

Scientific aspects of soil fertility and functions in the formation of yield

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New methodological approaches to understanding the phenomenon of "soil fertility" and functional effects of various factors of yield formation are showed. Functions of soil in crop production are considered. The feasibility of the term fertility (productivity) agrofitosystemy are established.

Key words: *soil, fertility, productivity, methodology, agrofitosystem.*

The term "fertility" was introduced into use to explain the difference in cropping capacity of plants on neighboring plots of land. The concept included the difference in chemical composition, first of all, in content and reserves of minerals for plants nutrition. [7]. Later fertility was considered the principal characteristic of soil. But now using the term "fertility of soil" is rather doubtful as its meaning does not reflect the essence of the notion, and it is difficult to give its scientific definition as well as to determine the units of measuring the fertility of soil [1].

Disparity of the meaning consists in the fact that fertility – the ability to reproduce – is characteristic only of living organisms and soil is not the one.

Impossibility of giving the full scientific definition of the term «soil fertility» can be illustrated with its development from the ability to supply the plant constantly both with water and minerals [4] and then – with air, heat and favourable physical and chemical conditions for normal growing and development [9] or, even, ability to provide growing and reproduction of plants with all the necessary conditions (not only with water and nutrients) [8].

To determine the level of soil fertility differentiated approaches are used. As the every-day and industrial notion, "fertility" means the yield; at the economic level it is determined as productivity of plants, grown on this soil, what in both

cases is considered as quantity of produce from the unit of area, that is cropping capacity. The paradox of such a measurement lies in the fact, that we estimate the basic property of soil according to the level of yield, that is, by means of another natural body – the plant [1], what divides out the term «soil fertility» into two separate notions – soil and fertility.

We see the way to overcome such a contradiction in dividing the notion of fertility into productivity and fertility [6], where fertility is characterized by soil properties (humus content, soil reaction, content and reserves of nutrients, etc). Productivity, which besides the soil fertility depends on weather conditions, plants characteristics, technologies applied, we propose to define as the quantity of the grown biomass. Thus the yield is a criterion of soil productivity, which eliminate contradiction between soil fertility and its quantitative characteristic.

Thus, the purpose of the given paper is scientific analyses of soil properties and functions in agricultural production and human life aiming at determination the essence of the notion «fertility and units for its measurement as well as correctness of using the term» soil fertility.

In present day understanding the notion of fertility is connected with soil as its basic characteristic, and this fact causes the necessity of considering each component of the term separately.

The up-to-date generally accepted definition of soil as «fertile, complex, polyfunctional and polycomponent open multiphase structural system in the surface layer of rock weathering crust, which is a complex function of the rock, organisms, climate, relief and time» [8], in spite of the using complicated terminology, does not reveal the essence of the notion «soil». This definition shows the role of natural factors and the place of formation the soil and its complex structure. But its basic function is condensed to having the property of fertility, that is production function, which is directed to satisfying the consumption needs of the society.

Such a one-sided approach narrows the dialectical methodology of cognition this phenomenon to egocentric one, what leads to various complications and misunderstanding.

Soil, the element of biosphere, was formed without human participation, and its main purpose is to implement its global function – to provide life and to regulate its density on the Earth, creating conditions for organic substance synthesis – basis for living organisms nutrition. That's why definition of soil as «upper weathered layer of the Earth crust, the place of interaction of all the planetary spheres transformed by plants and other biota of edaphone into optimal, adequate to external conditions, habital, which manifests itself in synthesis of living (organic) substance from minerals, what provides conditions for existence and density of life for secondary producers», what includes also production function of soil, will be more justified.

Because of many-sided influence of soil on plant biomass yield formation with direct action of soil properties and indirect action of non-soil factors of yield formation, soil is attached to non-characteristic functions. In particular, in agricultural production soil is considered to be a means, object and product of labour [8,9].

The analysis of correspondence of soil to those economic categories [3] showed that considering the soil as a product of labour in agricultural production is determined by changes of its properties as a result of application certain technologies. But in this case we do not take into consideration the fact, that soil properties are changed quantitatively, not qualitatively, that is, indices of natural soil properties are decreased or increased, but new anthropogenic characteristics are not created. Besides, technological influence on soil is made not for changing its characteristic, but for creating optimal conditions for vital activity of plants and changes of soil properties has secondary effect. Amount of technological measures depends on economic conditions of the farm and, in most cases, the amount of them does not influence definitely neither on the vital activity of plants, nor on the properties of soil. Together with it, technological effect resulted in soil properties

changes does not widen the spheres of its application, what is the obligatory characteristic of the product of labour [3, 5].

Giving the soil the status of «object of labour» does not have economic substantiation, because object of labour takes part only in one production cycle and fully changes its natural form, but the soil does not.

Means of production consists of means of labour. Participation of soil in many production cycles without principal changes of form corresponds to indications of a part of means of production and thus – to indications of means of labour. To indications of object of labour corresponds seeding material of plants with a short cycle of life or the plant itself with its long cycle.

Thus, when the soil economic status of means of labour and the plant – object of labour integrates the soil and the plant into basic means of plant production, that is the sown field, orchard, forest.

