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INFLUENCE OF THE PHYSICAL AND MECHANICAL PROPERTIES OF SOIL ON THE PROGRAMMED YIELD OF AGRICULTURAL CROPS

The problem of soil research is now extremely relevant to many agricultural industries. The productive value of the soil depends on many variable factors, including humidity, temperature, composition, processing methods, fertility, which, in turn, are determined by the content of inorganic and organic components. Soils with a large amount of organic substances and the optimal content of minerals are considered to be the most productive in terms of fertility.

The article thoroughly analyzes the role of the physical and mechanical properties of the soil in providing a programmable crop crop. The key role of the soil environment in the growth of plants and the formation of yields, as well as the impact of its physical and mechanical state on water, air and nutritious regimes is indicated.

The basic parameters are considered: density of laying, humidity, granulometric composition, degree of structure, water permeability, capillary and aeration level. A comparative analysis of different types of soils in the context of their suitability for the cultivation of individual crops is given. It is described as a violation of the physical and mechanical equilibrium of soils (compaction, erosion, loss of structure) adversely affect the development of plants, causing oxygen deficiency, impaired moisture absorption and reducing the activity of the root system.

Particular attention is paid to agrotechnical methods that contribute to the improvement of the physical condition of soils: the use of organic fertilizers, cultivation, mulching, sideral agriculture, as well as crop rotation as a way of preserving fertility. Organic substances in the soil can be vegetable, animal, microbial or anthropogenic origin. The definition of physicochemical parameters of soil of agrochemical analysis is considered. This measure allows you to accurately determine the chemical composition and fertility of the soil. This is crucial for choosing appropriate crops and the required amount of mineral and organic fertilizers. The calculations of fertilizer application standards and a programmable yield of potential yield of sugar beetroot crops.

Keywords: *Soil, physical and mechanical properties, soil structure, density, humidity, yield, yield programmatic, agrotechnics, soil protection agriculture, root crops, beetroot.*

Introduction. The rational use of soil resources is one of the most important areas of sustainable agricultural development. The agricultural sector faces a number of global challenges, among which the most critical are: climate change, soil degradation, reduction of fertile land, increasing prices for mineral fertilizers, as well as an increase in the need for food as a result of increasing the population of the planet. Therefore, the need for in-depth study of factors, such as physical and mechanical properties of soils, which directly affect the yield of crops [1], is increasing.

The physical and mechanical properties of soils contain a complex of characteristics that determine its condition, structure, water-air regime, density, strength, plasticity, capillary activity, resistance to erosion, etc. They have a decisive

effect on the development of the root system, the ability of plants to absorb moisture and nutrients, as well as on the overall biological activity of the soil environment. The discrepancy between these properties with optimal agrotechnical parameters leads to a number of negative consequences: soil compaction, reduction of water permeability, oxygen deficiency for roots, formation of surface crust, deterioration of microbiological activity and, as a consequence, reduction of yield [2].

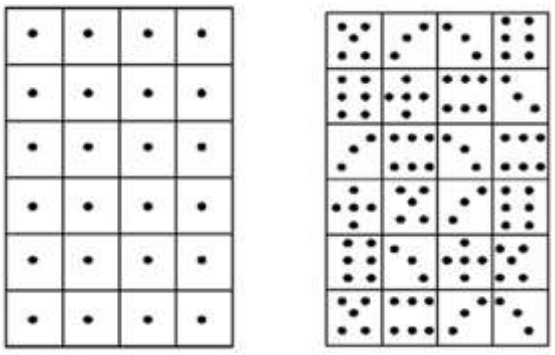
Despite the considerable number of studies in the field of soil science, in production practice, the need for monitoring and adjusting the physical and mechanical state of soils is often underestimated. In most farms, the main attention is paid to the introduction of fertilizers and plant protection products, while soil conditions are considered as a constant background that requires minimal intervention. This approach is erroneous, because the physical parameters of the soil can vary significantly depending on the system of cultivation, climatic conditions, water regime and technologies of cultivation of crops [2-5].

The study of this issue in conditions of intensive agriculture, as well as in the transition to biological and organic production, becomes especially relevant. The search for effective agrotechnical solutions aimed at improving the physical condition of the soil (unprecedented cultivation, deep loosening, use of siderates, mulching, organic fertilizers), requires scientific substantiation, research data and adaptation to regional conditions [6]. The need for a comprehensive analysis of the physical and mechanical properties of the soil, as one of the main factors in ensuring a sustainable and qualitative crop is relevant.

