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FEATURES OF THE APPROACH TO ASSESSMENT OF FROST RESISTANCE OF BREEDING MATERIAL IN THE GENUS LOLIUM L.

Abstract.
The research results are presented to improve the methods of assessment and selection of breeding material of multiflorous and perennial ryegrass in terms of frost resistance. It was found that in the primary stages of breeding (collection and hybrid nurseries), to differentiate a significant number of numbers, it is advisable to use an "optimized approach" for freezing hardened seeds

Keywords: *Lolium multiflorum, Lolium perenne, ryegrass, frost resistance, germinated seeds, method, freezing, hardening, evaluation.*

Lolium multiflorum is characterized by high forage performance among other cereal forage grasses. Perhaps the first after Italy, the Swiss appreciated the Lolium multiflorum. Somewhat later, it began to be used in England, Holland, Denmark, Belgium. We used it both in the mixture of grass and in clean crops.

In monoculture, Lolium multiflorum gives 500-700 centners per hectare during the growing season. Forage mass, or 80-100 kg / ha. dry matter. The high sugar content of 180-220 g / kg of dry matter of the first cut and an average of 120 g / kg from the next slopes provides a high energy intensity of her forage. The carbohydrate-protein ratio of the feed mass (1.5: 1) is optimal and can be consumed in large quantities by all types of ruminants. The green mass, mown at the beginning of earing, has a digestibility of up to 80% [1]. The Lolium multiflorum is not whimsical to soils, but shows the best performance on well-moistened light loams. The plant also grows well on mineralized peatlands. It is usually insensitive to the reaction of the soil solution [12, 13]. The most favorable conditions for the growth and development of multiflorous ryegrass are humid summers and mild winters, it does not tolerate frost, prolonged snow cover, and is also sensitive to severe frosts. Therefore, the area of its distribution is limited. According to many researchers, in particular [4, 7], the frost resistance of multiflorous ryegrass is characterized as rather weak.

Varieties of multiflorous ryegrass used in Ukraine are characterized by an unstable harvest over the years due to low drought resistance, disease and lodging. However, even more significant are the yield losses of this crop due to unfavorable wintering conditions. The frost resistance potential of multiflorous ryegrass is still significantly lower compared to other cereal grasses. Therefore, it is necessary to create varieties of multiflower ryegrass, which, along with a complex of the most important valuable economic traits (productivity, drought resistance, lodging resistance and disease resistance), will also have maximum frost and winter hardiness.

It is known that the most reliable methods for assessing any trait are field However, it is not possible to single out the most frost-hardy, winter-hardy forms in natural conditions every year. To date, a number of approaches have been developed to determine the frost resistance of winter grain crops [3, 5, 6 ,9]. However, most of them have both their advantages and disadvantages: laboriousness and injury to the root system of plants during sampling in the field, inconsistency of the obtained data on the maximum frost resistance of the genotype, etc. In addition, the temperature and exposure modes of most methods of artificial freezing worked out for winter wheat, therefore, for differentiation, it is necessary to improve it specifically for multiflowered and perennial ryegrass, as a less frost-resistant crop. Consequently, it became necessary to develop new approaches to establishing the frost resistance of multiflorous ryegrass, which increased the accuracy of the assessment of this trait, were devoid of many of the disadvantages of previous methods and provided the selection of frost-resistant genotypes for further use in the breeding process.

The purpose of the research is to improve the culture of multiflorous ryegrass and perennial approaches to the assessment and selection of frost-resistant breeding material at different stages of the breeding process.

Materials and research methods.

The studies were carried out in 2010-2016. In the field and laboratory conditions in the department of selection and seed production of forage crops of the NSC "Institute of Agriculture of the NAAS" according to generally accepted methods [2, 8, 10]. Since the task of the research was to develop practical approaches, temperature and exposure modes for determining frost resistance, they are considered in the research results.

Research results.

The primary direction of research was the development of a method that would provide an opportunity to conduct a preliminary assessment of a significant number of numbers and select frost-resistant genotypes at different stages of the breeding process (collection and hybrid nurseries). For this, the method for assessing winter wheat by frost resistance by freezing hardened germinated seeds was taken as a basis for the MIP [11]. Conducted by us in 2010-2016. Studies have shown that the temperature and exposure conditions of hardening and freezing of germinated seeds, which are used for winter wheat, do not correspond to the biology of multiflorous and perennial ryegrass. Therefore, it was necessary to work out the named elements precisely for the latter. For this, 44 collection samples of multiflorous ryegrass were evaluated, as well as 4 selection numbers - 2005 / 22-12; 2005 / 41-5; 2006 / 4-15; 2006 / 22-32 Ukrainian selection, 53 collection samples of perennial ryegrass; 8 varieties of Ukrainian selection - Orion, Leta, Andriana 80, Drohobychsky 1, Drohobychsky 2, Drohobychsky 16 Horizon, Ruslana; 6 wild-growing forms that were found in nature - 01/2006; 02/2006; 03/2006; 04/2006; 05/2006; 06/2006., Hybrids of different generations (F2 - F4) of multiflorous ryegrass.

Improvement of our method in assessing the frost resistance of multiflorous and perennial ryegrass in germinated hardened seeds includes the following stages: I - seed germination (one day at a temperature of + 18, 20 °C); II - hardening of germinated seeds: temperature decrease every 24 hours by 1 °C from 0 to minus 5 °C (five days) and hardening at the same temperature (five days) III - freezing at temperatures of minus 8, 10 and 12 °C with lowering the temperature by 1 °C every 6:00 (freezing exposure - 24 hours). At a temperature of minus 10 °C, it is possible to immediately discard low frost-resistant material. IV - freezing at temperatures of minus 14, 16 and 18 °C with a decrease in temperature by 1 °C every 6:00 (freezing exposure - 24 hours). Survival at a temperature of minus 14 °C indicates an above average level of frost resistance of ryegrass, and they can be compared and differentiated according to this feature. Freezing temperature minus 16 °C helps to identify forms with frost resistance, close to the maximum level for today for multiflorous ryegrass. Freezing at a temperature of minus 18 °C and below under the given conditions of quenching and dynamics of temperature decrease leads to almost 100% loss of samples. Plants obtained from hardened germinated seeds that survived after freezing are counted 7-10 days after gradual defrosting of the samples. Table 1 shows the results of freezing by this method of the output forms of ryegrass of various origins. In order to test the possibility of using this approach for evaluating and selecting from hybrid material, a series of freezing of hybrids of the second and subsequent hybrid generations of various crossing combinations was carried out. The hybrids were frozen at temperatures of minus 14, 16 and 18 °C.

