ЕВРАЗИЙСКОЕ НАУЧНОЕ ОБЪЕДИНЕНИЕ
EURASIAN SCIENTIFIC ASSOCIATION
www.esa-conference.ru

# Mineral fertilizers and soil properties in agriculture

Maussumbayeva Aida Makenovna, candidate of Agricultural Sciences, associate professor
Yerimbet Rizuan Yedilbekuly, мaster's student
Oxikbayev Berikzhan Kylyshbekovich, candidate of Biology Sciences. senior lecturer
Kabdrakhmanova Ainur Kanatovna, master, senior teacher
Daurenbekova Sholpan Zhumabekovna, candidate of Biology Sciences, associate professor
Zhetysu University named after I. Zhansugurov, Kazakhstan, Taldykorgan

***Annotation.*** *The negative effect of long-term use of mineral fertilizers on the properties of the soil is shown: the content of humus decreases, and its quality deteriorates due to changes in the ratio of humic and fulvic acid. The fertility of the soil and the direction of various chemical and biological changes in it largely depend on the acidity of the environment.*

**Keywords:** *Mineral fertilizers, humus, crop yield, plant.*

According to calculations conducted by the UN, the world's population, at the current rate of growth (0.4% per year in developed countries and 1.6% in developing countries), could exceed 8 billion people by 2025. To meet the food needs of humanity, it will be necessary to produce about 4,000 million tons of grain in the world, which corresponds to a yield of 4.5 t/ha [1].

It is obvious that such an increase in grain production on existing acreage is impossible to achieve without the active use of mineral fertilizers. One of the most urgent tasks of modern agronomy, Ecophysiology is the study of the processes of adaptation of plants to specific conditions of their habitat and protection from the extreme effects of this environment, as well as increasing the dynamics of plant development and productivity. Adaptation is a response of the body caused by changes in the habitat and leads to the restoration of temporarily lost vitality or reproductive potential. Each living organism has a unique adaptive complex of ecological and physiological responses of the body to changes in the environment that have occurred in the course of evolution. The plant is a source of food for all living things, oxygen-forming, and a factor of psychological positive influence[2].

The Republic of Kazakhstan is one of the youngest and fastest growing independent countries in the world. Kazakhstan is located between the Siberian taiga to the North and the deserts of Central Asia to the South, bordered by the Caspian Sea to the West and the Tien Shan and Altai mountain ranges to the East (UNDP, 2002). About 60% of the territory of Kazakhstan is occupied by Plains. Deserts and semi-deserts occupy about 50% of the territory, most of which are located in the Turan lowland. Dry territories extend from the Caspian Sea to the plains at the foot of the Semirechye, Dzungarian Alatau and Tien Shan mountains. These vast territories have different geological structures and landscape features. The northern parts of Kazakhstan are covered with steppe and forest-steppe (Danayev, 2008)[3].

One of the most important problems of modern agriculture is the preservation of soil fertility. Soil degradation leads to a gradual decrease in the volume of product formation and catastrophic changes in the environment[4].

Plant hormones or phytohormones, organic substances produced by plants, are formed in other parts of the plant that differ from nutrients and are usually not where their effects are observed. These substances, even in low concentrations, regulate the growth of plants and their physiological response to various influences. In recent years, several phytohormones have been synthesized, which are used in agricultural production. They are used to control weeds and produce seedless fruits. Phytohormones inhibit plant growth processes. Especially the ability of hormones to regulate growth is shown in experiments with plant tissue cultures. If we separate the living cells that have retained the ability to divide from the plant and feed them the necessary nutrients and hormones, they will begin to grow actively[5].

Humus content is the main indicator that characterizes soil fertility. Experimentally, it was found that an increase in the humus content in sod-podzolic soils by 1% increases the yield of acreage by more than 25% [2]. Similar data were obtained in other studies.

The aim of the paper is to study the long-term use of different doses and ratios of nutrients for the productivity of agricultural plants.

According to leading soil scientists, over the past 100 years, the reserves of organic substances in the chernozems of the country have halved [5].

