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9.5 Features of scientific research from protection and quarantine of plants

Scientific research is the study of a specific object, phenomenon or object in order to reveal the patterns of its origin and development, which is the basis for the formation of new scientific knowledge. The basis of scientific research is objectivity, the ability to reproduce the results, their provability and accuracy [315, 316].

There are the following stages of research [317, 318]:

1) preliminary analysis of existing information on the research issue;

2) study of conditions and methods of solving problems;

3) formulation of initial hypotheses and their theoretical analysis;

4) planning, organization of the experiment (experiment) and its implementation;

5) analysis and generalization of results;

6) testing of initial hypotheses on the basis of investigated factors, final formulation of new laws and laws, explanations and scientific predictions;

7) implementation of proposals in production (for applied research).

Research methods

Among the general scientific methods in the protection of plants, the following are most often used: hypotheses, experiment, observation, analysis, synthesis, induction, deduction, abstraction, concretization, analogy, modeling, formalization, inversion, generalization [319].

Hypothesis – a scientific assumption, the true meaning of which is uncertain. There are hypotheses as a method of developing scientific knowledge and as an integral part of scientific theory [315, 320].

If the breeder offers a new variety of culture, the working hypothesis about the viability of the variety is put forward on the basis of its characteristics, which gives the State Commission for Testing and Protection of Varieties. There are the following rules for hypotheses [316]:

- ✓compliance of hypotheses with the facts to which they relate;
- ✓of the hypotheses, the most suitable is the one that explains more facts;

✓to explain the facts, the connection of hypotheses with them should be the closest;

✓contradictory hypotheses cannot be once true;

✓when making a hypothesis should be aware of the probability of their conclusions.

An experiment is a method of cognition by means of which an object and the processes that take place in it are studied in artificial but controlled conditions. The experiment tests hypotheses that are put forward when planning an experiment.

Modern science uses different types of experiments: qualitative, quantitative (measuring), mixed, thinking and computing.

Observation – purposeful focus of the researcher on the phenomena of experiment or nature, their quantitative and qualitative registration [321].

The purpose of observations in scientific agronomy is to identify the best elements of agricultural technology, technologies, varieties, soils, etc., which help to increase yields and improve its quality. The main requirements for observation are as follows: [318, 322]

➢obtaining unambiguous research results;

➢objectivity, ie the possibility of control through repeated observation;

➢use of accurate instruments for monitoring;

➢correct interpretation of the results of observations.

Analysis – a method of research by which the studied object is imaginatively or practically divided into constituent parts for the purpose of more detailed study (for example, the experiment is first analyzed by repetitions, and each repetition – by individual sections, options). Plants in the dynamics of their growth are analyzed either after a certain period of time - once a decade, a month – or by phases of plant development. To determine the chemical composition of plants are first divided into separate organs – leaves, stems, fruits, roots and more [318, 323].

Synthesis – a combination of dismembered and analyzed parts of the studied object or several objects into a single whole. The task of the synthesis is to obtain the necessary data for more complete conclusions and generalizations on the basis of a

detailed analysis [319].

Induction is a method of research by which judgments lead from facts to concrete conclusions. If the leaves of plants turn yellow, they conclude that there is a lack of nitrogen nutrition; if it acquires a purple hue - about the lack of phosphorus in the plant, if the leaves wither, it is the basis for the conclusion about the deterioration of the water regime of the soil.

Deduction is a method of research that allows partial and individual conclusions to be drawn by analyzing general propositions and facts. The application of any general provision, law or regularity to partial conclusions is also carried out by the deductive method [324].

Abstraction – mental selection of the main object of research, its most significant connections. Two types of abstraction are used [321]:

- identification - to create concepts about systems, classes;
- isolation – to highlight the main among the third party, which is the most important issue of abstraction.

Concretization is a method of research by means of which one passes from the abstract to the concrete. For example, having identified the main process in the creation of organic matter – photosynthesis – and understanding its essence, the researcher mentally returns to the plant, environment, system "environment – plant", considers the interaction of plants with all factors of its life. Therefore, the methods of abstraction and concretization are very interrelated, complementary and should be used by the researcher together with other methods [316, 325].

Analogy is a method by which knowledge about already known objects, objects or phenomena is transferred to other still unknown, but similar to known and previously studied. The conclusion is made by analogy [317].

Modeling – a method of studying objects, processes and phenomena on their models [318].

Formalization – a method of studying objects using individual elements of their forms, which reflect the content of the object. Most often, formalization is used using mathematics, presenting evidence in the form of sequential formulas [319].

Inversion – a method of unusual study of an object, phenomenon, object at a certain angle or even from the opposite side of that studied earlier [316].

Generalization is a method by which one imaginatively moves from individual facts, phenomena and processes to identification in thoughts or from one concept, judgment to a more general one [317].

Special research methods include those used in scientific agronomy, so they are also called specific scientific. This group includes the following main methods: laboratory, vegetative, lysimetric, vegetative-field, field, expeditionary. Each of them can be used in conjunction with other special and general scientific methods [325].

