

**MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE
SUMY NATIONAL AGRARIAN UNIVERSITY**

Department of Agriculture, Soil Science and Agrochemistry

"APPROVED"

Head of Department

_____ Kharchenko O.V.

“ _____ ” _____ 2019

EDUCATIONAL - PROFESSIONAL PROGRAM

Agrochemistry and Modern Aspects of Fertilizer Application

PROGRAM SUBJECT AREA 201 Agronomy

Faculty: Agrotechnology and Environmental Management

2019 - 2020 academic year

Educational - professional program Agrochemistry and Modern Aspects of Fertilizer Application
for postgraduate students of the program subject area 201 Agronomy

Developers: Prasol V. I., associate Professor, Department of Agriculture, Soil Science and
Agrochemistry, Ph.D. with a degree in science

The program was approved at a meeting of the Department of Agriculture, Soil Science and
Agrochemistry.

Protocol of April 22, 2019 No. 21

Head of the Department

(signature) **(Kharchenko O.V.)**
(surname and initials)

Approved:

Dean of the Faculty _____

(Kovalenko I.M.)

where the discipline is taught

Supervisor of the training Department _____

Registered in electronic database: date _____ **2019**

1. 1. Description of the course

Name of indicators	Field of study, subject area, higher education level	Profile of discipline
		full-time education
Amount of credits – 4,0	Field of study: 20 “Agrarian Sciences and Foodstuffs” (code and name)	<i>Selective</i>
	Program subject area 201 “Agronomy” (code and name)	
Modules – 3		Academic year:
Content modules: 3		2019-2020
Individual research task: The sequence of control of the spread of mineral fertilizers to the correct level of application		Course
Total amount of hours -104		2
Weekly hours for full-time study: classrooms –5.4 individual work of the student - 1,3		Semester
		3
	Lectures	
	44	
	Practical, seminars	
Laboratory		
Individual work		
16		
Assessment:		
credit		

Note

The ratio of the number of hours of class to individual work is:
for full-time study - 84,6/15,4)

Goals and tasks of the discipline

Goals: to develop deep knowledge and skills of postgraduate students in the rational use of fertilizers and chemical ameliorants to ensure high crop yields, reproduce soil fertility, preserve the environment, and master modern methods of analysis in the soil-plant-climate-fertilizer system.

Task: consider the ways to reproduce soil fertility, environmental problems when applying fertilizers. It is reasonable to use fertilizers and other chemical products in alternative and precision agriculture, to suggest possible ways of obtaining biologically valuable crop products.

As a result of studying selective discipline the graduate student must know:

- a modern understanding of the mechanism of nutrient intake and their absorption by plants, the physiological role of each element for plants, as well as the concept of effective technologies of storage and use of fertilizers;

- classification of fertilizers, their interaction with the soil-absorption complex, features of application of mineral fertilizers, their impact on the size and quality of the crop, classification of methods of determining fertilizer rates for crops and features of the use of yields for individual crops, as well as have a concept about the impact of fertilizers on environment.

be able:

- select samples of plants and soil for agrochemical analysis, determine the content of available forms of nutrients in the soil, calculate the stocks of nutrients in the soil;

- evaluate the modern range of fertilizers, products, biotechnologies in order to develop scientifically proved systems for their application;

- develop and implement projects of environmentally friendly techniques and technologies for the production of high-quality crop products, taking into account the features of agro landscapes and economic efficiency;

- be able to provide professional advice, own justifications and conclusions for professionals and the general public.

The general competencies that the applicant must master

Code	General competencies
GC 1	Ability to learn, master modern knowledge, self-improve and form a systematic scientific outlook
GC 2	Ability to critically analyze and evaluate modern scientific achievements, synthesis of holistic knowledge, complex problem solving
GC 3	Ability to abstract creative thinking, identify, receive, systematize, synthesize and analyze information from various sources with the use of modern information technologies in scientific activity.
GC 5	Ability to generate new ideas and make informed decisions to achieve goals.

GC 8	Ability to take initiative, take responsibility, motivate people and move toward a common goal
GC 11	Ability to prepare scholarly texts, present, discuss, debate and debate scientific results in their scientific work in state and foreign languages, to an extent sufficient for full understanding, demonstrating a culture of scientific verbal and written language.