The determination of nutrient utilization coefficients from the soil showed that when applying mineral fertilizers, they usually increase in comparison with unfavorable options. When determining the circumstances of this phenomenon, a significant increase in humus mineralization processes caused by nitrogen fertilizers was found [6]. Each unit of fertilizer nitrogen contributes to the additional mobilization of soil nitrogen from 0 to 1.2 units . This leads to an increase in mobile compounds in the soil and, as a result, to an increase in the nutrient utilization rates of plants. Mobile nitrogen compounds formed as a result of mineralization of organic substances, as well as nitrogen from mineral fertilizers, are added to the geochemical migration. Their share of the total number of infiltration nitrogen losses from arable land is from 10 to 50% [7,8].

This was confirmed during the study of the qualitative composition of humus. Under the influence of mineral fertilizers, the ratio between Humic and fulvic acids changes, the proportion of sugar-and oxygen-containing compounds, protein-like residues increases. According to some researchers, long-term use of mineral fertilizers has significantly reduced the proportion of humic acids. Given that humus substances are an important environmental factor affecting the vital activity of soil organisms, their destruction inevitably leads to changes in the natural structure of pedocenoses.

The use of bentonite as a source of nutrients for agricultural plants is very effective for agriculture in the Republic of Kazakhstan today. Bentonite - (given the name "bentonite" due to its discovery in Benton land in the United States) during the Soviet Union, more than a dozen centers of origin were found and processing foci were established in the Caucasus, Cherkass Region [11]. According to recent studies, bentonite has been found on the territory of Kazakhstan and its composition is still being studied.

Currently, the problem is that the use of bentonite as a source of nutrients for plants is also a very effective technology for the agricultural economy. In this regard, for the dynamic development of Agriculture in the Republic of Kazakhstan, it is necessary to create opportunities for the use of this technology.

The most effective methods obtained by using bentonite as a source of nutrients for plants and using the indicators obtained from the results of the examination can be used in the field of Natural Sciences, Agriculture.

*X-ray diffractometric analysis of the bentonite phase structure, detected on the automated diffractometer "Expert-Pro"*

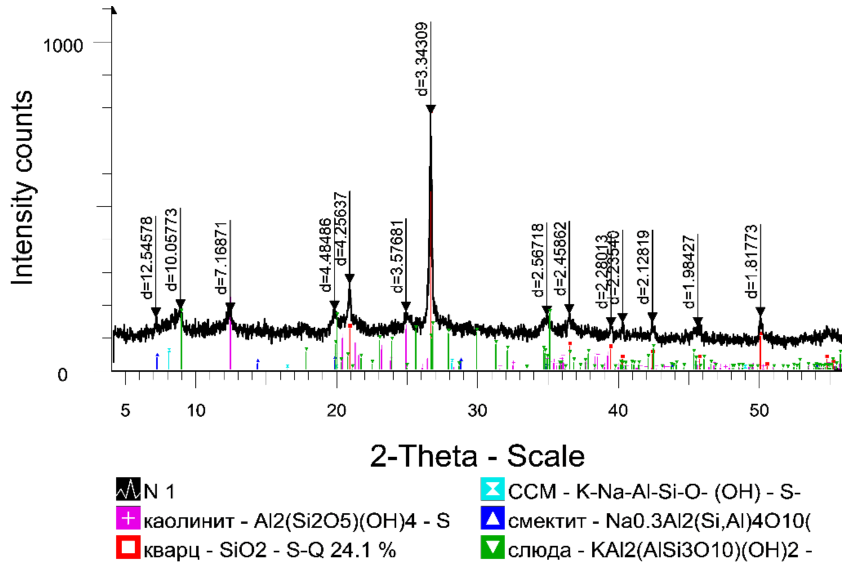


**Figure 1. Xrd-raw clay in X-ray analysis**

According to the results of X-ray diffractometric analysis of the phase composition of bentonite-montmorillonite clay: kaolinite, Quartz, clay mineral, smectite and Mica (fig.2).

The main rock-forming mineral of bentonite-montmorillonite clay in the middle tentek River Valley deposit is kaolinite (30.9%), the composition of which corresponds to the formula AL2(Si2O5) (OH) 4 and quartz (SiO2) with a concentration of 24.1%. Smectite (Na0.3al2 (Si,Al)4o10 (OH)2·2H2O) is 16.2%.