Analysis of recent research and publications. The restoration and regulation of the physical and mechanical properties of soils is an important task, which depends on which the food safety and the sustainable development of the agricultural sector depends on. The characteristics that determine the physical condition of the soil and change under the influence of physicochemical factors form the physical properties of the soil: density, moisture, granulometric composition, porosity, plasticity, capillary, water permeability, clutch of particles, etc. [1-3, 7, 8, 14]. Obtaining accurate data through research is important for further programming of the planned crop yield.

An important indicator, which is widely used in soil-genetic, agroforestry and agrotechnical studies, is the density of the soil, which is necessary for the evaluation of its structure, changes during anthropogenic use, especially during mechanical cultivation, as well as in the calculations of soil moisture, humus, nutrients, nutrients, mineralizations. The density in soils varies from 0.9 to 1.8 g/cm3 (in forest litter and peatlands - from 0.1 to 0.4 g/cm3), depends on the granulometric and mineralogical composition, humus content, as well as the structural condition of the soil. As a consequence, the more humus in the soil and the more it is structured, the lower its density and vice versa [1-3, 14].

Materials and methods. Soil analysis allows you to accurately determine the chemical composition and fertility of the soil, which is crucial for choosing the cultivation of crops and the necessary fertilizers. The selection of soil samples by square or adaptive nets is common. The use of the square mesh method is the simplest, which is carried out on homogeneous field soils every 1, 3, 5, 10 hectares, etc. For example, for a sub - analysis on average on an area of 80 hectares it is necessary to make 1600 soil punctures (Fig. 1) [3, 7, 8].



a) b)

Fig. 1. Schemes of soil sampling: a) sampling in the center of the grid; b) possible options for placing the collected samples to create a mixed sample [7]

Removal of soil samples when using the adaptive mesh method is randomized depending on the field factor selected (navigation data, yield maps, soil differences, or other zoning methods), where the main attention is paid to the content in the soil, etc. The productive value of the soil can be detected by the existing degree content of chemical elements. [3, 7, 8].

Results. At the present stage of agriculture development, programming of the yield of all crops, including beetroots is a prerequisite for its intensification. Beetroots biological crop contains much more nutrients than most grain crops [9-13].

To calculate the potential crop, we use the method of photosynthetic activity of radiation (FAR) [3]:

$$PC = \frac{Q \cdot K_a}{10^2 \cdot C}, \quad (1)$$

where PC is the yield of absolute mass, c/ha;

K_a - Use coefficient FAR, %, K_a = 5 %;

Q - FAR amount for the growing season, kJ/ha, C= 16,76 · 10^8;

C - the amount of energy accumulated by a substance, Q=1190·10^6 kJ/ha.

$$PC = \frac{1190 \cdot 10^8 \cdot 5}{10^2 \cdot 16{,}76 \cdot 10^6} = 355 \text{ c/ha}.$$

We determine the potential harvest of basic products, t/ha:

$$PC_a = \frac{10PC}{(100 - B) \cdot \varepsilon_u}, \quad (2)$$

where PC_a - potential harvest of basic products at standard humidity, t/ha;

B - Standard humidity, %;

$\varepsilon_и$ - сума частин у відношенні основної продукції до побічної.

$$PC_a = \frac{10 \cdot 35{,}5}{(100 - 76) \cdot 1{,}4} = 10{,}7 \text{ t/ha}.$$

We define the climatic harvest:

$$KH_a = \frac{100 \cdot W}{W \cdot K_W}, \quad (3)$$

where KH_a - climatic-protected crop of absolutely dry substance with a limiting moisture, t/ha;

W - supply of productive moisture, W=400 mm;

K_W - Water use coefficient, K_W = 10 m^3/t.

$$KH_a = \frac{100 \cdot 400}{400 \cdot 10} = 10 \text{ t/ha}.$$

We calculate the potentially possible crop taking into account the main climatic guidelines:

$$H = 2{,}3 \cdot h + 313{,}5 \cdot K - 35{,}03, \quad (4)$$

where h - duration of the vegetative period, days;

K - Humidity indicator.

$$K = \frac{W_b + H}{0{,}18 \cdot \varepsilon \cdot \Theta}, \quad (5)$$

where W_b- the amount of productive moisture in the meter layer of soil before sowing, mm;

H - rainfall during the growing season, mm;

$\varepsilon \cdot \Theta$ - the sum of active temperatures at n = 160, H = 540, $\varepsilon \cdot \Theta$ =2430.

$$K = \frac{220 + 540}{0{,}18 \cdot 2430} = 1{,}74.$$

H = 2,3·15 + 31,35 · 1,74 - 35,03 = 54,02 t/ha.

Planned beetroots yield 54 t/ha.

Calculation of fertilizer standards for programmable yield.

An important condition for crop programming is the development of a proper fertilization system for crop crops.

