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**THE FORMATION OF SOYBEAN  
PHYTOCENOSIS AND SEEDS  
QUALITY DEPENDING ON THE  
INTENSIFICATION FACTORS**

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*The scale of soybeans cultivation in the world agriculture it takes a leading place among crops due to its valuable biological and economic properties. Soybeans are ahead of all other crops in terms of acreage growth. Today, the varietal spectrum has grown enormously and the gross grain yield of soybeans has increased. However, the realization of the genetic potential of modern varieties remains rather low and the average yield in Ukraine is 1,2-1,9 t/ha.*

*First of all, maintaining and improving the quality of soybean seed is an important task, along with increasing yields. Vegetation of plants in the period of growth and development and their productivity depend in a certain way on the quality of the seed material, namely: germination, purity, sanitary condition, etc.*

*The scientifically sound fertilizer application system combines basic and row fertilizers and fertilization of cultivated plants during the growing season.*

*Foliar nutrition is called leaf uptake and absorption by the plant of nutrients, amino acids and growth regulators that the root system does not supply enough. The essence of such nutrition is that readily available nutrients of fertilizers enter the vegetative organs of the plants, quickly penetrate the protective wax barrier - cuticle, epidermis - and enter the cells of the plant. The permeability of epidermal cells of the multilayered cuticle depends on the concentration of the nutrient solution, the phase of growth and development, the area and nature of the cover of the leaf blade, climatic conditions, the time of feeding, the shape of the nutrient and other factors.*

*The results of studying the influence of foliar fertilizers on the formation of soybean varieties phytocoenosis productivity and their influence on the qualitative indicators of seeds have been covered. The positive role of the foliar fertilizers action in the formation of individual productivity indicators of soybean plants was found. Foliar feeding is a measure of timely provision of balanced, composition and concentration of nutrients in ionic form – the most accessible for absorption by the leaf surface. Thus, the positive role of foliar fertilizers and varietal features of soybean in the formation of yield indicators was established.*

*Thus, the two-time use of the Vuxal Microplant microfertilizer in the budding and green bean phases in the cultivation of Kent soybean variety allows obtaining positive indicators of the chemical composition of the seeds.*

**Key words:** soybean, variety, complex of microelements, foliar nutrition, chemical composition, quality, productivity.

**Table. 3. Lit. 13.**

**Introduction (Formation of the problem).** The scale of soybeans cultivation in the world agriculture it takes a leading place among crops due to its valuable biological and economic properties. Soybean seeds contain more than 40% protein, which is balanced in amino acid composition, up to 19% oil, and up to 30% carbohydrates, in addition, a diverse range of vitamins and minerals, which makes it a great alternative to animal products [1]. Soybeans are ahead of all other crops in terms of acreage growth. For example, in the past decade, soybean crops in the Ukraine have grown by almost ten, growing by about 30% annually [2].

Today, the varietal spectrum has grown enormously and the gross grain yield of soybeans has increased. However, the realization of the genetic potential of modern varieties remains rather low and the average yield in Ukraine is 1,2-1,9 t/ha [3].

First of all, maintaining and improving the quality of soybean seed is an important task, along with increasing yields. Vegetation of plants in the period of growth and development and their productivity depend in a certain way on the quality of the seed material, namely: germination, purity, sanitary condition, etc.

**Analysis of recent sources and publications.** A powerful competitive soybean industry is emerging in Ukraine: sowing areas, yields and soybean seed production are growing rapidly. In this sense, Ukraine has taken priority and become a leader in soybean production in Europe. But, unfortunately, in conditions of production intensification, it is not always possible to maximize the genetic potential of soybean varieties and to make full use of the material and technical base in existing technologies [4,5].

According to the Harvest Online project, as of January 1, 2020, Vinnitsa region farmers obtained soybean yield at the level of 24,7 m. c./ha.

Soy is extremely valuable as a forage crop. The diverse chemical composition of soybean seeds determines the versatility of its use and exceptional importance for many sectors of the economy, not only here but also abroad, and feeds from soybeans feed animals in the form of meal, dermis, soybean meal, milk, protein concentrates, green feed, silage, and hay, straw. According to scientists, 1 kg of soy contains 1,26 feed units, 354 g of digestible protein, 28 g of lysine and other nutrients [6, 7].