At the initial stage of the breeding process of multiflorous ryegrass aimed at increasing winter and frost resistance, one of the important breeding methods is the selection of initial forms, preliminary assessment, with increased plant resistance to low temperatures. The best numbers of multi-flowered and perennial ryegrass, their dynamics of resistance to low temperatures, as well as critical temperatures are presented in Table 1, 2.

Multiflorous ryegrass is represented by only one breeding number –2005 / 41- 5, the plants of which, as expected, showed low resistance to low temperatures. Frost resistance of plants rapidly decreased at minimum temperatures, and the critical temperature was on the verge of minus 8 °C.

In these studies, perennial ryegrass was represented by collection samples, varieties, as well as a wild form selected in natural conditions

Table 1

Assessment of frost resistance of the output forms of multiflorous and perennial ryegrass in laboratory

Origin of numbers	Freezing temperature					
	−8		−10		−12	
	The number of germinated seeds that remained after freezing					
	шт.	%	шт.	%	шт.	%
Lolium multiflorum, breeding number						
2005/41-5	75	25	−	−	−	−
Lolium perenne, medium-sized collectible specimens						
England № 40260	293	98	290	97	290	97
Denmark № 40268	255	85	180	60	85	28
Lolium perenne, varieties of Ukrainian selection						
from. Leta	285	95	210	70	135	45
from. Andriana 80	294	98	288	96	285	95
from. Drohobytsky 1	290	97	160	53	84	28
from. Drohobytsky 2	291	97	200	67	125	42
from. Drohobytsky 16	290	97	220	73	155	52
Lolium perenne, wild, stunted form						
2006/1	294	98	290	97	288	96

Table 2

Assessment of frost resistance of the output forms of multiflorous and perennial ryegrass in laboratory

Origin of numbers	Freezing temperature					
	−14		−16		−18	
	The number of germinated seeds that remained after freezing					
	шт.	%	шт.	%	шт.	%
Lolium multiflorum, breeding number						
2005/41-5	−	−	−	−	−	−
Lolium perenne, medium-sized collectible specimens						
England № 40260	210	70	150	50	32	11
Denmark № 40268	−	−	−	−	−	−
Lolium perenne, varieties of Ukrainian selection						
from. Leta	−	−	−	−	−	−
from. Andriana 80	265	88	240	80	160	53
from. Drohobytsky 1	−	−	−	−	−	−
from. Drohobytsky 2	−	−	−	−	−	−
from. Drohobytsky 16	290	97	220	73	155	52
Lolium perenne, wild, stunted form						
2006/1	294	98	290	97	288	96

freezing conditions, the two collection medium-sized samples that were studied showed themselves in different ways. Sample from Denmark No. 40268 turned out to be of low stability, namely, the critical temperature did not exceed minus 12°C; increased plant resistance to low temperatures - 32 plants survived at minus 18°C, or 11%, characterized the second sample from England No. 40260.

Among the varieties of Ukrainian selection, 4 varieties - Leta, Drohobychsky 1, Drohobychsky 2 and Drohobychsky 16 were characterized by low resistance, and the critical temperature of the first three did not fall below minus 14°C. Only the Andriana 80 variety proved to be resistant to low temperatures - 160 plants, or 53%, survived at minus 18°C. This is one of the highest rates of plant resistance to low temperatures. According to the results of the studies, the wild-growing undersized form №. 1 - 01/2006 was characterized by increased resistance to low temperatures - at minus 18°C, 48 plants survived, or 16%.

Based on the results of the step-by-step assessment and selection of the output forms, the following numbers were identified: among the numbers of multiflorous ryegrass, selection number 2005 / 41-5; Among the numbers of perennial ryegrass, the following is distinguished: a collection medium-sized sample from England No. 40260, a Ukrainian variety - Andriana 80, a wild-growing undersized form 01/2006.

In order to test the possibility of using this method for evaluating and selecting from a hybrid material, a number of freezing of hybrids of the second and subsequent hybrid generations of various crossing combinations were carried out are presented in Table 3.

Table 3

Evaluation of hybrid populations of ryegrass when frozen in hardened germinated seeds

Hybrid population	Number of living plants		
	−14	−16	−18
№1 Lolium multiflorum 2005 / 41-5 / Lolium perenne wild form 01/2006			
F_2	8	4	2
F_3	12	6	3
F_4	17	10	5
№2 Lolium multiflorum 2005 / 41-5 / collection sample 40260			
F_2	2	2	−
F_3	5	2	−
F_4	8	3	−
№3 Lolium multiflorum 2005 / 41-5 / Andriana 80			
F_2	17	10	5
F_3	28	14	8
F_4	36	28	22
♀ Lolium multiflorum	−	−	−
♂ Lolium perenne	88	75	58

The hybrids were frozen at temperatures of minus 14, 16 and 18 °C. It should also be noted that at at a freezing temperature of minus 18 °C, hybrid combinations with survival in the range of 2-58 plants (Table 3) were revealed, which are of practical interest for further breeding work. We tested this approach to the possibility of selection and genetic evaluation of hybrids by frost resistance in interspecific hybridization. For this purpose, collection specimens and varieties, which were preliminarily evaluated in terms of frost resistance, were involved in the crosses.

