# Calculation of crop production using integrated plant protection against pests

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**Abstract.** The efficiency of the plant's integrated protection depends on the quality of monitoring quantity and type of pest insects. The analysis of current construction devices for pest insect monitoring shows that using a video light-emitted trap based on photovoltaic cells. This to allowing more exactly to analyze pest insect and useful forms. Sometimes it is difficult to move the experiment's plans. Especially if experiments have developed in one area (for example- the agricultural industry) and it needs to move in other areas. Because of the logic system on a basis – identical, but therefore, will be carefully considering possibilities, which with appropriate elements' interpretation of some form experiments. This must allow the success of using experiments in other tasks. The result of the crops' survey has shown more 3500 phytosanitary conclusions. In total, insecticide treatments versus pests were carried out in the region on an area of 146.612 hectares, including 35.290 hectares were used biological preparations on mixtures. The herbicidal treatment of crops against weeds was carried out at 764.273 hectares. Effective action with pests and illness of agro-culture is the most important part of modern intensive technologies. Modern intensive technologies of cultivation agro-culture provide for various using of the integrated system plants' defense. This system consists of agro-technical, biological, physical and chemical actions with organizational events. For increasing of agro-cultural development, energy-efficiency technologies must be using. Objective: Make analyze to using video light-emitted trap for identify a quantity and composition of pests. Tasks: 1. calculate the biological efficiency using by video light-emitted trap through mortality rate pests. It is need for decreasing of agricultural' damaging. 2. Calculate the economic efficiency of video light-emitted trap.

## 1 Introduction

A significant feature of agro-culture is the biological objects belong to the consumer energy system. Biological objects determine a technical regime of enterprise and add biological dependency in energy capacity of production. [3,4,5,6,9,10]
In order to resolve which factors can be is insignificant, necessary to understand this task. So many details may is drop out, even if biological description is clear. More details can be

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dropped during construction mathematical model of biological effects. Considering that model can be is exactly. The difficult ecological system may be depending by high quantity information. In addition, big success can be with the help of modern methods using by computers.

## 2 Identify of the biological effectiveness of using pesticide.

A timely identification maturation's time of population, with using integrated methods of pests' elimination, we can to achieve of pest's quantity decrease. [2,5,9,8].

For Example: Speed of increase pests' population is 10 insects per hour, if do not doing methods against this, Pests' quantity will be increasing by geometrical progression. For one hectare, the number of insects may increase 1200 times in five days. Example: In a first day were 240 insects, in an end of fifth day, population insects will be 288000 species.

The calculation of biological efficiency is determined by a percent of pests' mortality. A plant damaging decrease is determined by Abbot's equation.

$$Ab = \frac{\text{A}-\text{B}}{\text{A}} \cdot 100\% \quad (1)$$

Where A – pests' quantity while monitoring. B – pests' quantity after the chemical was used.

The number of pests determines the ratio of quantity pests while monitoring. Equation is:

$$\text{A} = \frac{\text{C}\cdot\text{K}t}{100} \quad (2)$$

Where C – pest's the quantity on the time, Kt - Time rate while pests' monitoring. Time rate while pest's monitoring till chemical using:

$$\text{K}t = \frac{t_{pt}\cdot 100}{t_b} \quad (3)$$

Where $t_{pt}$ – pests' monitoring time, $t_b$ – time till chemical using. [9,11,12,14].

For calculation of biological efficiency - three variants of pests' identify have been considered.

**Table 1.** Raw data for identifies biological efficiency with pests' monitoring.

| № | Indicator | Basic option (visual fields examination) | Light – emitted traps uses | Video light – emitted traps uses |
|---|---|---|---|---|
| 1 | While pests' monitoring till chemical using t=h | 120 | 72 | 48 |
| 2 | Quantity pests after pesticides using B | 72922 | 18144 | 2420 |
| 3 | Quantity pests on 1-hectare agricultural fields during the five days C | 288000 | | |

The calculated data put in table 2. The biological efficiency chemical using depends on toxicity and time, for hazardous organisms. To a large extent this dependency related to process quality. This dependency relates to preparative form, consumption rate, timeline and way of using a product. Also, this dependency relates to degree and equity using a product on the hazardous organisms and plants, weather conditions, product's wettability and endurance of parts on the treated planes.