The *laboratory metho*d is used to analyze plants, their environment in the laboratory to study the interaction between plants and environmental conditions, assess the quality of the crop, study metabolism in plants, study the physical, chemical and microbiological properties of soil and more [326].

The laboratory method involves not only detailed analysis, but also an objective and comprehensive synthesis of research results, followed by verification of proposals in practice.

Almost all vegetation and field experiments cannot be performed without the laboratory method of research. For example, laboratory tests can not do without the selection of land for the experiment, its planning and conduct [327].

Vegetation method – the study of plants grown in glass houses under controlled environmental conditions for a period of several days to several months. For perennials, research can take several years. The main purpose of the vegetation method is to study the importance of individual factors of plant life, the essence of the processes occurring in them, soil and in the system "soil – plant" [315, 317, 328].

The vegetation method makes it possible to maintain different conditions within the limits planned by the experiment – humidity, nutrient supply, solution pH, lighting, temperature, etc. However, this method does not study the influence of individual factors under study on plant productivity in changing natural conditions. Since the conditions of the environment in vegetation research are regulated and do not change as in the field, the number of vegetation periods, is repetitions of research in time, can

be reduced to a minimum [329].

Thanks to the vegetation method, many issues of agronomic science were studied: the availability of phosphorus plants from phosphorite flour; the need for direct contact of the root system, which absorbs phosphorite, with the fertilizer itself; the role of nodule bacteria in the assimilation of nitrogen by legumes from the air; the importance of manure as a source of carbon dioxide for plants. The vegetation method is often used in conjunction with the field.

The vegetation method proved to be very effective for studying the influence of various external factors on the mineral nutrition of plants, plant protection and metabolism, to study the dependence of plant growth on the temperature of the root zone and air. The role of water in plant nutrition, the phenomenon of photoperiodism, light intensity, daylight length, etc. are studied with the help of the vegetation method. In vegetation houses it is possible to compare the fertility of different soils and the efficiency of growing crops on them under the same conditions, especially plant protection [330].

Lysimetric method – the study of plants and soil properties in the field to study the balance of moisture and nutrients. Such studies are performed in very large vessels - lysimeters, which are periodically weighed. This method differs from vegetation in that plant life and soil properties are studied not in vegetation houses, but directly in the field, where lysimeters are inserted into dug pits so that the aboveground part of plants was in the same conditions as plants grown directly in the field. . Two of each lysimeter has a hole through which wash water is collected for chemical analysis [319].

The main issues studied by the lysimetric method are [315, 319, 330]:

- ✓ the dynamics of soil moisture; washing of precipitation; composition of water filtered through the soil;
- ✓ leaching of mineral salts from soil and fertilizers;
- ✓ loss of nutrients in the process of perennial fertilization;
- ✓ transpiration and evaporation of soil moisture, soil permeability, etc.

Vegetation-field method – the study of plants directly in the field in metal vessels without a bottom (in cylinders). This method is intermediate between vegetative and

field [331].

The soil in the cylinders is separated from the soil of the field only on the side, and from below it is in contact with it or the subsoil in the study area. Such cylinders can be installed not only on specially prepared areas, but also directly in crop rotation fields, where certain crops are grown on different agricultural backgrounds, on soils of different types, on areas with different exposure and steepness of slopes, etc.

This method is used to study the effectiveness of fertilizers, fertility of soil genetic horizons, model the conditions of the soil environment, various plant protection systems.

The vegetation-field method is also used in plant protection, selection work, agrometeorology, agriculture, crop production, modeling the necessary conditions of the soil environment. The use of mobile climate chambers made of polyethylene films, where the air temperature is regulated, makes it possible to model different weather conditions and even the climate depending on the phases of plant growth and development. This helps to reduce the negative impact of various natural conditions on crop formation [332].

Field research method is conducting field experiments (experiments). It is the main method of scientific agronomy, because it is with its help that theoretical research is connected with practical research: on the basis of its data, recommendations for agricultural measures, technologies and varieties for agricultural production are developed [333].

The main task of the field method is to identify significant differences between the variants of the experiment, to quantify the impact of life factors on plant yields and product quality.

Almost all scientific problems of agronomic science are solved using the field research method. For example, depth, timing and tillage methods are studied directly in the field. They also study different technologies of growing crops, the structure of sown areas, the best predecessors, methods and norms of irrigation, measures to combat water and wind erosion of soils, the effectiveness of organic and mineral fertilizers, soil reclamation measures, new varieties, hybrids and others [334].

Field experiments are conducted in scientific institutions and in the conditions of their production, the ultimate goal is to assess the economic efficiency of options and the introduction of the best of them in production.

Although the field method is the main one in scientific agronomy, it cannot be contrasted with other special and general scientific methods. The effectiveness of this method is greatly increased when combined with other methods, the choice of which is determined by the research program.