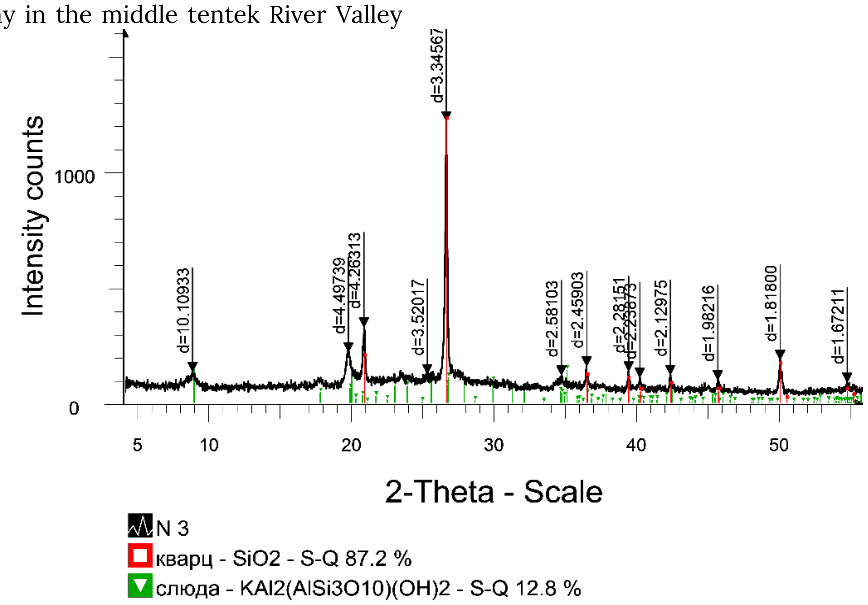


**Figure 2. Xrd-clay treated with sulfuric acid in X-ray analysis**

In the case of complete dehydration of clay modified with sulfuric acid at a temperature of 5000C, there is an increase in the content of quartz and Mica to 87.2% (KAl2(AlSi3O10)(OH)2, the concentration of which is equal to 12.8%. There is a significant decrease in the aluminum content.

Using X-ray fluorescence analysis, the initial and modified elemental composition of bentonite-montmorillonite clays of the Middle tentek River Valley deposit was determined (table.1).

Table 1.**primary and modified elemental composition of bentonite-montmorillonite clays of the Middle tentek River Valley deposit.**

| Sample | Composition, % | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Si | Al | Fe | K | Mg | Ca | P | Ti | Mn | Ni | Ag |
| Original clay | 23.88 | 8.883 | 11.91 | 3.522 | 0.874 | 0.595 | 0.505 | 0.652 | 0.147 | 0.009 | 0.223 |
| $CLY_{HCl}$ | 25.50 | 7.993 | 3.612 | 2.456 | 0.366 | - | 0.446 | 0.787 | 0.011 | 0.003 | 0.123 |
| $CLY_{H2SO4}$ | 29.36 | 6.95 | 2.772 | 2.012 | 0.242 | - | 0.424 | 0.837 | 0.01 | 0.002 | 0.111 |
| $CLY_{HNO3}$ | 23.66 | 8.168 | 8.357 | 3.149 | 0.503 | - | 0.427 | 0.679 | 0.06 | 0.005 | 0.204 |

Table 1 shows that the main component of clay in the Valley of the Middle tentek River is silicon, iron and aluminum. Titanium, manganese, and silver are found in small quantities. Treatment with salt, sulfuric and nitric acids destroys the element composition. In most cases, there was a breakdown of calcium ions and a decrease in magnesium volume from 42.5 to 72.3%. After treatment with sulfuric acid, potassium ions (up to 43%) were washed out. After the use of sulfuric acid, There is a 4.2-fold decrease in iron, an increase in Silicon by 29,368. After treatment with sulfuric acid, iron and aluminum were washed relatively slightly. As a result, we can conclude that acids wash structural cations in the following order.

Natural Clay was treated with concentrated salt, sulfuric and nitric acids. After washing and drying with water purified from chlorine ions, the clay was heated for 3 hours at a temperature of 5000C, and this treated clay was determined as a modified element composition.

Soil dehumification can have significant negative environmental consequences. Humus substances consist of 52-62% carbon. During their mineralization, $CO_2$ is formed, which enters the atmosphere and contributes to the formation of a greenhouse effect. It is believed that 20% of all carbon dioxide accumulated in the atmosphere as a result of anthropogenic activity was formed as a result of the destruction of organic matter in the soil .