**Table 2**. Calculated data of biological efficiency.

| № п/п | Indicator | Basic option (visual fields | Light – emitted traps use | Video light – emitted traps |
|---|---|---|---|---|

| | | examination) | | use |
|---|---|---|---|---|
| 1 | Time rate Kt=% | 120 | 60 | 40 |
| 2 | Quantity pests from time A | 345600 | 172800 | 115200 |
| 3 | Biological efficiency Ab=% | 78.9 | 89.5 | 97.9 |

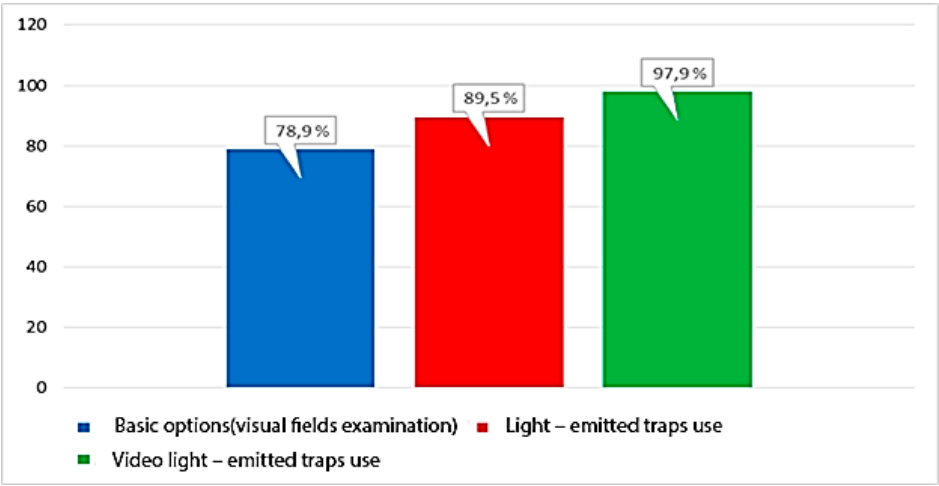


**Fig. 1.** the biology efficiency of chemistry usage on struggling with pests in various methods.

From picture 1 can see, in the case of temporary use of chemicals, we can achieve increased efficiency of video light-emitting trap on 19 percent compared to basic options and on 8.4 percent compared to the light-emitting trap.

## 3 Identify to economic effectivity

The economic effectivity of the chemical's application should be in straight dependent on biological effectivity.

However, performance can affect other factors. For example, direct effect on plants, timeline to treatment's spending (till and after using chemical), influence on pollinators, agricultural environment, etc.

If the treatment was been spend with delaying, after significant damage was done by pests or disturbed process of pollinating, to take with an account high biological efficiency, the economical effectivity can be decreased. [1,4,8,9]

The economical effectivity is determined by way of comparing crops from treatment's places, but with various timelines to using chemical products. It needs to monitoring pests.

$$Eb = C_{\text{м}} - Cb. \quad (4)$$

Where $Cb$ - crops with basic chemical applications kg/ha, $C_{\text{м}}$ – crops with chemical applications and pests' monitoring kg/ha.

The area of crops is 0.25 m2. All weights and weights together with straw in the field, after which trial sheaves are taken from it, which are weighed and placed in a gauze bag for drying and threshing. It is necessary to ensure high-quality products. [1, 3,4,5,6,9,10].

The basic indicators to characterize economical effectivity are the value of additional crops (in the money equivalent), conditional net profit.

The net profit of these actions (rub/ha) set by the difference between the increasing value of agricultural products (with into account the quality) and chemical using cost. This cost including charges for cleaning, a transit of additional products. The additional products

gained from chemical events. [1, 3,4,5,6,9,10].

An output indicator is proposed to using the crops with the qualitative account. Here we considering natural and costs estimates, cost in the 1 hectare, the first cost of products, annual economic effect, cost of work needed to make 1 kg products on the areas after chemical treatment. The chemical treatment doing with various methods of pests' monitoring. [1, 3,4,5,6,9,10].

