

NATIONAL UNIVERSITY OF LIFE AND ENVIRONMENTAL SCIENCES OF  
UKRAINE

DEPARTMENT OF AGROCHEMISTRY AND QUALITY OF PLANT  
PRODUCTS

Dean of the faculty of land management  
Karas Yevsyukov  
2022



CONSIDERED AND APPROVED  
By the collective of the Department  
of agrochemistry and quality  
of plant products  
report № 9, 16.05.2022  
Head of Department

A. V. Bykin

CONSIDERED

Guarantor, EP I.P. Kovalchuk

### SYLLABUS OF THE SUBJECT

Soil science and basic of agricultural chemistry (agricultural chemistry)  
(назва навчальної дисципліни)

Спеціальність: 193 Land management and geodesy  
(шифр і назва спеціальності)

Факультет: Land Management  
(назва факультету)

Syllabus compiled by: Associate Professor Nadia Bordyuzha,  
PhD in Agrochemistry

Kyiv - 2022

## 1. Description of the subject

Soil science and basic of agricultural chemistry (agricultural chemistry)  
(назва)

Field of the science, trend of the training, specialty, educational-qualification level		
Educational level	_____ bachelor _____	
Specialty	<u>193 Land management and geodesy</u>	
Field of the knowledge	Agriculture	
Description of the subject		
Kind	selective	
Whole of hours	90	
Amount of ECTS	3	
Amount of moodles	2	
Undergraduate thesis (якщо є в робочому навчальному плані)	_____ (назва)	
Control	exam	
Indexes of the subject for diurnal tuition and for tuition in correspondence course		
	diurnal tuition	tuition in correspondence course
Year of Training	_____ I _____	_____
Semester	_____ II _____	_____
Lectures	_____ 15 _____	_____ год.
Practis hours	_____	_____ год.
Laboratory hours	_____ 15 _____	_____ год.
Individual hours	_____	_____ год.
Individual tasks	_____	_____ год.
Amount of week hours for diurnal tuition: audience hours Individual hours –	2 30 год. 60	

## 2. The goal and task of the course

The goal of agricultural chemistry studying is to develop student's knowledge and abilities of soil fertility increasing and of fertilizers application and of modern analytical methods in the system "soil-plant-fertilizer".

The task of the course is to build up the theoretical knowledge and practical skills of fertilizers application in crop rotation and determination of nutrients cycle on farm taken into consideration the zones of crop production and plants features and their sorts' characteristics. The knowledge of agricultural chemistry allows to provide the best conditions for plants nutrition taking into account fertilizers properties, their interaction with soil. Using knowledge of agrochemistry future specialist will be able to determine the most effective forms, terms and methods of fertilizers application for soil fertility improvement.

As a result of agricultural chemistry studying **students have to get knowledge about:**

1. state and prospect of agricultural chemization in Ukraine and all over the world;

2. chemical composition of plants, characteristics of their nutrition and ways of its regulation;
3. soil properties connected with plant nutrition and fertilizers application;
4. methods of soil chemical melioration for soil fertility improvement;
5. mane types of mineral and organic fertilizers, modes of their manufacture and characteristics of usage; optimum conditions for storage and application;
6. system of fertilization and agricultural chemistry service for soil fertility improvement.

**Students have to be able after mastering the course:**

1. to determine the necessity of chemical melioration realization and calculate the rate of meliorants for correct soil pH;
2. to be able to identify fertilizers and provide optimum conditions for their application for improvement of soil fertility;
3. to calculate rate and define forms and methods of fertilizers application; estimate economic effectiveness of fertilizers application.

**Practical skills:**

**General skills:**

- Knowledge and understanding of the subject area and understanding professional activity;
- Ability to apply knowledge in practical situations;
- Skills to carry out safe activities;
- Ability to search, process and analyze information from various sources;
- Ability to work in a team;
- The desire to preserve the environment

**Special skills:**

- Basic knowledge of the main divisions of agrochemistry
- Ability to regulate the soil fertility and soil nutritive regimes for saving of soil strength and soil estimation.