Soybeans, like all legumes, are an important crop in the rotation link. It is recommended to return soybeans to their previous place of cultivation no earlier than two years. All grain, corn, sugar beet, potato, perennial cereals and other crops are suitable for soybean precursors. Unsuitable precursors are other legumes and perennial legumes (hosts of the same root rot pathogens) and crops that are hosts of sclerotin pathogens, such as sunflowers or cruciferous crops. Soybean is a valuable precursor for future crops. However, late harvesting of crops does not allow winter crops to be grown in all regions of Ukraine [8,9]. In addition, soy is enriched with nitrogen, so, like all legumes, it is an indispensable precursor to all crops.

That is why soybean crop areas in the world are growing and today make up about 55 million hectares, with an average seed yield of 21-24 m. c./ha. In Ukraine, soybean sowing areas vary considerably by year. Over the last decade, they amounted to 70-110 thousand hectares, with an average yield of this crop about

9 m. c. / ha. Gross soybean seed collection in the world in 2017 amounted to 3,75 million tone. [10].

Analyzing the material presented, we can conclude that it is advisable to use the modern agricultural production of the variety, because it acts as a biological foundation on which all the elements of technology of its cultivation are formed. The right or wrong choice reinforces or, on the contrary, weakens the effect of all other factors. Therefore, scientists have come to the conclusion that it is impossible to achieve high soybean yields without the introduction of new intensive varieties, inoculation of seeds, application of organic and mineral fertilizers, and the use of biostimulants and microfertilizers. Soybeans are noticeably ahead of all other crops in terms of growing acreage. In Ukraine over the past 10 years, soybean crops have grown nearly tenfold, increasing by an average of 30% annually [11].

Thus, the analysis of literary sources shows that for the full realization of the genetic potential of soybean varieties among the complex methods of cultivation technology, it is important to provide plants with mineral nutrients throughout the growing season. However, the question of the effectiveness of the use of new complex fertilizers on chelate-based soybean fertilizers in the cultivation of foliar fertilizers in the forest-steppe conditions of the Right Bank remains insufficiently studied.

**Conditions and methods of research.** Field studies to study the formation of different varieties of soybean productivity and its impact on the qualitative indicators of seeds were conducted on the research field of the VNAU for 2017-2018 years.

According to scientists, the cultivation technology and soil and climatic conditions play a crucial role in the maximum realization of the genetic potential of soybean varieties. Even in the conditions of instability of weather conditions for some years and limited components of agroclimatic characteristics of leguminous crops, scientific substantiation of effective growing technologies contributes to the increase of production level [12].

Soybean is a thermophilic culture, the area of distribution occupies a considerable area, and it is grown on a large territory - from the equator and almost up to 54 ° north latitude. It is one of the most demanding crops grown within the region in relation to hydrothermal conditions.

The lowest temperature of seed germination is in the range of 6-7°C, sufficient at the level - 12-14°C, and the optimum is considered to be 15-18°C. Soybean seedlings can withstand frosts up to minus 2-3°C. Soybeans start sowing when the air temperature is higher than 15°C. Especially to the conditions of providing warmth soybeans are demanding during the growing season, and even more so, during flowering and reaching. The optimal daily average growth temperature during this period should be 18-25°C. Therefore, temperature is one of the major climatic factors in soybean cultivation.

Along with this, in addition to temperature, moisture is also an important factor in getting a good crop. Soybeans are characterized by uneven use of moisture by the phases of plant growth and development. From seedlings to flowering there is

less need for soybean plants in moisture. Intense water consumption is noted in the flowering and bean formation phase.

The transpiration coefficient is 500- 650. Scientists have proved that the germination of soybean seeds absorbs 130-160% and more moisture from its mass.

The area where the study was performed is represented by gray forest soils, they have a light medium-loam granulometric composition [13]. The content of humus in the soil is medium (2.4%), the provision of phosphorus at the level of 21,2 mg.-eq. per 100 g of soil is high, potassium is low - 9,2 mg.-eq. per 100 g of soil. Hydrolytic acidity at 4,1, and the sum of absorbed bases 15,3 mg.-eq. per 100 g of soil.