Expected learning outcomes of the discipline

Code	Program results
PLR 1	Possess modern advanced conceptual and methodological knowledge when performing research and / or professional activities and at the border of subject areas of knowledge.
PLR 2	Have a thorough knowledge of the subject area and understanding of the profession, knowledge of the works of leading domestic and foreign scientists, fundamental work in the field of research, to formulate the purpose of their own scientific research as a component of the civilization process.
PLR 3	Possess the principles of financial support for research work, the structure of estimates for its implementation, preparation of the request for funding, preparation of reporting documentation.
PLR 5	To know the principles of organization, forms of realization of the educational and scientific process in modern conditions, its scientific, educational-methodical and normative providing, working out of scientific and informational sources in the preparation for lessons, application of active teaching methods.
PLR 9	Analyze scientific works, identifying debatable and under-researched issues, monitor scientific sources of information regarding a problem that is being investigated to establish their informational value through comparative analysis with other sources
PLR 14	To use modern information and communication technologies in communication, information exchange, collection, analysis, processing, interpretation of sources
PLR 17	Have the ability to act socially consciously and responsibly on the basis of ethical motives, to make informed decisions, to develop and self-improve

The correlation of the results of the discipline with the program results

Competencies	PLR 1	PLR 2	PLR 3	PLR 5	PLR 9	PLR 14	PLR 17
CC 1	*		*	*	*		*
CC 2		*	*	*		*	*
CC3	*	*	*	*			
CC 4		*	*	*	*		
CC 8	*		*	*	*	*	
CK 9	*		*		*	*	*

CC 1. Ability to formulate a scientific problem, develop working hypotheses, determine relevance, purpose, tasks that need to be accomplished to achieve the goal, evaluate the resources needed and time to implement, which implies a deep rethinking of existing and the creation of new holistic knowledge and / or professional practice.

CC 2. Ability to integrate research into agro-production and agronomy.

CC 3. Ability to have information on the current state and tendencies of development of the world and domestic agro-technologies of cultivation of crops.

CC 4. Ability to formalize specialized applied problems in the field of agro-industrial testing, to algorithmize them.

CC 8. Ability to process the obtained experimental data, establish analytical and statistical relationships between them and the studied parameters based on the use of standard mathematical packages of information processing.

CC 9. Ability to develop a system of experimental research for the practical validation of theoretical assumptions and to implement it in the agro-technological process.

2. The program of the discipline

Content module 1. Soil quality.

Topic 1. Introduction

The role of chemistry of agriculture in providing the population with food, industry raw materials. Chemization of agriculture as the most effective way of intensifying agricultural production. The system of application of special agrochemical products is the scientific basis for their effective use. Subject, research methods, communication with other disciplines.

Topic 2. The current state of agrochemical support of agriculture.

The market of special fertilizers. The use of agrochemicals as one of the main levers of increasing crop yields, obtaining high quality products and restoring soil fertility. The level of application of special agrochemical products in the world. Directions of development of agrochemical service in market conditions. The range of special agrochemical products. Peculiarities of application of fertilizers in organic farming.

Topic 3. Soil quality monitoring

Soil productivity. Soil as the basis of the planet's biodiversity. Soil monitoring and its components. Land monitoring program. Methods of soil analysis. Methods for determining trace elements. Methods for determining trace elements. Chemical, physical and biological properties that affect the availability of nutrients. Interpretation of analysis results.

Topic 4. Diagnosis of plant nutrition.

Types of diagnostics of plant nutrition. Macro and micronutrients in plant life and visual nutrition diagnostics. Soil and plant diagnostics of crop nutrition. Need to eliminate any imbalance. Relation of minimum and maximum laws with the law of return of the digested elements. Adverse effects of the lack of individual elements. The harmful effects of the excess of individual elements. Portable laboratories for plant nutrition diagnostics.

Content module 2.Strategy of fertilizer use

Topic 5. Classification and properties of fertilizers.

Fertilizer classification, assortment, and purpose. New approaches to the classification of mineral fertilizers. Basic technological properties of fertilizers and their characteristics. Preparation of fertilizer mixtures and errors in their preparation. Chelate, organo-mineral humic fertilizers. Fervants, adhesives and moisturizers, pH-active components and their characteristics. Influence of granular and encapsulated fertilizers on the physical and chemical properties of soil and soil microflora. Basic requirements for the quality of mineral fertilizer safety.

Topic 6. Features of application of mineral fertilizers

Features of application of nitrogen fertilizers. Features of application of phosphorus fertilizers. Features of application of potash fertilizers. Calcium, magnesium and sulfur fertilizers and their efficiency. Complex fertilizers and their impact on soil bio productivity.