But formation of the basic product of agricultural production, organic substance of plants in the whole and its economically valuable part in particular, occurs as the result of influence on the process of various factors. Upon the origin and specific character of action these factors are integrated into corresponding conditions of yield formation, namely climatic and geographical conditions, biological (biological and genetic peculiarities of the grown plants) conditions, soil conditions and anthropogenic (technological) condition of yield formation, or, as we got used to call it, fertility.

According to the effect of anthropogenic (technological) measures of crop growing made on the factors of these conditions, we put them into the order of importance [2]. With the purpose of doing this we put all the factors of yield formation into separate blocks of fertility conditions (see the table).

Factors of the block of climatic and geographical conditions are put down to the first order. It includes amount and duration of insolation, heat, amount and distribution of precipitation, hydrological and thermal conditions during the vegetation period, relief peculiarities, etc. Implementation of technological

operations does not change the action of factors of this block, but intensifies or weakens their action, thus ensuring adaptation of plants to them.

Factor of the second order include soil and biological conditions of yield formation, action of which is fully determined by the landscape and meteorological conditions and the intensity of this action – by anthropogenic conditions or technological operations.

Soil conditions of fertility are determined by properties of all the phases of soil – solid, liquid, gaseous and living. It is the substrate for rooting the plants, which influences yield formation with its chemical, mineral and granulometric composition, physical properties, humus content and properties of soil solution, water, air, temperature, microbiological and biochemical conditions, content and reserves of biophil and toxic substances, etc. The intensity of action of those factors fully depend on climate and geographical factors, but their quantitative action can be changed by implementation of technological operations (cultivation, chemical and engineering land-reclamation, fertilizers application, etc).

Biological conditions of fertility are joined together by such factors as biological peculiarities of a plant, variety (hybrid), their requirements to meteorological and soil conditions, kind of product, vegetation period, computability between organisms and others. These fertility conditions are fully dependent on weather and soil conditions of fertility. At the same time the technology determines the family of the plant, its variety (hybrid), kind of yield and concrete requirements to weather and soil conditions of growing.

Anthropogenic (technological) factors of fertility are determined by the requirements of the grown plant to soil and climatic conditions. Technological measures are directed to the most possible approximation of environmental conditions to the plants requirements.

Action of various conditions of fertility is resulted in formation the certain amount and quality of the yield of organic substance and its economically valuable part, as well as in content of toxic substances in the yield.

The analysis of the mentioned above facts shows, that such characteristic as «fertility of soil» does not exist. We can speak only about fertility of the system «soil – plant», which is a means of production of plant produce, and which possesses productivity, or fertility, which is formed due to interaction of factors of various fertility conditions, namely-weather, soil, biological and anthropogenic (technological). In other words, fertility is characteristic of agrophytosystems, that is, areas, on which agricultural plant products are grown.

Analysis of the present – day understanding the essence of the phenomenon and the term “fertility of soil», which was made on the basis of individual methodological approach, made it possible to come to the following conclusions:

1. Soil is the upper layer of the «Earth-crust, the phase of interaction of all the planetary mantles of the Earth, transformed by plants and other biota of edaphone into optimal, adequate to external conditions, environment for its living activity. This interaction is resulted in creation of organic (living) substance from mineral compounds, what, in its turn, provides the existence of secondary producers, including human being.

2. Soil is the component of the basic means of products, the other one is the plant, which is grown on it Efficiency of using the means of production, namely the system «soil-plant», on the economic level is measured by its productivity, which on the social level is substituted which the term «cropping capacity», that is amount of the plant produce harvested from the unit of area.

3. Plants yield formation is determined by the action of factors of fertility, which integrate into conditions according to the origin and direction of action namely: climatic and geographical, soil and biological as well as anthropogenic (technological) conditions of fertility.

4. Soil influences the process of formation the yield of organic substance directly, through the action of soil factors, and indirectly, through the soil, by weather, biological, anthropogenic (technological) factors of fertility conditions, which in a greater extent influence the action of soil fertility factors. The term

«fertility», as the synonym to the terms «cropping capacity» and «productivity», is characteristic only of the system «soil-plant» (field, crop rotation or agrophytosystems). That is why, we consider using the term «soil fertility» in the meaning of «productivity» or «cropping capacity» to be incorrect.

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Наукові аспекти родючості та функцій ґрунту у формуванні урожаю

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Запропоновано нові методологічні підходи до розуміння явища «родючість ґрунту» та функціональної дії різних чинників формування урожаю. Розглянуто функції ґрунту у виробництві рослинницької продукції. Встановлено доцільність застосування терміна родючість (продуктивність) агрофітосистеми.

Ключові слова: ґрунт, родючість, методологія, продуктивність, агрофітосистема.

Научные аспекты плодородия и функции почвы в формировании урожая

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Предложены новые методологические подходы к пониманию явления «плодородие почвы» и функционального действия разных факторов формирования урожая. Рассмотрены функции почвы при производстве растениеводческой продукции. Определена целесообразность применения термина «плодородие (продуктивность) агрофитосистемы».

Ключевые слова: почва, плодородие, методология, продуктивность, агрофитосистема.