The value of defended crops with changing product quality by using monitoring of pests, compared to first cost gain as in the difference in crops' cost in the areas.

$$Crc = \mathrm{C} \times C\mathrm{M} - C \times Cb, \quad (5)$$

Where $Crc$ – the cost of remaining crops with a quality changing, rub/ha

C – Cost of crops' realization with quality consideration, rub.

In the consisting of plant defending events' costs includes value of chemicals, cost of treatment. (including workers' salary) , depreciation of mechanization.

Chemical' expense is composed of the value (acquisition price)

$$\mathrm{C}n = Cp - \mathrm{P}p, \quad (6)$$

Where $Cn$ – Cost of pesticide on the unit of job. (1 ha) rub, $Cp$ – cost of pesticides, rub. /kg, $\mathrm{P}p$ – expense of pesticides, kg/ha.

As a result, in the current time, the chemical using a low expense level (0.1- 1 kg, l/ha). Expense on the chemicals' delivery, don't take into an account. They account for as much 0.07-0.1 rub/hour.

The salary expenses are determined in accordance with laws of agricultural enterprise, standards of developing, tariff rates, prices, including a possible allowance for leveling, extra pay for hazardous terms of labor ,etc

$$\sum S = \frac{[St(1 + \mathrm{K}v + \mathrm{K}a) \times \mathrm{K}]}{W}, \quad (7)$$

Where $\sum S$ – total expenses on salaries, requiring by making crops protection events, rub/ha. St – tariff rate for completing needed work (spraying with water, working in water delivery, etc.) rub. $\mathrm{K}v$- extra pay for hazardous labor. $\mathrm{K}a$ – coefficient of allowance. W - Technically based production rate on a particular type of work. (ha/hours). K – Generalized coefficient of pay outgoing on vacations and social insurance. [1, 3-16].

The amortizations are defined by all machine types using spraying. (Tractor, water-delivering cars). The cost defined by the equation:

$$\mathrm{A} = \frac{\mathrm{Ca} \times Na}{100 - \mathrm{T} \times Wr}, \quad (8)$$

Where, Ca – Cost of a car (rub.), Na – the standard of amortization pays from cars' balance. T – Loading of a car (hours), Wr – aggregate's performance. (Ha/ hours). The costs of current repair and maintenance of machines, cleaning, transportation, and refinement of the stored (additional) crop are determined similarly.

The net income of crops' protecting events defines by the difference of saved crops' cost and total expenses.

$$Ni = Csc - \mathrm{E}, \quad (9)$$

Where $Ni$ – net income, rub. /ha, $Csc$– Cost of saved crops based on the increasing of products' quality, rub. /ha, $E$ – expenses on the protecting events, rub./ha.

Expenses on the protecting events:

$$\mathrm{E} = \mathrm{C}p + \sum Z + \mathrm{A} + Zty, \quad (10)$$

where Zty – Expenses on the current repair and maintenance of cars, on cleaning, transportation, and saved crops refining.

The standard of cost-effectiveness protecting events is estimated as,the ratio of net income and expenses needed by gaining saved crops.

$$C = \frac{Ni}{\mathrm{E}} \times 100, \quad (11)$$

**Table 3**. Data for economic efficiency calculation

| № | Indicator | Basic option (visual fields examination) | Light – emitted traps use | Video light – emitted traps use |
|---|---|---|---|---|
| 1 | Crops harvests without chemical 2018y. kg/ha, | 2880 | | |
| 2 | Crops harvests with chemical 2018y kg/ha, | 3190 | 3231 | 3312 |
| 3 | Crop marketing price according to product quality C=rub. | 14.45 | | |
| 4 | Cost of chemical, Cp=rub./kg. | 942 | | |
| 5 | Chemical expenses, Rp=кг/га | 1 | | |
| 6 | Tariff rates for making of standards *Tr*= rub. | 62.5 | | |
| 7 | Allowance efficiency for hazardous labor, Kv | 1 | | |
| 8 | Allowance efficiency, Kn | 1.3 | | |
| 9 | Technically based production rate for a specified type of work *W* =ha/h. | 4 | | |
| 10 | Generalized rate, K. | 1.39 | | |
| 11 | Cost of cars Ca=rub. | 250000 | | |
| 12 | The depreciation rates *Ha=%.* | 13.5 | | |
| 13 | Loading of a cars T=time. | 8 | | |
| 14 | Performance of aggregate Wr=ha/hours. | 4.7 | | |

Calculated data put in table 4.