In order to obtain seed from hybrid populations, it is advisable to freeze hardened germinated seeds in autumn (approximately in the 2nd and 3rd decades of September), and after counting live plants, plant them in field conditions, in which they will undergo vernalization and further vegetation without additional costs

Thus, the improved method of freezing hardened germinated seeds makes it possible to evaluate, differentiate and select breeding material for frost resistance. The advantages of this approach are relatively low energy consumption, quick assessment of a significant amount of breeding material, and, if necessary, selections.

Conclusions.

For the first time in the conditions of the Forest-Steppe of Ukraine, as a result of the research carried out, the method of approach to determine the frost resistance of multiflorous and perennial ryegrass in different links of the breeding process was improved. The temperature and exposure modes of artificial freezing have been worked out, contributing to the differentiation of ryegrass breeding material by frost resistance in germinated seeds. In the primary stages of selection (collection and hybrid nurseries), to differentiate a significant number of numbers, it is advisable to use this method of freezing in hardened germinated seeds.

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ТЕХНОЛОГІЧНІ ПРИЙОМИ ПІДВИЩЕННЯ ПРОДУКТИВНОСТІ БДЖОЛИНИХ СІМЕЙ

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TECHNOLOGICAL TECHNIQUES TO INCREASE THE PRODUCTIVITY OF BEE FAMILIES

Анотація.

Узагальнено результати досліджень науковців щодо використання технологічних прийомів підвищення продуктивності бджолиних сімей. Відзначено залежність продуктивності бджолиних сімей від сили сім'ї, вікового складу, використання молодих високопродуктивних маток, забезпеченості сімей впродовж року доброякісним кормом, особливо в ранньовесняний та осінній періоди, застосування комплексних підгодівель, підтримання оптимального мікроклімату бджолиного гнізда, покращення кормової бази, впровадження раціональних способів попередження та боротьби з хворобами бджіл.

Abstract.

The results of research of scientists on the use of technological methods to increase the productivity of bee colonies are summarized. The dependence of productivity of bee colonies on family strength, age composition, use of young highly productive queens, provision of families with good quality food during the year, especially in early spring and autumn, application of complex fertilizers, maintenance of optimal microclimate of bee colony, improvement of feed prevention and control of bee diseases.

Ключові слова: *бджоли, продуктивність, сила сім'ї, бджолина матка, медозбір, кормова база.*
Keywords: *bees, productivity, family strength, queen bee, honey collection, fodder base.*

Introduction.

Beekeeping is an important branch of agricultural production, which is engaged in breeding bees to obtain bee products. It has long been one of the favorite crafts of our people, which provides valuable, nutritious and medicinal products, indispensable raw materials for industry.

However, the importance of beekeeping is not limited to production and profit from sales. Ukraine is a country of intensive agriculture, in which crops need pollination. Due to the pollination of entomophytic plants, honey bees have become an important element in maintaining diverse relationships in the animal and plant world. They account for up to 80-95% of pollination work on entomophytic crops, which allows to significantly increase the yield of orchards, field crops, improve seed quality and fruit taste. In areas without bees, 30 to 50% or more of the possible harvest is not selected, and the reproductive process on natural lands is disrupted.

The importance of bees as a living indicator of the environment is growing. They represent a "unique ecological link" in the system that ensures the stability and conservation of wildlife and are directly involved in maintaining the ecological balance on earth [30, 31, 33].

An integral part of the responsibilities of human activity is to provide the conditions necessary for the reproduction, maintenance and preservation of bees.

To address the issue of providing the population with bee products, scientists are constantly working to improve technological methods to increase the productivity of bee colonies.

Analysis of recent research.

Beekeeping, as an industry, has great prospects. The increase in honey production should be due to the use of new techniques and methods of keeping and using bees, which will increase the yield of marketable products. One of the most important prerequisites is to improve the efficiency of beekeeping, which depends on a complex of many factors.

Factors influencing the productivity and life expectancy of the bee family are divided into external and internal. The external ones include: climatic and weather conditions, flora and fauna, fodder base, pathogens, enemies and pests of bees, human economic activity (use of pesticides, herbicides). Most of these factors are almost independent of humans, but they are of great importance for the life and productivity of bee colonies.

The internal factors include those factors that are formed inside the nest as a result of the life of the bee family. They are important for productivity, can vary by person and are highly dependent on genotype.

From the group of internal factors of the bee family, the strength of the family is important. The more bees in a family, the stronger it is and the more products it can produce. During the active season, a bee family weighing 1 kg produces 7 kg of honey, 2 kg - 20 kg of honey, 4 kg - 49 kg of honey.

The strength of the bee colony is also important for pollination of agricultural plants. Young bees raised in strong families have well-developed organs for collecting and processing nectar and pollen, and young drones and queens have better-developed reproductive organs.

Of the internal factors, the main role belongs to the uterus, its phenotype and genotype. To create and keep families strong, it is necessary to use full-fledged breeding queens of breeding lines. The quantity and quality of the brood grown depends on the age, physiological condition of the uterus, the ability to lay eggs and the presence of a bribe. These factors affect the intensity of egg production of the uterus, which depends on the growth rate of the bee family. The larger the uterus, the better developed the ovaries, they have more fallopian tubes, the higher its fertility. The strength and productivity of bee colonies is directly dependent on the quality of queen bees and their ability to lay large numbers of eggs. The strength of the family affects the quality of bees, their composition, reflexes and the quality of the queens, and the number of bees depends on the quality of the uterus, the age of the family and the quality of the bees themselves [22, 23, 30].

Analysis of research results.

To increase the number of young bees in the fall before winter and spring - to use the main honey harvest, the uterus must lay a large number of eggs. Research Zotko M.O. [9] the influence of age and weight of queens on the intensity of development and productivity of bee colonies was established. According to the results of research, it is established that the uteruses of the Ukrainian steppe breed are characterized by high reproductive capacity and can lay up to 1101-2007 pieces / day of eggs during the period of maximum development of bee colonies. Uteri weighing 260 mg or more for two years tended to have better reproductive activity at the beginning and end of the season (13-31%).