Topic 7. Micro fertilizers and their efficiency.

The content of microelements in soils of Ukraine and Sumy region. The content of microelements in crops and their balance in rotation. Diagnosis of provision of plants with separate microelements. Types of fertilizers. Chelates and Functional Fertilizers. The concept of chelates and fillers. Characteristics of complexions. The degree of chelation. Filler substances. Functional fertilizer groups.

Topic 8. The role and importance of organic matter.

Functions of soil organic matter. Microorganisms and soil fertility. The value of microbiological preparations in agriculture. Features of application of microbiological preparations in technologies of cultivation of crops. Effect of organic fertilizers on soil bio productivity. Humic preparations. Humic substances. Mechanism of action of humic acids. The use of humic preparations. The effectiveness of humic drugs. Types of humates. Nitrification inhibitors. The use of nitrification inhibitors. Characterization of nitrification inhibitors. Nitrogen fertilizer effectiveness when using nitrification inhibitors.

Content module 3. Systems of cultivation and fertilization of crops

Topic 9. Fertilizer use system.

Conditions for the effective use of fertilizers. Principles of assembly of fertilizer systems. Use of fertilizers in crop rotations. Regulation of soil organic matter. Regulation of soil nutrient regime during soil cultivation. Diagnosis of plant nutrition and determining the need for fertilizers. Fertilizer planning and distribution based on the results of field experiments and agrochemical soil characteristics. Calculation of doses of fertilizers to obtain the planned yield. Zonal features of fertilizer application systems in Ukraine.

Topic 10. Use of fertilizers in precision agriculture.

Definition of a true no-till. Fertilizers in no-till technology. Information support for soil fertility monitoring and agrochemical certification of agricultural lands. Theoretical foundations of precision agriculture. The technology of compensatory mineral deposits in the precision farming system. Agrotechnical aspects of application of variable rates of application of mineral fertilizers. Agricultural mapping software in

precision farming. Conceptual bases of organization of information support of precision agriculture on the reclaimed lands.

Topic 11 . Technology of use and organization of works on fertilization.

Basic requirements for transportation and storage of mineral fertilizers. Methods of application of mineral fertilizers and agrotechnical requirements. Machines for the application of solid mineral fertilizers. Machines for the application of liquid fertilizers. Technological schemes for the supply of mineral fertilizers and methods for their application. Machines for applying organic fertilizers. Technologies of application of organic fertilizers.

Theme 12. Fertilization and quality of the environment.

Soil quality, laws of agrochemistry and their use. Lability of available soil elements. The need for a new revision of the law of returning elements to the ground. Justified and unjustified excess in the soil of nutrients made with fertilizers. The equilibrium value of the elements in the soil. Two main factors characterizing the relationship between the amount of fertilizers and the biological quality of products. Joint effects of soil and fertilizers on animal health. Toxicants and their maximum levels in soil, water, plants. Ways to reduce the flow of toxicants into different objects when using fertilizers. Fertilizer use and environmental protection.

4. The structure of the discipline

Name of content modules and topics	Amount of hours					
	Total amount	Full-time				
		Including				
		1	p	lab	ind	Ind.w
1	2	3	4	5	6	7
Module 1. 1. Soil quality.						
Content module 1. Soil quality.						
Topic 1.Introduction	0,5	0,5				
Topic 2. The current agro-ecological state of the land resources of Ukraine and the priority tasks of their reproduction	5,5	1,5	2,0			2,0
Topic 3. Soil quality monitoring	10,0	4,0	6,0			
Theme 4. Diagnosis of plant nutrition	12,0	4,0	6,0			2,0,0
Total amount of Content Module 1	28,0	10,0	14,0			4,0
Total amount of Module 1	28,0	10,0	14,0			4,0
Module 2. Strategies for the use of fertilizers						
Content module 2. Fertilizer strategies.						
Topic 5 Classification and properties of fertilizers	10,0	4,0	4,0			2,0
Topic 6. Features of application of mineral fertilizers	10,0	6,0	4,0			
Topic 7. Micro fertilizers and their	10,0	4,0	4,0			2,0

efficiency						
Topic 8. The role and importance of organic matter	10,0	4,0	4,0			2,0
Total amount of Module 2	40,0	18,0	16,0			6,0
Module 3. Systems of cultivation and fertilization of crops						
Topic 9. Fertilizer use system	16,0	8,0	6,0			2,0
Topic 10. Use of fertilizers in precision agriculture	10,0	4,0	4,0			2,0
Topic 11. Fertilizer and environmental quality	10,0	4,0	4,0			2,0
Total amount of Module 3	36,0	16,0	14,0			6,0
Total amount of hours	104	44,0	44,0			16,0