**3. Program and Structure of the course**

Name of the moodle and topics	Amount of hours					
	diurnal tuition					
	whole	include				Ind w
1		p	lab			
1	2	3	4	5	6	7
Topic 1. Agrochemistry. Plant nutrition in connection with soil fertility	14	2		2		10
Topic 2. The soil properties. Soil pH and soil chemical melioration	16	3		3		10
Whole in module 1	30	5		5		20
Topic 3. The soil nitrogen regime and it regulation	12	2		2		8
Topic 4. The phosphorus regime and potassium regime in soil. Its regulation	12	2		2		8
Topic 5. Complex regulation of soil nutritive regime	12	2		2		8
Topic 6. Micronutrients regime in soil and it regulation	12	2		2		8
Topic 7. Organic and biological fertilizers for optimization of sol properties	12	2		2		8
Whole in module 2	60	10		10		40
Whole	90	15		15		60

#### 4. Topic of the laboratory classes

№	Topic	Hours
1	Methods of soil sampling	3
2	Determination of soil pH and its role in land management	2
3	Soil testing. The determination of phosphorus using Kirsanov method. Studing of agrochemical map with phosphrus supply of soil Plant analysis.	2
4	Module test 1	2
5	Land maps and agrochemical maps. Building soil pH map and grochemical map with phosphrus supply of soil.	4
6	Module test 2	2
	<b>Whole</b>	<b>15</b>

#### 5. Control questions, test blok for determination of the level of the student knowledge

Test questions
1. The agrochemical maps
2. <b>Nitrogen fertilizers and it influence on soil fertility.</b> Classification of the nitrogen fertilizers. Description of the nitrogen fertilizers in every group.

#### Test blok

Question 1. Objects of agricultural chemistry are [3 points]:	
1	Plant
2	Animal
3	Fertilizer
4	Soil

Question 2. Fertilizers are used in order to:	
1	To provide better soil conditions for tillage
2	Supplement the natural soil nutrient supply
3	To provide weeds with nutrients
4	To provide better conditions for soil insects.

Question 3. Type of plant nutrition that supply plants with carbon oxide (IV) is:	
1	Leaves nutrition
2	Air nutrition
3	Root nutrition
4	Carbon nutrition

Question 4. Plants nutrients divided into macro- and micronutrients in dependence on:	
1	Radius of the ions that nutrient form
2	Importance of nutrient for plant growth
3	Amount of nutrient in plant roots
4	Amount of nutrient in plant

Question 5. Macroelement, component of proteins, chlorophyll and genes compounds is:	
1	

Question 6. Who much is the concentration of ....in plants?:	
a) nitrogen	1. 1.5-2.0 %
b) phosphorus	2. 0.5-0.7 %
c) potassium	3. 25%

	4. 1-3 %
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Question 7. The main indexes for determination of quality of winter wheat grain are [2 points]:	
1	Protein content
2	Fat content
3	Gluten content
4	Sugar content

Question 8. Properties of the soil that are the subject of agricultural chemistry investigations are :	
2	Pryanishnikov
3	Kirsanov
4	Pavlov

Question 9. Which compounds of the phosphorus in the soil is not easy available for plants [2 points]:	
1	$\text{Ca}_3(\text{PO}_4)_2$
2	$\text{K}_2\text{HPO}_4$
3	$\text{Ca}(\text{H}_2\text{PO}_4)_2$
4	$\text{Mg}_3(\text{PO}_4)_3$

Question 10. To determine correctly nutrient content of fertilizers for adequate fertilizers.	
a) nitrogen fertilizers	1. $\text{K}^+$
b) phosphate fertilizers	2. N
c) potassium fertilizers	3. $\text{P}_2\text{O}_5$
	4. $\text{NO}_2$
	5. $\text{PO}_4^-$
	6. $\text{K}_2\text{O}$

#### 6. Methods of studied

1. visual;
2. laboratory;
3. practice, etc.

#### 8. The forms of knowledge control

Modules, exam

#### 9. Parameters for estimation of students' knowledge

According to "Regulations about Module-Rating System of students' teaching and estimation of their knowledge" (NULES of Ukraine, 27.12.2019, #1371), student's knowledge are estimated in points (maximum 100) according to following table:

Student rating, balls	The definition ECTS mark	
	exam	Final test
90-100	Perfectly	Credited
74-89	Well done	
60-73	Satisfactory	
0-59	Bad	not credited

To determine the rating of the student (listener) for mastering the discipline  $R_{DIS}$  (up to 100 points) the obtained rating for certification (up to 30 points) is added to the rating of the student (listener) for academic work  $R_{NR}$  (up to 70 points):  $R_{DIS} = R_{HP} + R_{AT}$ .