**Table 4.** Calculated data for economic efficiency

| № | Indicator | Basic option (visual fields examination) | Light – emitted traps use | Video light – emitted traps use |
|---|---|---|---|---|
| 1 | Economic efficiency, Ab=kg/ha. | 310 | 351 | 432 |
| 2 | Cost of saved crops, considering the quality of all products, *Csc*=rub. /ha. | 4479 | 5072 | 6242 |
| 3 | Cost of chemical on the work unit 1 ha *Cn*=rub | 941 | | |
| 4 | Total salary expenses, requiring to crops protection events ∑*Z* =rub./ha | 72 | | |
| 5 | Amortization expense. All types of cars spraying with water. A=rub. | 541 | | |
| 6 | Expenses on the current repair and maintenance of cars, on cleaning, transportation, and saved crops refining Zty=rub. | 760 | 912 | 1140 |
| 7 | Net income, Nd=rub. /ha. | 2135 | 2606 | 3548 |
| 8 | Expenses, requiring to crops protection events, E=rub. /ha. | 2344 | 2466 | 2694 |
| 9 | Cost-effectiveness rate of protection events , R=% | 91 | 105 | 132 |

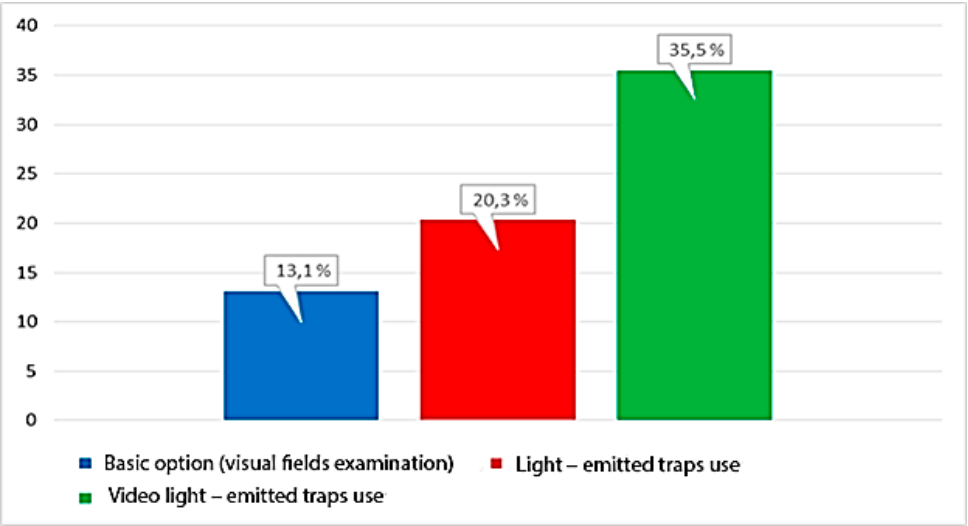


**Fig. 2.** Economic efficiency. Cost-effectiveness of protection events.

As can be seen from calculations of economic efficiency with the timely application of pesticides, the number of crops has increased depending on the basic and is 122 kilograms per hectare, the net income is 3548 rub. per hectare, the profits rate of protective measures from basic is 41%.

## 4 Conclusion

1. The calculation of biological efficiency with using “Video light- emitting traps” we can see, pests mortality has increased on 19 percent comparing with basic options and on 8.4 percent comparing with using of light-emitting traps.

2. The calculation of biological efficiency with timely chemical application revealed is harvest increasing in dependency from basic options. The quantity of harvest is 122 kg per hectare. The net income is 3548 rub per hectare. The profits rate of protective measures from basic is 41%.

3. From all the above it should be clear that there are many acceptable for building and analyzing the effectiveness of the use of the "Video Light – emitting traps" in determining the number and species composition of insect pests. In most cases, these are still fairly simple and simplistic processes, but they point to realistic research.

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