Hydrothermal conditions during the years of exploration were characterized by certain features. It should be noted that overall average monthly air temperatures and precipitation during the growing season (April-September) were favorable for soybean cultivation.

During the growing season, soybeans, both in 2017 and in 2018, were well supplied with heat, compared to average annual values. During the sowing period, the air temperature fluctuated between 9.2-13.2 °C and was close to the annual average, however, with less rainfall causing delayed emergence.

Soybeans are characterized by uneven use of water by the phases of plant growth and development. Critical to wet consumption is the flowering period – watering the seeds, when water shortages can lead to a sharp decrease in yield.

Moisture supply during the 2017 growing season proved to be insufficiently favorable and uneven in terms of moisture supply, both in the initial stages of growth and development, and during the main growing seasons. During the whole growing season, precipitation fell by 65.0% less than the average long-term norm.

The average monthly air temperature in June was 19.1 °C and in the first decade it exceeded the average by 2 °C, and in the future there was an increase in temperature to 21.4 °C in August.

Factors that affect the formation of yield include precipitation, air temperature, and length of daylight, the sum of effective temperatures that directly affect the growth and development of crops. The relatively close location of the territory of the economy from the waters of the seas formed here the conditions of temperate continental climate.

Rainfall for the year is 534-540mm, of which about 80% falls during the growing season. As a rule, the first autumn frosts come in September (September 17), and the last spring frosts in April (April 23). Snow covers the earth for 90 days. And the prevailing winds are the northwest.

On the whole, the assessment of the soil and climatic conditions of the VNAU field of study indicates that they are generally favorable enough for the formation of high and sustainable yields of basic crops, including soybeans. The research was conducted during 2017-2018 at the research field of Vinnytsia National Agrarian University. The studies involved the study of the action and interaction of two factors: A – variety; B – foliar feeding (fertilizing).

The area of the accounting site is 30 m<sup>2</sup>. Spring barley was the precursor. The fertilizer system involved the introduction of phosphorus and potassium fertilizers (superphosphate simple granular and 40% potassium salt) at the rate of P<sub>60</sub>K<sub>60</sub> kg / ha a.s. for basic tillage and nitrogen in the form of ammonium nitrate (N<sub>30</sub>) for pre-sowing cultivation.

Seed was treated 14 days before sowing with Maxim XL 035 FS (1 l / t seed). The day before sowing was carried out inoculation of seeds with the preparation Optimaz 200.

The experiment used different maturity groups of SAATBAU soybean varieties: Merlin (100 days) and Kent (120 days) with recommended seeding rates, namely 650 and 550 thousand units / ha, respectively. The varieties are characterized by significant and stable yields and high quality seed composition.

Organic-mineral fertilizer Vuxal Microplant with a rate of 1,5 l / ha was applied on the appropriate variants of the experiment. This fertilizer is recommended for the foliar feeding of crops grown using intensive technology. The use of Vuxal Microplant guarantees the supply of all trace elements needed by the plant during its active growth. Eliminates acute and prevents hidden micronutrient deficiency, which increases crop productivity. The composition of Vuxal Microplant includes: total nitrogen – 78,0 g / l; water-soluble potassium – 157,0 g / l; water-soluble magnesium – 47,0 g / l; water-soluble sulfur – 202.5 g / l; water soluble boron – 4.7 g / l; copper soluble – 7.9 g / l; water-soluble iron – 15.7 g / l; water-soluble manganese – 23,6 g / l; water-soluble molybdenum – 0.15 g / l; water-soluble zinc – 15.7 g / l.

Research, accounting and observation were conducted in accordance with generally accepted tested and recommended methods in plant growing.

**Outline of the main research material.** According to the results of the studies, it was noted that the indicators of soybean plant productivity and seed quality depended on the factors studied. It is well known that, despite the large number of soybean mineral nutrients, the yield level in production conditions is practically determined by several basic elements. Among the macroelements are, first of all, nitrogen, phosphorus, potassium, and of microelements – zinc, boron, molybdenum, copper, manganese and others.