#### 10. Методичне забезпечення

1. Agricultural Chemistry: Manual / М.М. Gorodniy, I.V. Prystash, P.M. Kyveryga. – К, 2007. – 234 p.
2. Agricultural Chemistry: Manual to lecture classes / I. V. Loginova., N. P. Bordyuzha. – К: СОМПРИНТ, 2012. – 75 p.
3. Agrochemical Analysis: Manual to laboratory work / I. V. Loginova., N. P. Bordyuzha. – К: СОМПРИНТ, 2012. – 75 p.

#### Електронний навчальний курс:

Soil Science and Basic of Agrochemistry <https://elearn.nubip.edu.ua/mod/page/view.php?id=338867>

#### 11. Рекомендована література

##### Basic literature:

4. Agricultural Chemistry: Manual / М.М. Gorodniy, I.V. Prystash, P.M. Kyveryga. – К, 2007. – 234 p.
5. Agricultural Chemistry: Manual to lecture classes / I. V. Loginova., N. P. Bordyuzha. – К: СОМПРИНТ, 2012. – 75 p.
6. Agrochemical Analysis: Manual to laboratory work / I. V. Loginova., N. P. Bordyuzha. – К: СОМПРИНТ, 2012. – 75 p.
7. Смирнов П.М., Муравин Э.А. Агрохимия. – М.: Агропромиздат, 1991. – 288 с.
8. Радов А.С. и др. Практикум по агрохимии / А.С. Радов, И.В. Пустовойт, А.В. Корольков; Под ред. И.В. Пустового. – М.: Агропромиздат, 1985. – 312 с.
9. Агрохімія: Підручник / М.М. Городній, А. В. Бикін, Л.М. Нагаєвська. – К.: ТОВ “Алефа”, 2003. – 786 с.
10. Лісовал А.П., Макаренко В.М., Кравченко С.М. Система застосування добрив. – К.: Вища шк., 2002. – 318 с.
11. Tisdale S.L., Nelson W.L., Beaton J.D. Soil Fertility and Fertilizers. – Mew York: Macmillan Publishing Company, 1985. – 754 p.
12. Brady N.C. The nature and properties of soils / Nyle C. Brady, Ray R. Weil. – 13<sup>th</sup> ed. – Upper Saddle River, New Jersey “Prentice Hall”. – 2002. – 960 p.

##### Internet recourses

<a href="https://elearn.nubip.edu.ua/course/view.php?id=1819">https://elearn.nubip.edu.ua/course/view.php?id=1819</a>	
<a href="http://www.fertilizer.com">http://www.fertilizer.com</a>	US Fertilizer Corporation
<a href="http://www.fertilizer.org/ifa">http://www.fertilizer.org/ifa</a>	International Fertilizer Industry Association
<a href="http://www.efma.org">http://www.efma.org</a>	European Fertilizer Manufacturers Association
<a href="http://www.ifdc.org">http://www.ifdc.org</a>	An International Center for Soil Fertility and Agricultural Development
<a href="http://fao.org">http://fao.org</a>	Food Agricultural Organization
<a href="http://www.tfi.org">http://www.tfi.org</a>	The Fertilizer Institute

##### Additional literature

1. Власюк П.А. Биологические элементы в жизни растений. – К.: Наукова думка, 1969. – 460 с.
2. Довідник працівника агрохімслужби / Під ред. Б.С. Носка. – К.: Урожай, 1986.

3. Прянишников Д.А. Избранные сочинения: В 3 т. – М.: Сельхозиздат, 1963. – 2105 с.
4. Nutritional Disorders of Plants: Development, Visual and Analytical Diagnosis / Ed. by Werner Bergmann. – Jena; Stuttgart; New York: G. Fisher, 1992. – 741 p.
5. Miller R.W., Gardiner D.T. Soil in our environment. – New Jersey, 2001. – 750 p.
6. Soils in our environment / Raymon W. Miller, Duane T. Gardiner. – 9<sup>th</sup> ed., 1997.
7. Soils: an Introduction / Michael J. Singer, Donald N. Munns. – Upper Saddle River, New Jersey “Prentice Hall”. – 1996. – 480 p.