In order to increase the number of bees and strengthen the bee colony before the main honey harvest, the uterine egg-laying is required. To do this, use different fertilizers. Providing the bee family with nutritious carbohydrate and protein feed all year round is the basis of high productivity. Bees raised in such conditions, resistant to disease, have better physical development.

In order to identify the effect of biologically active substances on the egg production of queen bees Vedmid I. V., Sheremeta V. I., Kaplunenko V. H. [5] conducted an experiment in which control families were fed sugar syrup, experimental - sugar syrup with the addition various biologically active substances and drugs. The first experimental group used top dressing "Glutam 2BM", the second - cobalt chloride (8 mg per 1 liter of syrup), the third - cobalt aquachelate (8 mg Co per 1 liter of syrup) and the fourth - top dressing "Nanstimulin", the active substance which is a mixture of monosodium glutamate and cobalt aquachelate. Feeding was carried out every other day at 200 g of syrup per bee colony. Studies have shown that feeding bee colonies sugar syrup with biologically active substances contributes to the intensification of egg production. The queen bees had the highest egg production, whose families were fed pure Glutam 2BM and Nanostimulin. It was found that in the case of feeding families of pure sugar syrup and with the addition of biologically active substances, the uterus shows significant individual characteristics of egg production, and insufficient pollen in the bee family probably reduces the effectiveness of stimulating effect on egg production of the uterus. sugar syrup, and with the addition of biologically active substances.

Honey bees have developed an instinct for economical consumption of food supplies. In the spring, bees lack their own honey, and some of its varieties are completely candied by spring. Insects cannot feed properly, so the issue of proper food supply is important.

According to the results of research Mishchenko O.A., Lytvynenko O.M., Afara K.D., Kryvoruchko D.I. [17] determined the effectiveness of carbohydrate-protein feeding, namely, the influence of protein feed (bee pollination) on the development of bee colonies and physiological parameters of bees in the absence or low level of its receipt. The influence of the use of carbohydrate and protein fertilization on the spring growth of bee colonies and their preparation for the effective use of honey collection has been studied, the expediency of its use in order to improve the physiological parameters of bees has been shown. Studies have confirmed the feasibility of carbohydrate-protein fertilizers in the form of a paste (candy), which includes: powdered sugar - 500 g, liquid honey - 125 g, bee pollen - 155 g, water - 30 ml. It was found that in all periods of accounting for bees, the families of the experimental group, fed in the form of candy with bee pollination, grew more brood than control, which on average grew 22.3% less brood.

The mass of larvae is one of the indicators of normal life of bees. Studies to determine the effect of carbohydrate and protein feed on live weight of 6-day-old larvae and newborn bees show that in the families of the experimental group live weight of 6-day-old larvae averaged 154.96 ± 0.60 mg, which is 8.61 mg more than in the control group (146.35 ± 0.87 mg); live weight of newborn bees of the experimental group receiving carbohydrate-protein feeding was 93.02 ± 0.59 mg, which is 2.57 mg more than the weight of bees of the control group, whose live weight averaged 90.45 ± 0.43 mg .

Carbohydrate-protein feeding affects the growth of bee colonies and promotes the growth of a strong family before the honey harvest, the production of larger larvae, which, in turn, allows you to get more complete bees.

Protein-carbohydrate feeding contributed to the increase of honey productivity of bee colonies at the honey harvest, which averaged 19.7 kg of marketable honey against 14.1 kg in the control group, which is 5.6 kg less. The introduction of bee pollen into the candida during the spring development of bees contributed to more intensive uterine egg laying - 11.3% more than in the control. There is also a positive effect of carbohydrate and protein nutrition on the reproductive function of the uterus.

The proposed method of feeding is simple and effective and can be recommended to beekeepers to increase the honey productivity of bee colonies and increase the intensity of egg production of queen bees. However, bee pollination can be used for feeding only in the absence of infectious and invasive diseases of bees in apiaries. It is also worth noting that bee colonies, regularly receiving carbohydrate and protein feed throughout the spring and summer, did not stop developing and no family went into a swarm state.

Scientists and practitioners have been researching the methods and means of feeding bees for many years. Complex stimulant preparations, which contain protein, mineral and vitamin components, stimulate the development of bee colonies and increase their productivity. The effect of various additives on honey bees depends on their composition. Razanova O.P. and Holubenko T.L. [27] studied the type of effect of stimulant supplements, which include vitamins, proteins and minerals, studied the productivity of queen bees, honey production and perga in bee colonies for stimulant feeding. For this purpose, complex additives were used - stimovit and antivir, which are designed to feed bee colonies for therapeutic purposes and to stimulate growth and productivity. They consist of a mixture of pollen, garlic extract and glucose.

Stimulating feeding of bees in the spring helped to increase the average daily egg production of queens in bee colonies, which received as a supplement stimulating drugs antivirus and stimovit, by 20.9 and 26.9%, respectively. The medical productivity of families in the spring was higher by 26.0% in the second group for the introduction of antivirus and by 30.1% - in the third group due to stimovit. At the end of the active season, this figure increased in the respective groups by 8.4 and 10.1% compared with the control, which was given as a stimulating feed pure sugar syrup. At the end of the spring period, bees in the experimental groups harvested more perga, respectively, by 21.8 and 29.1%. The best indicators were found in the group of bee families, which were stimulated with stimovit.

The age of the bees has an important influence on the nature of development, productivity and survival of the family. It is important that the age groups of bees are naturally formed in the family at all periods of its life. Therefore, beekeepers need to regulate the age of the family so that in the spring there is an intensive increase in nursing bees, the main bribe has accumulated a lot of flying bees, and before winter to have a sufficient number of physiologically young bees in the nest. Instincts and reflexes that determine the behavior of individuals and the family as a whole are important for the life and productivity of the bee family. Manifestation of the swarming instinct reduces the honey harvest and requires large unproductive labor costs, so the prevention of swarming - is one of the important tasks of managing the life of the family and increase the productivity of the apiary.