5. Topics and plan of lessons (full-time education)

№	Topic name	Amount of hours
1	<p>Topic 1.Introduction.</p> <p>1. Condition, problems and prospects of fertilizer application.</p> <p>2. Fertilizer production and their efficiency.</p> <p>Topic 2. The current agro-ecological state of the land resources of Ukraine and the priority tasks of their reproduction</p> <p>1. Anthropogenic factors and their impact on the environment.</p> <p>2. The main soils of Ukraine, their agro-ecological status and the priority tasks for their reproduction.</p> <p>3. Soils of Polesie, Forest-Steppe, Steppe and their agricultural use. Soil testing and land quality assessment.</p>	0.5 1.5
2	<p>Topic 3. Soil quality monitoring</p> <p>1. Soil productivity.</p> <p>2. Soil monitoring and its components.</p> <p>3. Methods for determining trace elements.</p> <p>4. Chemical, physical and biological properties that affect the availability of nutrients.</p> <p>5. Interpretation of analysis results.</p>	4,0

3	<p>Topic 4. Diagnosis of plant nutrition</p> <ol style="list-style-type: none"> 1. Types of diagnostics of plant nutrition. 2. Macro and micronutrients in the life of a plant organism and visual diagnostics of nutrition. 3. Soil and plant diagnostics of crop nutrition. 4. Relation of the laws of minimum and maximum with the law of return of assimilated elements. 5. Portable laboratories for the diagnosis of plant nutrition. 	4,0
4	<p>Topic 5 Classification and properties of fertilizers</p> <ol style="list-style-type: none"> 1. Fertilizer classification, assortment and purpose. New approaches to the classification of mineral fertilizers. 2. The main technological properties of fertilizers and their characteristics. 3. Chelate, organo-mineral humic fertilizers. 3. Effect of granular and encapsulated fertilizers on the physical and chemical properties of soil and soil microflora. 4. Basic requirements for the safety quality of mineral fertilizers. 	4,0
5	<p>Topic 6. Features of application of mineral fertilizers.</p> <ol style="list-style-type: none"> 1. Features of application of nitrogen fertilizers. 2. Features of application of phosphorus fertilizers. 3. Features of application of potash fertilizers. 4. Calcium, magnesium and sulfur fertilizers and their efficiency. 5. Complex fertilizers and their impact on soil bioproductivity . 	6,0
6	<p>Topic 7. Micro fertilizers and their efficiency</p> <ol style="list-style-type: none"> 1. The content of micro elements in soils of Ukraine and Sumy region. 2. The content of micro elements in crops and their balance in rotation. 3. Types of fertilizers. Chelates and Functional Fertilizers. The concept of chelates and fillers. 4. Technology of application of micro fertilizers. 5. The effectiveness of microfertilizers and features of their application. 	4,0
7	<p>Topic 8. The role and importance of organic matter</p> <ol style="list-style-type: none"> 1. Functions of soil organic matter. 2. Features of application of microbiological preparations in technologies of cultivation of crops. 3. Effect of organic fertilizers on soil bioproductivity. 4. Humic preparations. Humic substances. 5. Types of humates. Nitrification inhibitors. The use of nitrification inhibitors. 	4,0

	6. Organic-mineral and fermented fertilizers.	
8	Topic 9. Fertilizer use system 1. Conditions for the effective use of fertilizers. 2. Principles of assembly of fertilizer systems . 3. Regulation of soil organic matter. 4. Regulation of soil nutrient regime during soil cultivation. 5. Diagnosis of plant nutrition and determining the need for fertilizers. 6. Planning and distribution of fertilizers based on the results of field experiments and agrochemical soil parameters. 7. Calculation of doses of fertilizers to obtain the planned yield. 8. Zonal features of fertilizer application systems in Ukraine.	8,0
9	Topic 10. Use of fertilizers in precision agriculture 1. Fertilizers in no-till technology. 2. Information support for soil fertility monitoring and agrochemical certification of agricultural lands. 3. Technology of compensatory application of mineral fertilizers in the precision farming system. 4. Software for mapping agricultural land in the precision farming system. 5. Conceptual principles of organization of information support of precision agriculture in the reclaimed lands.	4,0
10	Topic 11. Technology of use and organization of works on fertilizer application 1. Basic requirements for transportation and storage of mineral fertilizers. 2. Methods of application of mineral fertilizers and agrotechnical requirements. 3. Machines for application of solid mineral fertilizers. 4. Technological schemes of mineral fertilizer supply and methods of their application. 5. Organic fertilizer application technologies.	4,0
11	Topic 12. Fertilization and quality of the environment 1. Soil quality, laws of agrochemistry and their use. 2. The equilibrium value of the elements in the soil. 3. Two main factors that characterize the relationship between the amount of fertilizers and the biological quality of products. 4. Toxicants and their maximum levels in soil, water, plants. 5. Fertilizer use and environmental protection.	4,0
	Total amount	44,0