**SUBJECT-MATTER**  
**of lectures on agricultural chemistry**  
**for the 1-nd year students of the Land Management Faculty**

**LECTURE 1 (2 hours)**

**Introduction.** The role of organic and mineral fertilizers in crop yield increasing, quality improvement, maintenance and increasing of soil fertility

The objective of agricultural chemistry and its place in the system of sciences. Assignments of agrochemistry. Theory of plants productiveness. Main laws of agricultural chemistry and their role to increase fertilizer use efficiency.

**Chemical composition of plants, plant nutrition and methods of it's regulation.** Plants nutrition, its types. Air and root nutrition.

Chemical composition of plants and factors that determine it. Plant production quality indices and fertilizers influence on biological quality of agricultural production.

Nutrients essential for normal growth and development of plants. Macro- and microelements. Role of nutrients in plant nutrition. Source of nutrients. Dynamics of nutrients utilization during the vegetation period of plants.

Diagnosis of plant nutrition and fertilizers requirements. Plant observation, plant tissue testing, plant analysis, soil testing, express-diagnosis and tools to diagnose the nutritional status of crops.

**LECTURE 2 (2 hours)**

**Agrochemical, agrophysical and biological properties of soil in connection with plant nutrition and fertilization.** Soil composition. Soil phases and their interrelation. Properties of mineral and organic soil parts. Forms of compounds in the soil that contain main nutrients. Soil organic matter. Humus and its necessity for soil fertility and plant nutrition. Ways of humus losses prevention.

Soil absorbing capacity, its types (mechanical, physical, biological, chemical, physico-chemical) and role in soil-fertilizers interaction and plant nutrition. Soil adsorbing complex, its composition and structure in different soil types.

Agrochemical characteristics of main soil types and fertilization effectiveness. Supply of nutrient for plants on different soils. Agrochemical maps, their making and their using.

**Soil chemical melioration (liming and gypsum application).** Soil pH. Soil classification depending on soil solution pH. Reaction of crops on soil acidity and effectiveness of liming.

Influence of lime on neutralization of soil acidity and improvement of soil agrochemical and agrophysical properties.

Liming materials: hard, soft calcareous rocks and carbonated industrial wastes. Neutralizing value or calcium carbonate equivalent of liming materials. Determination of lime requirement. Lime rate calculation. Lime activity duration. Terms of lime application and methods of placement.

Gypsum application on alkaline soils and solonetz. Gypsum interaction with soil and improvement of soil physical-chemical and agrochemical properties. Gypsum materials used for application.

Development of estimative documentaries for soil chemical melioration. Economical estimation of chemical melioration.

**LECTURE 3 (2 hours)**

**Nitrogen regime in soil and it regulation.** Functional role of nitrogen in plant growth and development. Plants nitrogen deficiency symptoms. Nitrogen sources for plant nutrition. Nitrogen reserves in soil. Importance of nitrogen biological fixation and leguminous plants for soil nitrogen enrichment. Nitrogen losses.

Forms of nitrogen fertilizers and main fertilizer nitrogen materials: ammoniacal (anhydrous ammonia, aqua ammonia); ammonium (ammonium sulphate, ammonium chloride); nitrate (sodium nitrate, calcium nitrate); ammonium–nitrate (ammonium nitrate, ammonium nitrate-sulfate); amide



(urea). Urea-ammonium nitrate (UAN solutions). Nitrogen fertilizers interaction with a soil. Influence of nitrogen on crop yield and soil properties.

#### **LECTURE 4 (2 hours)**

**Phosphorus regime in soil and its regulation.** Functional role of phosphorus for plants growth. Phosphorus sources for plants. Phosphorus uptake by plants. Phosphorus deficiency symptoms. Phosphorus in soil. Forms of phosphorus in soil. Phosphate retrogradation.