Kovalskyi Yu. V., Kovalska L. M. [10] investigated the influence of the number of open brood on the development of the swarm process and the age of queens on the intensity of swarming of honey bees. In families in which the number of open brood ranged from 13 to 15 thousand cells, the lowest breeding rate was found. The swarming instinct does not manifest itself if there are 2-3 young larvae per bee colony in the family. The emergence of the swarming process led to a decrease in the number of individuals at the larval stage, regardless of the nature of the bribe. The presence of one-year-old queens in nests increased the strength of families.

The decisive factor in the maximum production of honey along with the development of families is the nomadism during the spring-summer season, which significantly affects the level of food supply for bees. After all, in the absence of honey collection, the uterus stops laying eggs, bees do not secrete wax and do not build honeycombs. Due to the nomadism of the apiary, honey resources are more widely used, the production of beekeeping products increases accordingly, and the pollination of entomophilous agricultural plants is ensured.

Various species of honey plants are widespread on the territory of Ukraine. Hrechka H. M. [7] the honey-harvesting conditions of the Forest-Steppe of Ukraine were studied, and the possibilities of their use by bee families of the Ukrainian steppe breed were determined. The apiary was taken to the forest in the spring, and to the entomophilous crops in the summer. Honey plants of gardens, meadows, forests, roadside plantations, fields provided bees with supporting and basic honey harvests. The main agricultural honeysuckle are sunflower, sainfoin, buckwheat. Entomophilous crops are the basis of the forage base, but forest honeybees should also be used. Early spring forest honeybees provide bees with pollen - a necessary source of vitamins, proteins and fats. You can get a good honey harvest from linden and acacia plantations. The source of supporting honey is summer and autumn honey plants.

Extracting nectar and pollen from flowers, bees do important work on their pollination, significantly increasing crop yields. Bees intensify their work in the presence of a stronger honey plant. The flow of nectar into the bee colony stimulates the uterus to increase egg production, and the growing brood stimulates the flight of bees in search of food. The productivity of the bee family increases accordingly.

The growth of the family, its strength and productivity also depend on the quality of cells and their number. Eggs are more willing to lay eggs on light honeycombs, so they should be used more in the spring. A strong family needs additional honeycombs to store nectar and honey during the honey harvest, as their lack will reduce the strength and development of bee colonies, which will negatively affect their productivity.

In order for the bees to be able to place all the brood and feed stocks brought during the main honey harvest in the middle of the season, they must be kept in hives of a large enough volume. This is one of the conditions for building strong bee colonies.

Lack of fodder and its low quality are the main cause of winter losses. Long-term observations have shown that bee families that consume more food in the winter will produce significantly more honey next season than families that use less food, the uterus will lay more eggs, and the family will grow rapidly in the spring. These data indicate that bee families need to be fully provided with food for the winter period and bring it to the established norms: at least 2 kg per street of bees.

Also an important condition for intensive family growth is to ensure the optimal microclimate of bee housing. In the nest of bees it is necessary to maintain the optimal temperature (34-35 ºC) for the normal development of the brood, to support which the bees spend a lot of energy and food. To do this, if necessary, it is necessary to insulate the bee nest, reduce flight holes, limit air exchange. In summer, to reduce the cost of lowering the temperature, the hives are protected from excessive overheating.

Buhera S.I., Mishchenko O.A. [4] experimentally proven variant of insulation and sealing with polyethylene terephthalate (PET) transparent film of the upper part of the bee nest. The object of the study were Carpathian bees in one of the apiaries in the Kyiv region. With the traditional method of cushion insulation, there was a loss of heat produced by bees, and the weakening of bee colonies. During the use of the film, no heat loss actually occurred, and the condensate formed by bee respiration and chemical conversion of honey on the inside of the film remained in the nest. It was used in the form of water droplets by worker bees for internal needs. Breeding did not stop in families, so the need for water increased to 200-250 g per day. Bees used less energy to heat the nest, which directly affected their life expectancy and savings in food supplies. It is also noted that the bees in the experimental group produced gross honey by 25.5 kg, or 67.3% more than the control. The use of polyethylene terephthalate (PET) transparent film in the spring not only extended the lifespan of bees after hibernation, reduced their loss, but also helped to increase them before preparing for honey collection.

Prolonged rains reduce the flight activity of bees, adversely affect the secretion of nectar, reduce its sugar content. Razanova O.P., Lotka H.I. [29] the honey-collecting conditions from white acacia and the possibility of their use in the conditions of Vinnytsia region were investigated. According to research, the nectar productivity of acacia depends on weather conditions. The flowering period of acacia for the period of research fell on the end of May-beginning of June. White acacia produces nectar during the day and the bee family of medium-strength control hive produced from 2350 to 8400 g of nectar per day. One flower of white acacia released up to 5.3 mg of nectar under optimal weather conditions. At the beginning of the flowering period was 3.2 mg of nectar, on the third day - 5.3 mg, 4-9 days - the nectar content in the flower of white acacia was at the level of 4-4.2 mg, and from day 10 the nectar content decreased to 1.2 mg. Adverse weather conditions during the flowering of white acacia reduced the flight activity of bees. High wind speeds also affected their flight collection activities, and due to rainy and cloudy days, bee families did not collect a significant amount of nectar. Summarizing the results of the research, it can be stated that the best honey harvest is facilitated by warm, moderately humid, windless weather, during which the honey productivity of bee families from white acacia averaged 9.7 kg per family.

Bee diseases negatively affect the productivity of families, as well as dramatically increase costs. In bee colonies affected by infectious and invasive diseases, there is a significant departure of adult bees, the number of brood is reduced. In case of untimely measures for their recovery, bee families weaken and may even die. Issues of prevention and control of diseases should be under the constant control of the beekeeper, because in the apiaries there is a mixed form of co-occurring diseases, in particular, varroasis, rot, ascospherosis, and sometimes nosematosis. Productivity of nosematous bee families decreases to 60-70%, putrefactive - to 25-75%, varroat - to 50-80%.