Expeditionary research method is used to study and generalize agronomic issues directly in production through surveys of fields and crops grown on them. The purpose of expeditionary surveys is to determine the causes of lodging of bread; death of winter and perennial grasses; study of conditions for growing high and low yields in individual farms, in the district or region; study the causes of deterioration or improvement of product quality; study of the content of pesticides, radionuclides and nitrates in the products that exceed the permissible norms. Expeditionary research also reveals the spread of malignant and quarantine weeds, diseases and pests of crops, the appropriate structure of sown areas, the best predecessors, the most rational crop rotations, promising varieties for specific farms, their groups, the whole area or soil-climatic zone. This method is also useful to study the effectiveness of methods, timing and depth of tillage. To combat soil erosion, the expedition method first identifies the causes of its spread and the factors that contribute to its occurrence in specific farms or areas [315, 320, 323, 325, 330].

Expedition method is also used for soil research. At the same time dig soil sections, describe them, take soil samples for physico-chemical analysis. Geological drills determine the level of groundwater, which is of great importance for studying hydrological conditions in fields and crop rotations. Similar studies should be conducted periodically in scientific institutions that serve a particular region or zone. However, they can be performed by individual scientists in educational institutions [325].

To determine the effectiveness of an agricultural measure in expeditionary research determine the yield of crops, taking into account product quality.

Yields for previous years are taken from the annual reports of farms. The collected data are adjusted according to weather conditions for the respective years - air temperature and humidity, precipitation, soil temperature, etc.

Field experiment is a study conducted in the field on a specially designated area for at least three years with mandatory crop accounting.

Experience is the main method of studying the biological, ecological features of growth and development of productivity and quality of crops. It is the dominant method, its main task is to establish differences between options, quantify the effects of factors, conditions and methods of cultivation on yield and quality. Includes observation, obtaining correlations, adherence to changes in conditions and accounting for results.

The experiment is a study in which the researcher artificially causes the phenomenon and changes the conditions so as to study the essence of the phenomenon. its origin, influence of factors, causality and their interaction [322].

When conducting experiments, the main attention is paid not only to the study of individual techniques, but to the integrated development of energy-saving. environmentally friendly technologies for growing crops. To this end, you need to study the processes. which take place in plants. soil and environment.

Requirements for the experiment

The most important requirements or principles for experiments are [316, 320, 328]:

- compliance with the principle of a single logical cancellation;
- compliance with the rule of expediency;
- the typicality of the experiment;
- suitability of languages for any experiment;
- the possibility of reproducing research results in identical conditions;
- the ability, if necessary, to introduce additional options;
- conducting research on promising crops and varieties;
- availability of necessary documentation;
- accounting in addition to the main indicators (yield and product quality) and

related;

- the need to support experiments with basic statistical indicators.

Planning a field experiment

The planning of the experiment was first carried out by R. Fischer, the author of the method of analysis of variance. Planning includes several stages [327]:

- ✓ choice of topic, formulation of the task and definition of the object of research;
- ✓ analysis of the state of study of the issue;
- ✓ formulation of the working hypothesis;
- ✓ development of the scheme and methods of the experiment.

The gradation of the factor is its dose.

The difference between the two gradations is called the step of the experiment. Both the gradation and the step of the experiment must be selected very carefully. If the step of the experiment is too large, there is a danger of losing the maximum point. If the step is too small, it will lead to a significant increase in the area of the experiment, which can significantly affect its accuracy.

The parameter of the experiment is the reaction of the object to the factor or factors. The parameters can be yield or any other economically valuable features. The main requirements for the parameters are their measurability and physical content.

Requirements for the factor [321]:

- ❖ must be adjustable (drug doses, watering rates, sowing depth, etc.);
- ❖ the factor must be measured with sufficient accuracy;
- ❖ a combination of several factors;
- ❖ factors should not depend on each other.

The experiment must be properly modeled mathematically so that a specific method of statistical analysis can be used to process its results.

Documentation of plant protection research.

Primary documentation: experiment diary and journal. Also here are workbooks, laboratory journals, accounting information, tapes of recorders.

The diary is a notebook that should be adapted to be worn – have a thick cover,

small size. However, its scope should include all the information during the research. In the case of long-term research, you have to keep several diaries - one for each year. In order to avoid losses in the diary indicate the coordinates of the researcher [316].

The diary records in chronological order the data of observations, records and analyzes that were carried out, work. At the same time indicate the equipment and quality of work. Be sure to capture extreme factors. Outbreaks of diseases and pests. Sketches and photographs can also be used in the diary. It is necessary to photograph with definition of options, scale. The diary allows the encryption of records, but other users must have access to the information.

Diary form:

General information about the experiment

Topic

Name, purpose and objectives of the experiment

Year of bookmark and venue

Topic manager and responsible executor

The scheme of the experiment

Program and methods of basic research - observations, accounting, analysis

Who and when approved the program, methodology and scheme of the experiment.

Plan for placing the experiment in kind

The area of the research site

The area of the accounting area

Repetition

The total number of sites in the experiment

Experience area.

History of the research site

Soil, relief and microrelief, slope direction

Evaluation of the experimental site - the method of accounting, coefficients of variation, the error of the experiment.

Agrochemical characteristics of the soil before laying the experiment

Records are kept with a simple pencil or fountain pen. If amendments are made, be sure to indicate by whom, when, and for what reason.

Basic documentation. The final stage is to write a report or research paper in the form of an article or dissertation. This document provides recommendations for production. The report is drawn up in accordance with the requirements of the state standard, which determines the structure, design rules.