All mineral nutrients are organically interconnected in the life of the plant and play an important role. Therefore, the soybean fertilization system must be developed according to the needs of soybean plants for nutrients during the growing season.

The scientifically sound fertilizer application system combines basic and row fertilizers and fertilization of cultivated plants during the growing season.

Foliar nutrition is called leaf uptake and absorption by the plant of nutrients, amino acids and growth regulators that the root system does not supply enough. The essence of such nutrition is that readily available nutrients of fertilizers enter the vegetative organs of the plants, quickly penetrate the protective wax barrier - cuticle, epidermis - and enter the cells of the plant. The permeability of epidermal cells of the multilayered cuticle depends on the concentration of the nutrient solution, the phase

of growth and development, the area and nature of the cover of the leaf blade, climatic conditions, the time of feeding, the shape of the nutrient and other factors.

Scientists have noted the feasibility of using foliar fertilizers for growing crops, justifying the fact that during the growing season does not always create optimal conditions of mineral nutrition to form a high level of yield and quality of crop products, this is the tendency of plant growth and development. In addition, the application of foliar fertilizers several times reduces the consumption of fertilizers compared to the amount required to obtain the same effect when applied to the soil. The feasibility of using foliar feeding directly depends on the size of the assimilation surface, as well as the variety of factors studied.

During the conducted researches it was found that indicators of individual productivity of soybean plants, namely number of beans on one plant, number and weight of seeds from a plant and weight of 1000 seeds depended on varietal characteristics of culture and foliar nutrition (Table 1).

*Table 1*

**Individual productivity of soybean plants by variety and foliar nutrition  
(average for 2017-2018)**

Variety	Foliar fertilization (nutrition)	Number of beans, pcs / plant	Quantity of seeds per plant, pcs.	Weight of seeds from a plant, g	Weight 1000 seeds, g
Merlin	without recharge	16,1	30,7	4,5	146,8
	in the budding phase	20,9	40,3	6,2	153,8
	in the green bean formation phase	18,4	36,0	5,4	150,0
	in the budding phase + in the green bean formation phase	22,5	43,3	6,8	157,5
Kent	without recharge	17,0	31,2	4,4	139,7
	in the budding phase	22,1	49,5	7,2	146,2
	in the green bean formation phase	19,5	40,1	5,7	141,1
	in the budding phase + in the green bean formation phase	24,0	62,5	9,3	148,7

*The source is based on our own research findings*

The cultivation of Merlin soybeans, depending on the scheme of foliar application, contributed to the formation of 16,1-22,5 units / plant of beans, with the number of seeds from the plant was 30,7-43,3 units, and their weight – 4,5- 6,8 g.

Traditionally, higher indices of individual productivity were recorded in Kent soybeans, subject to double application of microfertilizers in the budding and green bean phases. The number of beans per plant was 24,0 pcs., the number of seeds per plant – 62,5 pcs., and their weight – 9,3 g.

The cultivation of Kent soybeans without the use of foliar fertilizers reduced the number of beans per plant to 17 units, the number of seeds per plant to 31,2 units, and their weight to 4,4 g.

One indicator of individual productivity of soybean plants is the mass of 1000 seeds. Having carried out the corresponding researches we have found out that it reached the maximum value on variants with carrying out two foliar feeding in the budding and green bean phases. Thus, for the Merlin variety it was 157,5 g versus 146,8 g without the fertilizer, whereas for the Kent variety it was 148,7 g versus 139,7 g, respectively.

Thus, as a result of the conducted researches the positive influence of foliar nutrition on the formation of individual productivity of the plants of soybean varieties studied by us was revealed.

The main indicator that determines the feasibility of the use of certain agrotechnical techniques for the cultivation of soybeans is the yield of seeds, which depends on the set of numerous physiological and biochemical processes of life of the plant organism.

During the researches the positive role of foliar fertilizers of microfertilizers Vuxal Microplant on the yield of soybean seeds was revealed. Thus, on average during the years of research, when growing soybean Merlin variety on the variant without the use of foliar fertilization, the seed yield was 2,34 t / ha (Table 2).