6. Seminar topics (full-time)

N ^o	Topic name	Amount of hours
1	Modern technologies in the agro-industrial complex ..	2,0
2	Agronomy today. Winter cereals and rapeseed.	2,0
3	No-till and not just modern farming systems.	2,0
Total		6,0

7. Topics for practical classes (full-time study)

N ^o	Topic name	Amount of hours
1	Calculation of stocks of available soil nutrient forms.	2,0
2	Preparation of mixtures of mineral fertilizers.	2,0
3	Standardization of indicators of quality of mineral fertilizers.	2,0
4	Calculation of the need for negligent and functional fertilizers for growing crops.	2,0
5	Calculation of the volume of working solution for the pre-sowing bacterization of seeds. Requirements for the inoculation of legumes	2,0
6	Characteristics of growth promoters. Advantages and differences of adjuvants.	2,0
7	Calculation of rates of application of mineral fertilizers on planned productivity	2,0
8	Acquaintance with precision farming technology in precision agriculture	2,0
9	Mastering the technology of compensatory application of mineral fertilizers in the precision agriculture class.	4,0
Total		20,0

8. Laboratory topics (full-time)

N ^o	Topic name	Amount of hours
1	Diagnosis of plants. Determination of nitrogen, phosphorus and potassium content in plants.	4,0
2	Methods of determining the availability of nutrient forms for soil.	6,0
3	Preparation of mineral fertilizer mixtures.	4,0

4	Determination of the plant's safety with macro and microelements by means of the portable laboratory of functional diagnostics "Agrovector PF-014"	4,0
Total		18,0

9. Individual work (full-time study)

№	Topic name	Amount of hours
1	Directions of development of agrochemical service in market conditions	2,0
2	Fervants, adhesives and moisturizers, pH-active components and their characteristics	2,0
3	Characteristics of complexons. The degree of chelation. Filler substances	2,0
4	Mechanism of action of humic acids. The use of humic preparations. The effectiveness of humic drugs.	2,0
5	Agrotechnical aspects of application of variable rates of application of mineral fertilizers. Agricultural mapping software in precision farming	4,0
6	Machines for the application of liquid fertilizers.	2,0
7	The need for a new revision of the law of returning elements to the ground. Justified and unjustified excess in the soil of nutrients made with fertilizers	2,0
Total		16

10. Individual tasks

1. Preparation of abstracts:

1.2. The role of chemical absorption in the application of fertilizers (examples of the formation of slightly soluble and insoluble salts).

1.5. The main causes of "nitrate contamination" of groundwater.

1.8. Vermicomposts, their production and use.

1.10. The importance of soil maps and agrochemical cartograms for the development of a rational system of fertilizer use in the farm.

2. Calculation tasks:

2.3. Calculation of stocks of batteries in the soil.

2.4. Calculation of the farm's need for lime fertilizers.

2.8. Determining the needs of the farm for organic fertilizers.

2.9. Distribution of fertilizers by forms and terms of application.

11. Методи навчання

1. Learning methods according to the source of knowledge:
 - 1.1. Verbal - explanations, lectures, seminars, discussions, discussions.
 - 1.2. Visual - use and demonstration of videos, multimedia files.
 - 1.3. Practical - individual performance of the work and its protection, modeling of processes of transformation of batteries in the soil, performance of calculation tasks.
 2. Methods of learning by the nature of the logic of knowledge
 - 2.1. Analytical.
 - 2.2. Methods of synthesis.
 - 2.3. Deductive method.
 3. Methods of teaching by the nature and level of students' individual mental activity.
 - 3.1. Problematic.
 - 3.2. Partial search.
 - 3.3. Research.
 - 3.4 Reproductive.
 - 3.5. Explanatory and demonstrative.
 4. Active teaching methods - the use of technical training tools, debates, the use of problematic situations, excursions, group research, self-assessment of knowledge, the use of educational and supervisory tests, the use of supporting lecture notes and others.
 5. Interactive learning technologies - use of multimedia technologies, interactive whiteboard and spreadsheets, dialog learning, student collaboration and others.
- Personalized Learning
Differentiated Instruction
Inquiry-based Learning

