at night lose the stability in flight and fall into the trap’s pheromone installed under the LEDs or into the other kinds of catchings.

In the work [7, 15] are presented the constructions of a light trap known by now for monitoring the number and phases of development of insects. Besides, there was carried out a theoretical analysis of the design of a single-slot light trap.

2. Methods

The research methodology is based on a review of existing and applied control methods at irrigation pumping stations, comparative analysis, and comparison of these methods, taking into account the operating conditions of irrigation pumping stations.

When comparing control methods, the operational data of the Kizil-Bayrak, Ulugbek II, Ittifok, Navoi, Turkiston, and Teshiktash-1 pumping stations were taken. Kizil-Bayrak, Ulugbek II, Ittifok, Navoi and Turkiston pumping stations have overestimated technical performance compared to the actual required. Teshiktash-1 pumping station has very different water consumption and water supply schedules. When processing data, standard statistical techniques and programs were used.

Our designs are assembled as follows [8]. As a light source, LEDs emitting a white light was used. A solar battery with a constant voltage of 6 V was used as a power source. In the device the main element is considered the twilight relay. In the electric scheme of the work carried of the light trap there was not the switch (on-off). The role of the twilight relay is the following: when it gets dark, that
is, when evening dusk sets in, the relay automatically connects the LEDs to the battery. Wherein, the LEDs emitting white light are on. So as the relay of lighting (with the other words relay of twilight) is switched on in the electric scheme of the light trap, it is becoming easy the observation of the processes happened around the light trap. With the fixed video camera the observation carried out with the help of a computer not leaving the controlling place. LEDs can work in different brightness. In this case the regulation of amperage given to LEDs occurs with the help of impermanent resistor.

For smooth regulation of the electric amperage or voltage in the chain, slide rheostats are used. The main part of this electrical device is a conductive element with impermanent resistance. The engine rheostat is equipped with a sliding contact that is in touch with a wire of resistor alloy reeled upon an insulating base.

At its movement, the resistance between it and the end of the wire windings changes. In other words, a change in resistance is achieved by changing the number of windings of wire through which the amperage flows [9, 10, 11, 12, 13, 14]. Thus, the brightness of LEDs can be adjusted.

As soon as it gets light, i.e. when morning dusk sets in, the relay automatically disconnects the LEDs from the power source. During daylight hours, the battery is automatically connected to the solar battery. To control the battery charge level, as well as to prevent current leakage in the solar battery at night, on the scheme the control diodes are connected. The general view of the device and its emplacement on vegetable fields are shown in Fig. 1a.

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**Figure 1 (a and b)** The common appearance of light trap and its emplacement in the vegetable fields.
3. Results and Discussion

We conducted several experiments on catching butterflies and the results of experiments show that the trapping of many species of insects can be significantly increased if we select the spectrum of light (in this case we used filters that give different lights), which has highly attractive properties. Light traps attract those insects which active flight occurs at dusk or night, butterflies that fly into the light and fall on pheromone traps. Thus, in our case, there are two methods of controlling agricultural pests - electro physical and biological which are integrated. Besides, we added mechanical methods here. We matched the cardboard paper of suitable size and width for it. With the help of cardboard paper we made cylindrical, cone-shaped tubes or nets. Thereby we had been conducting the experiments for several weeks. Thus, we attracted to trap both pests and useful insects. In such traps the insects are not harmed. Herewith it can be done the monitoring of the kinds of butterflies without any difficulties. Methods of trapping butterflies using light have existed for a long time. In the late 60s and early 70s of the last century, as it got dark, the fires were lit with a rag dipped in diesel fuel, and butterflies flew into the fire. In such methods the insects, in spite of the fact that they were useful or pests all died out. In biological methods we often used different traps (attractants), when pests come to the odour of the trap for eating (food), and the species of different sex searches for themselves a pair for coupling (sex traps). In that way, the efficiency trapping the insects increases. Besides all experiments were repeated several times using different light filters (yellow, red, and blue). Depending on the specter’s color the insects of different kinds and amounts are trapped (the largest trap occurs in the yellow color). It is necessary to note that depending on the spectrum the kinds of insets differentiate from each other. But these are our primary assumptions. To set the consistent pattern of experiment several seasons are required.

The difference between our device (light trap) and the light trap described in [4] is the following: there are a twilight relay and a resistor that controls the brightness of the LEDs (Fig. 2.). One should note that relay of twilight, by far, makes easy human labor. The light traps constructed by us with the help of twilight relay and solar elements allow getting the objective information about species and sex type, date, and dynamics of flying out, egg-laying formation and fertility of many kinds of agricultural pests and trapping harmful pests with little waste of time and resources.

![Figure 2. Position of LEDs, emitting white light.](image)

4. Conclusions
Thus, the light trap constructed by us with the use of light diodes, solar batteries, and especially relay of twilight makes easy human’s labor in making experiments that give the opportunity, without any difficulties, to observe the process occurring around the trap. The method is ecologically clean, easy in use, and comfortable while transportation.

The method allows getting objective information about kind and sex type, date and dynamics of flying out, egg-laying formation, and fertility of many kinds of agricultural pests and trapping harmful pests with little waste of time and resources. In the near future we are planning to improve existing and construct new devices without light filters and make monitoring for amount and phase of development pests, based on the photo-electric converter (PEC) and light diodes emitting the waves of different length (here will be no need of using light filters), and also relay of twilight. Exactly to this kind of light mostly useful and harmful butterflies come. After carrying out experiments we will set the task to determine optimal versions of trapping the harmful butterflies, to begin series production of light traps, and in due course provide agricultural farms with them.

Thus, the proposed method is eco-friendly, simple to use, and does not require frequent human intervention, easy asa method, and device for monitoring. Shortly we plan to improve existing and develop new devices without light filters and to monitor the number and phase of development of pests based on photoelectric converters (PECs) and LEDs emitting waves of different lengths (there will be no need to use light filters) as well as twilight relays. Exactly on such light fly beneficial and harmful butterflies more. After the experiments, we have the task of determining the optimal options for catching harmful butterflies, starting mass production of light traps, and timely providing farms with them.

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