Maslii I.H., Niemkova S.M., Stupak L.P., Desiatnykova O.V. [15] conducted epidemiological studies on bee diseases and monitoring data in 17 regions of Ukraine. Bacterial, fungal, viral infections and infestations cause great damage to beekeeping, leading to the death of adults, larvae and pupae. This reduces the development of bee colonies and adversely affects honey and pollination productivity. Human intervention also contributes to the spread of bee diseases: nomadic apiaries, exchange of breeding material, non-compliance with the recommendations for diagnostic tests for pathogens and veterinary measures in apiaries. Also in the conditions of reduction of the areas of crops of entomophilous cultures the high concentration of bees is registered. This contributes to the creation of favorable conditions for the development of various pathogenic microorganisms and parasites, their transmission from sick to healthy individuals, spreading throughout Ukraine. Reducing the risk of disease spread is possible with timely diagnosis, clinical examinations of apiaries, laboratory tests, organization of measures for the recovery of bee colonies, disease prevention.

Significant damage to beekeeping is caused by poisoning of bees with chemicals - pesticides and herbicides, due to the widespread use of pesticides in agriculture. In Ukraine in 2018 due to poor quality pesticides and lack of information on the schedules of field cultivation killed about 45 thousand bee families.

Crop production is the main source of honey and an important factor in improving the fodder base, which due to climate change is unevenly distributed by honey harvest according to the seasons. The purpose of research Kucheriavyi V.P., Razanova O.P., Razanov O.S. [14] was the determination of nectar productivity and sugar content in the nectar of a rare honey plant species - roundhead. The plant was sown on infertile soils in the Vinnytsia region. Round-headed golovaten is unpretentious, resistant to adverse conditions and secretes nectar even in dry weather. Flowering of honeydew in the year of research lasted 35 days and took place in the hot conditions of 2017. The following year, the nectar productivity of the plant increased to 591.1 kg / ha, or 51.4% compared to last year. The sugar content in the nectar was 1.19-1.27 mg. The flight activity of bees during the flowering of round-headed beetles was 197 pieces in 3 minutes. Roundhead has a high sugar content of nectar. The sugar content in the nectar of one flower was 1.27 ± 0.0018 mg in 2017, which is 6.7% more than last year. In the second year, nectar productivity increased to 591.1 kg / ha, or 51.4%. Despite the infertile soil and hot conditions for the growing season, the medical productivity of round-headed beetles was high.

Conclusions.

The productivity of bee colonies depends on the improvement of technological methods: application of advanced beekeeping methods, improvement of pollination qualities of bees, improvement of queen production, improvement and expansion of fodder base resources, preservation of bee colonies in winter, stimulation of uterine egg production with diseases, conducting systematic surveys of bee colonies.

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ЕФЕКТИВНІСТЬ ЗАСТОСУВАННЯ ПРЕПАРАТІВ БАКТЕРІЙНОГО ПОХОДЖЕННЯ ПІД ЧАС ВИРОЩУВАННЯ КАПУСТИ БРЮССЕЛЬСЬКОЇ В УМОВАХ ПРАВОБЕРЕЖНОГО ЛІСОСТЕПУ УКРАЇНИ

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EFFICACY OF APPLICATION OF PREPARATIONS OF BACTERIAL ORIGIN DURING THE GROWING OF BRUSSELS CABBAGE IN THE CONDITIONS OF RIGHT-RIVER FOREST STEPPE

Анотація.

Проблема вирощування високоякісної сільськогосподарської продукції та сировини – надзвичайно гостра для України, оскільки в останні десятиріччя площа деградованих і малородючих ґрунтів постійно зростає і станом на 2019 рік досягла 15млн. га. Одним із напрямів її розв'язання є розвиток органічного виробництва сільськогосподарської продукції як сучасної системи організації сільського господарства, що дає змогу вирощувати високоякісну й безпечну продукцію та мінімізувати негативний вплив агротехнологій на навколишнє природне середовище.

Тривалий час капуста брюссельська вважалась екзотикою на українському ринку. На теперішній час все більше виробників у пошуку нових ринків професійно займаються її вирощуванням. Однак через порівняно невелику місткість ринку вирощування капусти брюссельської не гарантувало стабільних фінансових результатів. Тому частка цієї культури у структурі площ фермерів овочівників залишалася невеликою.

Abstract.

The problem of growing high-quality agricultural products and raw materials - extremely acute for Ukraine, since in recent years decades, the area of degraded and infertile soils is constantly and as of 2019 reached 15 million hectares. One of the directions of its solution is the development of organic agricultural production as modern agricultural organization system, which allows grow high-quality and safe products and minimize negative the impact of agricultural technology on the environment.

For a long time, brussels sprouts were considered exotic in the ukrainian market. Currently, more and more manufacturers are looking for new markets to professionally grow it. However, due to the relatively small market capacity for growing brussels sprouts, it did not guarantee stable financial results. Therefore, the share of this culture in the structure of the areas of farmers 'chambers remained small.

Ключові слова: *капуста брюссельська, органічна технологія, біопрепарати, вітаміни.*
Keywords: *brussels sprouts, organic technology, biological products, vitamins.*

Вступ. Аналіз літературних джерел і практичний досвід свідчать про зростання зацікавленості населення в розширенні не лише традиційного сортименту овочевих культур, а й нових видів, які можна використовувати в овочівництві. Людина освоїла надзвичайно малу кількість видового розмаїття рослинного світу, яка не перевищує 0,2–0,3% [4,6].

Капусту брюссельську було виведено лише на початку XIX ст. з листової, і нині вона є самостійним видом. Вона поширена у багатьох країнах Західної Європи, особливо в Англії, Бельгії, Нідерландах, Німеччині, Данії. В Україні ця капуста з'явилася в середині XIX століття. Сьогодні овочівники займаються її виробництвом у районах із помірними літніми температурами й тривалою теплою осінню.