The negative consequences of humus mineralization under the influence of any agrotechnical methods, including the use of nitrogen fertilizers, reducing the direct supply of nutrients in the soil, deterioration of its properties, the emergence of environmental problems, are not only, but also reducing the possibility of non-biological nitrogen fixation. Currently, there is evidence of the existence of mechanisms of chemical nature that provide nitrogen fixation in the soil without the participation of living organisms. According to experts, the need for nitrogen in field conditions of agricultural crops is met by 40-50% by fixing it with natural humus substances. Changes in the quality of humus can have a significant negative impact on the activity of abiotic nitrogen fixation systems in the soil, since their functioning depends on the physical and chemical properties of organic substances.

Among experienced agronomists, there is often an opinion about the absence of an increase in PH if moderate doses of fertilizers are used. However, studies have shown that the annual use of 38 kg/ha of ammonium nitrate and 70 kg/ha of the active substance potassium chloride during crop rotation increases the acidity of peat-podzolic clay soils to a depth of 60 cm [9].

Deterioration of agrochemical indicators of the soil affects the efficiency of the applied fertilizers and, as a result, the yield of plants. For example, if in the first year of application of mineral fertilizers, potato and oat crops increased from 118 to 251 kg/ha and from 25 to 40.1 kg/ha, respectively, then after 10 years of regular application, they no longer increased, but, on the contrary, reduced the yield of field crops [5]. Similar data was obtained in other experiments.

The negative effect of systematic non-application of fertilizers to plants is associated both with acidification of the soil solution, and with an increase in the content of aluminum, manganese and iron compounds that inhibit plant growth [6]. In this case, the number and species composition of microorganisms changes. Among them, phytopathogenic species appear. Deterioration of individual indicators of soil chemical characteristics reduces the resistance of plants to water deficiency [8] and other environmental factors.

Calculations carried out to determine the relationship between base leaching and fertilizer application show that on clay soils, each kilogram of introduced nutrients leads to a loss of 0.5 kg of Sao and 0.06 kg of MgO, and on sandy soils-1.0 and 0.19 kg, respectively. therefore, in fertilized areas, it is recommended to add 60-80 c / ha of MgO [5].

Negative consequences of applying fertilizers include an increase in the mobility of some trace elements contained in the soil. They are actively involved in geochemical migration. This leads to the formation of a deficiency of Zn, Si, MP in the arable Layer [10]. Limited intake of trace elements on plants negatively affects the processes of photosynthesis and the movement of assimilates, reduces their resistance to diseases, insufficient and excessive moisture, high and low temperatures. When there is a lack of trace elements, the main cause of disorders in plant metabolism is a decrease in the activity of enzyme systems.

The lack of trace elements in the soil forces the application of fertilizers with trace elements. For example, in the United States, their use increased from

34.8 to 65.4 thousand tons in the period from 1969 to 1979 .

The possible content of related elements in superphosphates and other types of mineral fertilizers widely used in modern agriculture is given in Tables 2 and 3.

Table 2. **Composition of impurities in Superphosphates, mg / kg [6]**

| **Mixture** | **Composition** | **Mixture** | **Composition** |
|---|---|---|---|
| Arsenic | 1,2-2,2 | lead | 7-92 |
| Cadmium | 50-170 | Nickel | 7-32 |
| Chrome | 66-243 | Selenium | 0-4,5 |
| Cobalt | 0-9 | Zinc | 4-79 |
| Vanadium | 20-180 | Manganese | 50-143 |

When applying mineral fertilizers at the rate of NPK 109 kg/ha, about 7.87 g of copper, 10.25 – zinc, 0.21 – cadmium, 3.36 – lead, 4.22 – nickel, 4.77 – chromium fall into the soil [5]. According to the Central Institute of agrochemical service of Agriculture, during the entire period of use of phosphorous fertilizers, 3200 tons of cadmium, 16633 – lead, 553 – Mercury were introduced into the soil of the former USSR. Most of the chemical elements entering the soil are in a weakly active state. The Half – Life of cadmium is 110 years, zinc – 510, copper – 1500, lead-several thousand years [5].