Groups of phosphate fertilizers: water-soluble (monosubstituted): ordinary superphosphate, triple or concentrated superphosphate; citrate-soluble (disubstituted): dicalcium phosphate or precipitate; citric acid soluble (disubstituted): basic slag or thomas slag, phosphate slag; not-readily soluble (trisubstituted): rock phosphate. Interaction of phosphate fertilizers with soil and fertilization effectiveness increasing on different soil types of Ukraine. Importance of phosphate fertilizers for land estimation.

#### **LECTURE 5 (2 hours)**

**Potassium regime in soil and its regulation.** Functional role of potassium for plant nutrition. Sources of potassium and its uptake by plants. Potassium plants deficiency symptoms. Potassium in soil. Forms of potassium in soil and their importance for plant nutrition.

Groups of potassium fertilizers depending on mode of production: row potassium salts; concentrated (potassium chloride or muriate of potash, potassium sulfate, sulfate of potash magnesia, potassium carbonate); composite (30% and 40% potassium salt, potassium electrolyte). Chlorinated and chlorine-free potassium fertilizers, their effectiveness for crops in different soil-climatic zones of Ukraine. Influence of potassium fertilizers on soil properties.

#### **LECTURE 6 (2 hours)**

**Complex regulation of nutritive regimes in soils.** The importance of balanced fertilization for normal plants growth and improvement of soil fertility.

Multinutrient fertilizers: the number of nutrients (double, triple); by the mode of production: complex (monoammonium phosphate, diammonium phosphate, ammonium polyphosphate, potassium nitrate), compound (nitrophos, nitrophoska, nitroammophos, nitroammophoska, ammoniated superphosphates), mixed or blended fertilizers. Multinutrient fertilizers with micronutrients. Possibilities of mixing fertilizers.

#### **LECTURE 7 (2 hours)**

**Micronutrient regime in soil and its regulation.** Micronutrients regimes in soils. Functional role of zinc, copper, manganese, molybdenum, cobalt and boron in plant growth. Sources of micronutrients and their uptake by plants. Diagnostic of plant supply with micronutrients and deficiency symptoms. Micronutrient fertilizers classification. Assortment of micronutrient fertilizers (zinc, copper, manganese, molybdenum, cobalt and boron fertilizers) and effective technology of their application. Micronutrient chelates. Micronutrient fertilizers efficiency to crops on different soil types.

#### **LECTURE 8 (2 hours)**

**Organic fertilizers.** Role of organic fertilizers for soil fertility improvement, improvement of the conditions of plant growth and rising the effectiveness of mineral fertilizers. Advantages of organic-mineral fertilization of crops.

**Manure** (farmyard or stable manure, slurry or litterless manure), its composition and characteristics of application.

Litter materials and importance of litter. Manure depending on the rate of decomposition: fresh manure, semi-rotted manure, rotted manure, fine manure. Manure storage: field dung-heap, dung-yard. Conditions of manure storage. Technology of manure application in different soil-climatic zones of Ukraine to different crops.

Litterless manure, characteristics of its storage, transportation and application.

**Liquid manure**, its chemical composition and technology of application. Decreasing of nitrogen losses from liquid manure.

**Poultry manure**, its composition, storage and coefficients for utilization of nutrients by crops. Application of poultry manure to different crops.

**Sapropel**, its composition and application to different crops.

**Peat**, types and kinds of peat, botanical composition and content of nutrients. Peat properties (ash percentage, moisture capacity, absorption capacity). Peat application in agriculture.

**Composts**, importance of organic sources composting. Importance of microbiological processes in nutrient transformation in available for plants forms. Composts based on peat and other agricultural and industrial wastes. Their importance for crop fertilization.

**Vermicompost** and liquid biohumus. Technology of production and application.

**Green manure** and its role for soil enrichment by organic matter, nitrogen and other nutrients. Crops used as green manure. Forms of green manure (fool, mowing, stubble). Technology of green manure growing and application.

**Bacterial fertilizers (bio-fertilizers) and growth activators.** Importance of soil microorganisms. Microbial seed inoculants for leguminous plants (rhizotrophin, nitragin) and factors that influence nitrogen fixation effectiveness. Bio-fertilizers based on free-living microorganisms (phyzophil, azotobacterin). Phosphate-mobilizing microorganisms (phosphobacterins). Technology of bio-fertilizers application.