Капуста брюссельська – дворічна рослина. У перший рік життя утворює стебло висотою до 60 см і більше, циліндричної форми, тонке, з рідкими довгочеренковими листками зеленого або сірозеленого забарвлення. У пазухах листків із бруньок утворюються дрібні, 1–5 см в діаметрі, округлі або овальні стеблеві бруньки (качанчики), схожі за будовою на головки капусти білоголової. Кількість качанчиків на рослині може досягати до 90 і більше. З настанням фази господарської придатності качанчики щільнішають, закриваються, набувають легкого блиску і блідо-зеленого кольору. Качанчики нижньої частини стебла випереджають за швидкістю росту і вступанням у фазу господарської придатності качанчики середнього і верхнього ярусів, а тому завдяки вибірковому збиранню достиглих качанчиків одержують найвищі врожаї. Прищеплення брюссельської капусти (видаляється верхівкова брунька, яка не утворює качанчика) призводить до більш одночасного достигання качанчиків і дозволяє проводити все збирання за один прийом, що треба враховувати торговельним працівникам.

Капуста брюссельська має широке розповсюдження у північнозахідних європейських країнах: Великобританії, Нідерландах і Франції. Завдяки високій морозостійкості рослин, погодні умови в цих країнах дозволяють проводити збирання врожаю цієї капусти впродовж усієї зими. В Україні ж з цієї причини капусту брюссельську збирають останньою. Для свіжого споживання її збирають багаторазово вручну, починаючи з нижньої частини стебла, потім із середньої та верхньої. З метою постачання великих партій широко практикують комбайнове збирання. Показники якості капусти брюссельської для свіжого споживання в Україні висвітлені у стандартах ДСТУ 1915-91, ДСТУ 1916-91. У країнах ЄС використовують UNECE STANDARD FFV-08 Brussels sprouts [1,2,4].

Мета статті: вивчення ефективності застосування препаратів біологічного походження при вирощуванні капусти брюссельської в умовах Правобережного Лісостепу України.

Умови та методика досліджень. Дослідження по вирощуванню капусти брюссельської проводилися на дослідних ділянках Вінницького національного аграрного університету впродовж 2018-2020 року.

Вивчення ефективності застосування біопрепаратів проводилося на групі ранньостиглих гібридів - Франклін F_1 та Діамант F_1, строки сівби насіння - 10 квітня.

Повторність дослідів чотириразова, схема садіння рослин 0,7 х 0,5 м, площа облікової ділянки 21 м^2, попередник – перець болгарсьський [3].

Препарати, які використовували у дослідженнях: Азотофіт, Міко-Хелп

Фітоцид-Р , ФітоХелп та Бітоксибацилін – БТУ.

Виклад основного матеріалу.

Опис препаратів, які використовували в дослідженнях:

Азотофіт - універсальний біопрепарат для покращення родючості ґрунту і живлення рослин. Діючою речовиною є клітини природної азотфіксуючою бактерії *Azotobacter chroococcum.*

Міко-Хелп - багатофункціональний, багатокомпонентний мікробний препарат , особливо ефективний при кореневій гнилі.

Фітоцид-Р – біопрепарат з фунгіцидною дією для захисту рослин від хвороб.

ФітоХелп - біопрепарат із антимікробною та ростстимулюючою дією, особливо ефективний проти бактеріозів.

Бітоксибацилін - БТУ - біоінсектицид для захисту рослин від комах-шкідників, їхніх личинок та кліщів [5].

Таблиця 1

Біометричні показники гібридів капусти брюссельської залежно від використання біопрепаратів у 2018-2020 рр.

Гібрид	Біопрепарат	Кількість листків на рослині, шт.	Висота рослини, см.	Кількість головок на рослині шт.	Маса однієї головки, г
Франклін F_1	Без застосування (контроль)	45,9±2,2	68,8±14,5	18,6±4,4	9,1±0,7
	Азотофіт	44,7±5,5	75,0±32,9	21,8±3,3	9,8±1,1
	Бітоксибацилін-БТУ	44,5±4,6	76,7±28,2	21,8±8,1	9,9±1,2
	Міко-Хелп	43,7±4,3	76,6±30,2	21,0±6,9	9,3±1,2
Діамант F_1	Без застосування (контроль)	42,1±5,5	70,2±22,9	18,1±3,3	8,9±0,9
	Азотофіт	46,1±5,5	72,5±32,7	23,7±7,7	9,2±1,3
	Бітоксибацилін-БТУ	44,7±4,6	79,3±24,1	25,2±7,2	9,5±1,1
	Міко-Хелп	46,0±2,5	81,3±30,8	25,4±8,8	9,8±1,2

Джерело: Сформовано на основі результатів досліджень

Згідно отриманих даних можна відзначити що використання препарату Азотофіт на обох досліджуваних гібридах дало позитивний результат – більшу кількість листків на рослині, найбільшу висоту рослин можна відзначити за використання препаратів Міко-Хелп та Бітоксибацилін-БТУ по гібриду Франклін F_1, по гібриду Діамант F_1 найбільшу висоту відзначено у досліді із використанням Міко-Хелпу. Найкращими кількісними та якісними показниками продуктового органу відмічено дослід за використання препарату Бітоксибацилін-БТУ по гібриду Франклін F_1 , в якому середня маса головки становить 9,9±1,4, та по гібриду Діамант F_1 за використання препаратів Бітоксибацилін-БТУ та Міко-Хелп – від 9,5±1,1 до 9,8±1,2 г.

Рис.1-2. Проведення фенологічних спостережень та збирання і підготовка до зважування плодів капусти брюссельської

Висновки. Отже, згідно отриманих даних можна зробити висновки що вирощування капусти брюссельської з використанням препаратів біологічного походження є досить ефективним, в наслідок їх застосування значно покращуються показники біометрії, що в подальшому позитивно впливає на показники урожайності, також варто відмітити високу ефективність біопрепарату Міко-Хелп у боротьбі із кореневими гнилями. В загальному можна зробити висновок що перехід овочівництва та рослинництва в цілому на органічну систему вирощування є дуже важливим задля збереження та в перспективі і покращення стану грунтів у нашій країні.