When applying the fertilizer in the budding phase, the yield increased to 2,68 t / ha, which is 0,34 t / ha more than the control variant.

*Table 2*

**Soybean seed yield depending on intensification factors, t / ha  
(average for 2017-2018)**

Foliar fertilization (nutrition)	Variety			
	Merlin		Kent	
	t/ha	± to control	t/ha	± to control
without recharge	2,34	-	2,37	-
in the budding phase	2,68	+ 0,34	2,85	+ 0,48
in the green bean formation phase	2,55	+ 0,21	2,64	+ 0,27
in the budding phase + in the green bean formation phase	2,75	+ 0,41	3,00	+ 0,63

SSD<sub>05</sub> t/ha (2017 yr.): A - 0,085; B - 0,135; AB – 0,163.

SSD<sub>05</sub> t/ha (2017 yr.): A - 0,097; B - 0,077; AB – 0,126.

*The source is based on our own research findings*

The use of fertilizing in the green beans phase contributed to the formation of 2,55 t / ha of seeds, or 0,21 t / ha more control. Formation of the highest indices of seed productivity of soybean Merlin variety was noted in the variant with two-time application of Vuxal Microplant in the budding and green bean phases. The yield was 2.75 t / ha, which is 0.41 t / ha more than the version without fertilizer.

Somewhat higher yields were observed in the cultivation of Kent soybeans. So 2,37 t / ha of seeds were obtained without fertilizing. At the single application of microfertilizers in the budding phase, the yield increased by 0,48 t / ha, which was 2,85 t / ha, compared to the control. In the green bean formation phase, foliar feeding increased productivity by 0,27 t / ha, with a yield of 2,64 t / ha.

Due to its unique chemical composition, soybean seeds are used both for food and forage purposes, as they have no equal, they have equal productivity and quality composition. According to the generalized data, the soy protein and fat content of soybeans is influenced by weather conditions. Increasing the temperature during the period of flowering – ripening contributes to the increase of fat content and reduction of protein. However, the rest of the researchers claim that the increase in protein content in seeds occurs in conditions of insufficient humidity, elevated air temperature during the formation of its yield.

The laboratory researches conducted by us allow confirming that varietal features of culture and carrying out of foliar fertilizations influenced the chemical composition of soybean seeds (Table 3).

Table 3

**Chemical composition of soybean seeds, depending on the variety and foliar nutrition, % (average for 2017-2018)**

Variety	Foliar fertilization (nutrition)	Chemical content,%				
		crude protein	crude fat	crude fiber	crude ash	NFE
Merlin	without recharge	34,83	19,55	11,79	5,39	28,44
	in the budding phase	36,40	18,69	10,86	5,31	28,74
	in the green bean formation phase	35,56	19,12	11,39	5,33	28,60
	in the budding phase + in the green bean formation phase	36,94	18,15	10,46	5,22	29,23
Kent	without recharge	35,94	19,20	11,46	5,44	27,96
	in the budding phase	37,54	18,29	10,96	5,32	27,89
	in the green bean formation phase	36,84	18,77	11,21	5,35	27,83
	in the budding phase + in the green bean formation phase	39,03	17,93	10,72	5,24	27,08

*The source is based on our own research findings*



It was noted that on the variant without root feeding, the chemical composition of Merlin soybean was as follows: crude protein content – 34,83%, crude fat – 19,55%, crude fiber – 11,79%, crude ash – 5,39%, NFE – 28,44%.

Maximum indicators of crude protein content of Merlin soybean seeds were observed when combining nutrition in the budding and green beans phases, whereby crude protein content was 36,40%, crude fat – 18,69%, crude fiber – 10,86%, crude ash – 5,22%, NFE – 29,23%.

In the non-nutrient variant, the content of crude protein in Kent soybeans was 35,94%, crude fat – 19,20%, crude fiber – 11,46%, crude ash – 5,44%, and NFE – 27,96%.

### **Conclusions and prospects for further research.**

The highest yields of Kent soybean were recorded in the double fertilizer application in the budding and green bean phases, which amounted to 3,00 t / ha, with growth up to 0,63 t / ha.