12. Control methods

1. Rating control on a 100-point ECTS rating scale.
 2. Conducting intermediate control during the semester (intermediate certification).
 3. Multicriteria assessment of potential work of students:
 - the level of knowledge demonstrated in practical, laboratory and seminar classes;
 - being active in discussing issues raised in the classroom;
 - results of laboratory work protection;
 - express control during class sessions;
 - individual study of the topic as a whole or of individual issues;
 - fulfillment of analytical and calculation tasks;
 - writing abstracts;
 - test results, written tasks in the course of control work.
- Assessment of the applicant is carried out by commission (the committee includes members of the department)

13. Distribution of points received by students for credit (full-time study).

Current testing and individual work											Together for modules and Ind.w.	Intermediate certification	Sum
Content module 1 - 10				Content module 2- 30				Content module 3- 30					
T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	85 (70+15)	15	100
2	3	3	2	8	8	7	7	10	10	10			

T1, T2 ... T11 – content module topics

Rating scale: national and ECTS

Sum of points for all kinds of educational activity	ECTS grade	Score by a national scale
		for exam, course project (work), practice
90 – 100	A	perfectly
82-89	B	fine
75-81	C	
69-74	D	satisfactorily
60-68	E	
35-59	FX	unsatisfactory with the possibility of reassembly
1-34	F	unsatisfactory with the compulsory re-study of the discipline

14. Methodological support

1. Guidelines for soil protection / V.O. Grekov, LV Datko, V.A. Zhilkin, M.I. Maystrenko et al. - K., 2011.- 108 p.
2. Methods of agrochemical soil survey and features of fertilizer application / ed. D.M. Bantserovsky, S.I. Melnika, OG Tarariko, VA Zhilkina.- K .: DIA, 2005. - 208 p.
3. Methods of agrochemical certification of agricultural lands / ed. S.M. Ryzhuk, MV Forest, D.M. Bentsarovsky, K., 2003, 64 p.

15. Recommended literature

Basic

1. Hostenko GM Agrochemistry: textbook. / G.M. Mistress. - K .: SIK GROUP Ukraine LLC, 2018. - 556 p.
2. Hostenko GM Fertilizer application system: Educ. manual / G.M. Mistress. - K .: SIC GROUP Ukraine LLC, 2015. - 332 p.
3. Likhchvor VV Mineral fertilizers and their applications / V.V. Likhchvor - Lviv: Ukrainian Technologies, 2008. - 312.c.
4. System of fertilization of crops in agriculture of the early twentieth century / Ed. S.A. Balyuka, M.M. Miroshnichenko. - K .: Alfa-Stevia LTD, 2016. - 392 p.
2. Shevchuk MI, SI,. Agrochemistry: Textbook / M.Yu. Shevchuk, S.I. Veremeenko, VI Lopushnyak - Lutsk: Overhang, 2012. - 468 p.

Additional

1. Agro-economic and environmental bases of forecasting and programming of crop yield level: Textbook / OV. Kharchenko, VI Prasol, S.M. Kravchenko, V.A. Mokrenko. - Sumy: University Book, 2014. - 240 p.
2. English-Ukrainian Dictionary of Soil Science and Agrochemistry / GM Economyenko, OO Oliynyk, IV Prokopchuk, O. Yu. ed. GM Hostess. - K. : CJSC "Nichlava", 2013.- 255 p.
3. No-till - a step towards perfect agriculture. -K. : "Grain". CJSC Money and the World. 2007. - 128 p.
4. Tanchik SM No-till and not just modern farming systems. - K. : Uninvest Media LLC. 2004. - 157 p.
5. Kharchenko OV Agro-economic and ecological substantiation of the level of nutrition of crops: Textbook / OV. Kharchenko, VI Prasol, OV Ilchenko. - Sumy: "University Book", 2011. - 126 p.
6. Soil quality and current fertilization strategies / Ed. D. Melnychuk, J. Hoffman, M. Gorodnyi. - K. : Aristey, 2004. - 488 p.

16. Information resources

1. Agrostat program
2. Mikrosoff XL Package