Table 3. **Heavy metal content in fertilizers and limes, mg / kg [6]**

| **View удобрения** | Zn | Cu | Ni | Pb | Fe |
|---|---|---|---|---|---|
| **Potassium chloride** | 3,11 | 8,67 | 4,33 | 8,67 | 680,53 |
| **Ammonium nitrate** | 0,20 | 0,25 | 0,84 | 0,05 | 603,00 |
| **Lime** | 10,83 | 12,67 | 26,00 | 26,50 | 4853,00 |

Soil contamination with heavy and toxic metals leads to their accumulation in plants. Thus, in Sweden, the concentration of cadmium in wheat has doubled in this century. There was a 3.5-fold increase in the content of cadmium in wheat grains with the use of superphosphate in a total dose of 1680 kg/ha administered in parts for 5 years [6]. According to some authors, when the soil was contaminated with Strontium, its content in potato tubers increased three times [5]. In our country, Kazakhstan does not yet pay enough attention to the contamination of plant products with chemical elements.

The use of contaminated plants as food or feed is the cause of various diseases in humans and farm animals. The most dangerous heavy metals include mercury, lead, and cadmium. The penetration of lead into the human body leads to sleep disorders, general weakness, mood disorders, memory disorders, and a decrease in resistance to bacterial infections [9]. The accumulation of cadmium in food products, the toxicity of which is 10 times higher than lead, leads to the destruction of blood red blood cells, destruction of the kidneys, intestines, softening of bone tissue. Paired and triple combinations of heavy metals enhance their toxic effect [10].

The WHO committee of experts has developed standards for the entry of heavy metals into the human body. Every week, a healthy person weighing 70 kg can get 3.5 mg of lead, 0.625 mg of cadmium and 0.35 mg of mercury without harm to health [11].

Japanese scientists found that the penetration of fluorine into the human body with food and water increased by 2.7 times by 1965 compared to 1958. The increase in environmental pollution of fluorine gave the Swedish government grounds to prohibit its use in water disinfection [10].

Thus, the analysis of these data shows the multifaceted effect of mineral fertilizers and himmeliorants on soil properties.

**References:**

1. *Киперман Ю.А., Комаров М.А.* Агрохимические руды и минеральные удобрения на рубеже XXI века // Минеральные ресурсы России. 2012, №4. С. 38-44.

2. *Еримбет Р. Е, Кабдрахманова А.К* Қоректік зат көздерінің өсімдіктердің өсімталдығына әсері «Global Scince and innovations 2019: Central Asia» Х-том - Нур-Султан – 2019 «Общенациональное движение «Бобек», 2019.

3. *Dzhenn R.K., Amen R.D What* is germination // V KN . Physiology and biochemistry of rest and seed germination // пер. с англ. Н.А. *Аскоченской, Н.А. Гумилевской* и др.; под ред. *М.Г. Николаевой* и Н.В. *Обручевой. М.: Колос*, 2000. С. 19–46.

4. *Jones R.L., Stoddart J.L. Gibberellins and seed germination* / пер. с англ. *Н. А. Аскоченской, Н. А. Гумилевской* и др.; под ред. *М. Г. Николаевой* и *Н. В. Обручевой. М.: Колос*, 2005. С. 99–132.

5. The effect of embryo axis, 6-ben-zylaminopurine and kinetin on protein metabolism in protein bodies during germination of lentil seeds / I. Alvarez [et al.] // J. Plant Physiol. 1987. V. 126, № 4/5. P. 319–328.

6. Appleford N.E.J., Lendon J.R. Hormonal Regulation of -Amylase Gene Expression in Germinating Weat (Triticum aestivum) Grains // Physiol. Plantarum. 1997. V.100, № 3. P. 534–542.

7. Bewley J.D. Seed germination and dormancy // Plant Cell. 1997. Vol. 9. P. 1055–1066.

8. Bewley J.D., Black M. Seeds. Physiology of Development and Germination: Second Edition. N.Y.: Plenum Press, 1994. 445 p.

9. Bonetta D., McCourt P. Genetic analysis of ABA signal transduction pathways // Trends Plant Sci. 1998. Vol. 3. P. 231–235.

10. Borisova T.A., Kefeli V.I. Exogenous Abscisic Acid Can Stimulate Seed Germination // Physiology of Abscisic Acid. 30 Years of Discovery. [Abstr.] International Symp. Puschino, October 25–28, 1993. P. 5.

11. Busk P.K., Pages M. Regulation of abscisic acidinduced transcription // Plant Mol. Biol. 1998. Vol. 37. P. 425–435.