Thus, the positive role of foliar fertilizers and varietal features of soybean in the formation of yield indicators was established.

Repeated use of microfertilizer Vuxal Microplant in the budding and green bean phases in the cultivation of Kent soybean allows obtaining the following indicators of chemical composition of seeds: crude protein content – 39,03%, crude fat – 17,93%, crude fiber – 10,72%, crude ash – 5,24% and NFE – 27,08%.

The feasibility of carrying out foliar feeding can be explained by the timely provision of balanced in composition and concentration of nutrients in the ionic form – the most accessible for absorption by the leaf surface. With balanced nutrition, plants grow normally and withstand weather variability.

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### **АНОТАЦІЯ**

#### **ФОРМУВАННЯ ПРОДУКТИВНОСТІ ФІТОЦЕНОЗІВ СОЇ ТА ЯКОСТІ НАСІННЯ ЗАЛЕЖНО ВІД ФАКТОРІВ ІНТЕНСИФІКАЦІЇ**

Висвітлено результати досліджень впливу позакореневих підживлень на формування продуктивності фітоценозів сортів сої та якісні показники насіння. Формування найвищих показників насінневої продуктивності сої було відмічено на варіанті з дворазовим застосуванням Вуксал Мікроплант у фазах бутонізації та утворення зелених бобів. При цьому урожайність насіння у сорту Мерлін складала 2,75 т/га, а у сорту Кент – 3,00 т/га. Провівши відповідні дослідження, ми виявили, що максимального значення маса 1000 насінин досягала на варіантах з проведенням двох позакореневих підживлень у фази бутонізації та зелених бобів. Так, для сорту Мерлін вона складала 157,5 г проти 146,8 г на варіанті без добрив, тоді як для сорту Кент 148,7 г проти 139,7 г відповідно.

Двократне застосування мікродобрива Вуксал Мікроплант у фазах бутонізації та зелених бобів при вирощуванні досліджуваних сортів сої дозволяє отримати наступні показники хімічного складу насіння: вміст сирого протеїну – 36,94-39,03 %, сирого жиру – 17,93-18,15 %, сирій клітковини – 10,46-10,72 %, сирій золи – 5,22-5,24 % та БЕР – 27,08-29,23 %.

**Ключові слова:** соя, сорт, комплекс мікроелементів, позакореневі підживлення, хімічний склад, якість, продуктивність.

**Табл. 3. Літ. 13.**

## **АННОТАЦИЯ ФОРМИРОВАНИЕ ПРОДУКТИВНОСТИ ФИТОЦЕНОЗОВ СОИ И КАЧЕСТВА СЕМЯН В ЗАВИСИМОСТИ ОТ ФАКТОРОВ ИНТЕНСИФИКАЦИИ**

*Представлены результаты исследований влияния внекорневых подкормок на формирование продуктивности фитоценозов сортов сои и качественные показатели семян. Формирование высоких показателей семенной продуктивности сои было отмечено на варианте с двукратным применением Вуксал Микроплант в фазах бутонизации и образования зеленых бобов. При этом урожайность семян у сорта Мерлин составляла 2,75 т/га, а у сорта Кент - 3,00 т/га.*

*Проведя соответствующие исследования, мы обнаружили, что максимального значения масса 1000 семян достигала на вариантах с проведением двух внекорневых подкормок в фазы бутонизации и зеленых бобов. Так, для сорта Мерлин она составляла 157,5 г против 146,8 г на варианте без удобрений, тогда как для сорта Кент 148,7 г против 139,7 г соответственно.*

*Двукратное применение микроудобрения Вуксал Микроплант в фазах бутонизации и зеленых бобов при выращивании исследуемых сортов сои позволяет получить следующие показатели химического состава семян: содержание сырого протеина - 36,94-39,03%, сырого жира - 17,93-18,15%, сырой клетчатки - 10,46-10,72%, сырой золы - 5,22-5,24% и БЭВ - 27,08-29,23%.*

***Ключевые слова:** соя, сорт, комплекс микроэлементов, внекорневые подкормки, химический состав, качество, продуктивность.*

***Табл. 3. Лит. 13.***

### **Інформація про автора**

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