The use of information technologies to assess the parameters of environmental safety of technological processes in the agro-industrial complex

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Abstract. Agro-industry involves the adoption of a set of measures to preserve the harvest. A well-proven method is the treatment of crops with chemicals. The effectiveness of this method is beyond doubt, but the question about the environmental safety of the technological process arises. The lack of environmental monitoring of the spraying system does not allow controlling the incomplete deposition of chemical plant protection products, i.e. soil contamination. As a proposal for solving this problem, an information and software complex equipped with touch sensors has been developed. Sensors are installed on plants and on the soil, which makes it possible to measure the concentrations of precipitated particles during the spraying process, considering environmental safety parameters. The received information is transferred to the system database. The use of an information and software complex, if necessary, allows to make operational decisions on the regulation of the chemicalization process and the preservation of soil quality.

1. Introduction
The treatment of crops with chemicals means of protection is necessary to preserve the crop and, in general, has a good economic effect. Spraying systems equipped with various types of spray devices provide targeted deposition of pesticides, but at the same time, the spray spectrum contains particles of different sizes. Fine particles are carried by the wind, while large ones roll off the plant leaves onto the soil. There is a need to develop and test an information and software complex that monitors the process of land cultivation in remote mode [1-4,10-16].

The purpose of the study is to create and test the information and software complex for the study of the process of spraying pesticides, which in the future allows solving the problems of improving the environmental parameters of soils and the effectiveness of the process of chemical treatment of crops.

2. Materials and methods
To study the process of spraying chemicals, wireless sensors located at certain points of the field according to the requirements of the standard were used to determine the concentration level of pesticides deposited on plants and on the soil. The main elements of this complex are sensors [5-7].

Wireless sensor systems are miniature devices on which processor, memory, digital-to-analog and analog-to-digital information converters, radio frequency transceiver and sensors are placed. The coating of the sensitive surface of the sensors is selected considering the type of chemical preparation used and its characteristics. The sensors are connected to the system via digital and analog connectors.
The location of the measuring devices on the field, across the movement of the technological machine, allows to obtain information about the uniformity of spraying and dispersion of particles deposited on soil and plants, as well as their concentration [8], Figure 1.

![Figure 1. Layout of piezo sensors (B₁-Bₙ), according to movement direction](image)

The information software of the spraying process allows [9]:
- to form a data bank for processing objects, sections;
- to study the characteristics and differentiate pesticides by hazard class and direction of action;
- to study technologies and technical means of applying pesticides;
- to analyze the methods of spraying according to the criteria of efficiency and environmental safety;
- to control meteorological elements (air velocity, humidity) during the spraying process.

The database acts as input parameters for the study of the technological process of spraying pesticides, used for subsequent evaluation, Figure 2.

![Figure 2. Diagram of input parameters and output data of the study of the technological process of spraying pesticides.](image)
The work on the management of the information and software complex is carried out as follows: initially, the crops to be processed are selected. The chemicals required for this process are selected from the database. The spraying system and the type of spray device used at the moment are determined.

The primary information comes from sensors located in the area where the measurements are carried out. The collected information is electronically sent to the information block, where it is further processed by information analysis and evaluation system. The option of transmitting information in electronic form is assumed, which ensures the adoption of operational decisions on the adjustment of the spraying process, it is also possible to generate results using graphical visualization tools.

Figure 3 shows the scheme of sequential calling of objects of the information and software complex through the main button form.

![Diagram of sequential calling of objects](image)

**Figure 3.** Interrelation and interaction of objects of the information and software complex.

The data obtained during the research are processed in the form of a comprehensive program running under Windows 2007 operating systems in the Builder environment (programming languages C, C++, Java and VBA).

3. **Results of using the information system**

The information and software complex developed and confirmed by the certificate of computer programs is necessary for systematization of data on all elements of the technological process, their
storage in databases, updating parameters in connection with the emergence of new types of chemical plant protection products, processed crops and spraying devices, etc.

The presence of the Windows API application allows the received information to be presented in the form of graphs, diagrams, tables, Figures 4-5.

**Figure 4.** Example of visualization of the results of field measurements of deposited pesticide concentrations, considering the chemical preparation and technical device.

It is possible to provide the received information in the form of a table, Figure 5.

**Figure 5.** Results of a field study on sites with characteristics of concentrations on soil and plants (screenshot).

### 4. Conclusions

The age of information technology imposes new requirements for conducting field research and experiments.

The use of the proposed information and software package allows for remote analysis and control of the process of chemical treatment of crops. The variant of this solution is relevant not only from the standpoint of the promptness of taking corrective actions, but also ensures the safety of the person participating in the research.
References

[1] Kulikova N A and Lebedev G F 2020 Herbicides and ecological aspects of their application (M.: Book House "Librocom") pp 152

[2] Suslov S V and Sutorikhin I A 2018 Determination of the quality of spraying of pesticide preparations by various installations Polzunovsky Bulletin 2 106-109

[3] Komarov M M 2019 Environmental monitoring system based on a wireless sensor network. - Abstracts of reports. "Scientific and technical conference of young specialists of MIEI" (M.: MIEM) pp 145-148

[4] Digo S M 2007 Databases: design and use. (M.: Publishing house "Finance and Credit") pp 444

[5] Udartseva O V 2013 Information and software for environmental monitoring of aerosol spraying of pesticides Fundamental research 6(2) 310-314

[6] Udartseva O V 2013 Development of information and software for environmental monitoring of aerosol spraying of pesticides Proceedings of the Altai State University. Section "Management, computer engineering and computer science" 1/1 125-127

[7] Udartseva O V 2014 Assessment of the environmental friendliness of the process of aerosol spraying of pesticides using an information and software package Proceedings of the Altai State University. Section "Management, computer engineering and computer science" 1/2 127-129

[8] Udartseva O V 2015 Evaluation of spray devices of the process of chemicalization of lands using an information and software complex Bulletin of the Altai State Agrarian University 4(126) 160-164

[9] Udartseva O V 2013 Certificate of state registration of the computer program "Evaluation of the process of aerosol spraying of pesticides" 2013618765

[10] Reus J, Leendertse P, Bockstaller C, Fomsgaard I, Gutsche V, Lewis K, Nilsson C, Pussemier L, Trevisan M, van der Welf H, Alfarooba F, Blumel S, Isart J, McGrath D and Seppala T 2019 Results of the European CAPER Project. Comparing Environmental Risk Indicators for Pesticides 7 p

[11] Rogers R B and Ford R J 2015 The windproof Sprayer: its progress and prospects Agricultural Engineering 66(11) 11-13

[12] Rogers R B and Ford R J 2017 Development of the windproof sprayer ASAE 851003 1-8

[13] Russo Mario Vincezenzo, Campanella Luigi 2020 Determination of organophosphorus pesticides residues in human tissues by capillarygas chromatography negative chemical ionization mass spectrometry analysis J. Chromatogr. B. 780(2) 431-441

[14] Van der Werf H M and Zimmer C 2018 An indicator of pesticide environmental impact based on a fuzzy expert system Chemosphere 36 222-224

[15] Watermelons A 2019 One year routine application of a new method basedonliquidchromatography-tandem massspectrometry to the analysis of 16 multiclass pesticides in vegetable samples Aguera A, Lopez S, Fernandez Alba A R J. Chromatogr. A. 1045(1-2) 125 -135

[16] Averdieck W PCME Ltd. Optimising the efficiency of dust control equipment with a novel forward-scatter particulate monitoring instrument, PCME materials006 1(2) 152-158