We calculate the removal of certain nutrients of the planned crop:

$$B = Pch - C_B, \quad (6)$$

where B - removal of the nutritional element of the programmable crop;

Pch - Programmed crop, t/ha;

$C_в$ - removal of the nutrient and quantity of basic and by -products, kg/t;

P_N = 54 · 4,0 = 216 kg/t;

B_P = 54 · 1,8 = 81 kg/t;

B_K = 44 · 5,0 = 270 kg/t.

We calculate the norms of mineral and organic fertilizers together [14];

$$D = \frac{100 \cdot R - (N \cdot C_m + D_0 C_0 K_0)}{K_y C}, \quad (7)$$

where D_0 - dose of application of organic fertilizers, t/ha;

C_0 - mass of mineral substance in one tone of organic fertilizers, kg;

K_0 – The coefficient of use of mineral substances of organic fertilizers, %;

R - removal of nutrients with a planned crop, kg/ha;

N - the amount of nutrients in the soil, kg/ha;

K_m - the coefficient of use of mineral substance of soil, %;

K_y - The coefficient of use of mineral substance fertilizer, %;

C - the amount of active substance of fertilizers.

After calculations, 228 kg/ha - nitrogen, 85 kg/ha - phosphorus and 280 kg/ha - potassium fertilizers are required to produce 54 tons of beetroots, but part of the need (especially potassium and partially nitrogen) can be covered with organic fertilizers (manure, siderata).

Regulation of physical and mechanical characteristics of soils is an important area in ensuring a stable crop yield and maintenance of soil fertility.

Conclusions. The systemic combination of mechanical, chemical and biological measures provides a complex improvement of the physical and mechanical properties of the soil, optimization of the soil tillage system in order to reduce its destructive influence, which is the basis for sustainable agricultural production.

Improvement of agro-technologies and maintaining the ecological balance of soils is a priority for improving the physicochemical composition of soils and ensuring high fertility.

The physical and mechanical properties of the soil have a decisive effect on the quality and volume of agricultural crops. Important in the programming of yields the right approach in the analysis of soil conditions for growing crops and adapted specific conditions. As a result of the analysis, data on accurate agriculture can be obtained, in accordance with the productive value

of soil, the cost of differentiated fertilizers, the number of unspent materials and potential programmable yield. Such integration of different approaches and adaptation to specific soil and climatic conditions allows to provide an environmentally safe, resource-saving and highly productive agriculture

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ВПЛИВ ФІЗИКО-МЕХАНІЧНИХ ВЛАСТИВОСТЕЙ ҐРУНТУ НА ПРОГРАМОВАНУ УРОЖАЙНІСТЬ СІЛЬСЬКОГОСПОДАРСЬКИХ КУЛЬТУР

Проблема дослідження ґрунтів нині є надзвичайно актуальною для багатьох галузей сільського господарства. Продуктивна цінність ґрунту залежить від багатьох змінних факторів, включаючи вологість, температуру, склад, способи обробки, родючість, які, у свою чергу, визначаються вмістом неорганічних і органічних компонентів. Найпродуктивнішими з точки зору родючості вважаються ґрунти з великою кількістю органічних речовин і оптимальним вмістом мінеральних речовин.

У статті проаналізовано роль фізико-механічних властивостей ґрунту у забезпеченні програмованого урожаю сільськогосподарських культур. Зазначено ключову роль ґрунтового середовища у рості рослин та формуванні врожайності, а також вплив його фізичного і механічного стану на водний, повітряний і поживний режими.

Розглянуто основні параметри: щільність укладання, вологість, гранулометричний склад, ступінь структурованості, водопроникність, капілярність і рівень аерації. Наведено порівняльний аналіз різних типів ґрунтів у контексті їх придатності до вирощування окремих культур. Описано, як порушення фізико-механічної рівноваги ґрунтів (ущільнення, ерозія, втрата структури) негативно впливають на розвиток рослин, спричиняючи дефіцит кисню, порушення поглинання вологи та зниження активності кореневої системи.

Приділено увагу агротехнічним методам, що сприяють покращенню фізичного стану ґрунтів: застосуванню органічних добрив, обробітку, мульчування,

сидерального землеробства, а також сівозміни як способу збереження родючості. Аналіз ґрунту дозволяє точно визначити хімічний склад та родючість ґрунту, що є вирішальним для вибору відповідних сільськогосподарських культур та необхідних добрив. Приведені розрахунки норм внесення добрив та програмовану урожайність потенціального врожаю коренеплодів цукрових буряків.

Ключові слова: *ґрунт, фізико-механічні властивості, структура ґрунту, щільність, вологість, урожайність, програмованість врожаю, агротехніка, ґрунтозахисне землеробство, коренеплоди, цукровий буряк.*

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