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FORMATION OF SOYBEAN YIELD DEPENDING ON THE USE OF HERBICIDES

Abstract.
The combination of pre-emergence and post-emergence use of the studied drugs had a greater phytotoxic effect on the main weed species in soybean crops. Thus, cereal weeds were destroyed by 100%, Amaranthus retroflexus by 93%, and Chenopodium album by 94%. It should be noted in the areas where the composition was applied Frontier® Optima emulsion concentrate + Corum liquid concentrate + surfactant Metholate + Quantum - Molybdenum Chelate phytotoxic effect on weeds increased, and soybean plants later grew and developed better. Weed control rates for soybean weeds were 94-100% compared to control plots during the soybean harvest period. Yield of soybean seeds, where herbicides were applied in comparison with the control was on average: when using the herbicide Frontier®Optima e.c., 1,0 l/ha – 2,09 t/ha, Corum l.c., 1,5 l/ha + surfactant Metholate, 1,0 l/ha – in accordance 2,57 t/ha., and when applying Frontier® Optima e.c. + Corum l.c. + surfactant Metholate – 2,78 t/ha.

Keywords: *soybean, grains, weeds, herbicides, harvest.*

Formulation of the problem. Soybeans are a universal legume and oilseed crop. Growing soybeans in Europe produces an average of 3-4 tons of grains per hectare, while in Ukraine only 2 tons. Collectively, soybean is a strategic crop in solving the global food problem, is an extremely important source of vegetable protein and oil in the world, is the main protein ingredient in feed production, a powerful biological fixer of atmospheric nitrogen, a stabilizing factor in crop rotation. The main reason is the high weediness of the fields and the insufficiently. Therefore, the development of the most efficient, least economically and environmentally friendly weed control system using chemical plant protection products for growing soybeans in different farming systems is an extremely important element of innovative development in crop production.

Analysis of recent research and publications. Soybean production in the world is growing rapidly and reached 253 million tons, because it greatly affects the food security of civilization. Soybeans are grown in major agricultural regions in 90 countries. Its crops absorb 20 million tons of biological nitrogen, due to which the world economy receives more than 128 billion dollars a year. [4].

Analysis of statistical data conducted by Sendetsky V.M., indicates that in terms of soybean production, our country ranks first in Europe. Compared to 2016, in 2017 the harvest increased by 500 thousand tons - from 3.9 million tons to 4.3 million tons [16].

Under favorable weather conditions in 2018, the gross harvest of soybeans in Ukraine reached 4.3 million tons, which brought our country to 8th place among its world producers. However, the potential of the crop is much higher: in Europe, one hectare produces an average of 3-4 tons of grain, while in Ukraine only 2 tons. The main reason is high weediness and insufficiently effective protection of soybean crops [17].

Glycine max (L.) Merrill is the main legume in the world. It belongs to the strategic cultures and meets the most general needs of mankind [6].

A number of leading scientists Babych A.A., Babych-Poberezhna A.A. note in their works that soybeans have strongly entered the world agriculture and play a strategic role in solving the global food problem. Between 1961 and 2010, the world's soybean sowing area increased from 23.8 million hectares to 102 million hectares, it was grown by more than 90 countries in the main agricultural regions of the planet Earth, and the yield during this time increased from 11.28 to 25.5 c/hectares, production - from 26.9 million tons to 260.8 million tons [3].

In terms of intensity of biological nitrogen fixation, soybeans exceed other grain legumes. Characteristically, the average level of biological nitrogen fixation by legumes increased from 62 to 136 kg / ha, or 2.2 times. The variability of the intensity of biological nitrogen fixation among 12 main grain legumes was in the range of 48–183 kg / ha [3].

Soybean seeds contain 38-42% protein, 18-23% fat, 25-30% carbohydrates, including soluble sugars - 9-12% of seed weight, starch - 3-9%, fiber - 3-7%, about 2% phosphatides, 4- 7% of inorganic substances, microelements, enzymes and vitamins [15].

The main protein of soy - glycidin - is able to coagulate from fermentation, which allows you to make soybean seeds a large number of different foods. At the same time, medical science has established that foods made from soy contain antisclerotic substances, which is very important for the elderly [2].

The inclusion of soybeans in crop rotation and the use of bio-residues in the fertilizer system has a good effect on maintaining soil fertility. Soybean, as a legume, enriches the upper part of the root layer of the soil with well-digested forms of nitrogen, which makes it one of the best precursors [13].

Well-developed soybean crops biologically fix 155–198 kg / ha of nitrogen. Due to this, soybeans satisfy their need for nitrogen by 65–80% and are one of the best precursors in crop rotation [1].

Soybean, as a light-loving crop, forms a high yield only at the optimal for a particular variety of feeding area and density of plants, providing moisture and nutrients, but the main requirement - the best illumination of the leaf surface [19].

Soybeans remain weeded for 2-3 weeks from sowing to the appearance of the first trifoliate leaf. At this time, the future harvest is genetically laid down. If soy is not protected at this time, it genetically reduces the yield potential, and this process is irreversible. The most optimal period for weed control is the phase from the first to the third trifoliate leaf of the crop (this is the period from which soybeans are most "resistant" to action against dicotyledonous and cereal herbicides) [8].

At the beginning of the growing season, soybeans are quite competitive against weeds due to the significant reserves of plastic substances in the seeds and intensive growth. But later, the short length of the stem, slow growth in the initial period of development, low crop density (50-60 pieces / m^2) do not allow it to compete with weeds. Therefore, field litter is a significant obstacle to obtaining high and stable soybean yields. During the critical growing season on a weed background, soybeans significantly reduce their productivity. According to generalized long-term data, each quintal of raw mass of weeds causes a shortage of more than 13 kg of soybean seeds [18].

Shevchenko M.S., Shevchenko S.M., Derevenets-Shevchenko K.A., etc., in their work note that the decrease in gross harvest of crops due to weeds is 25-30%, in some cases exceeding 50 % [20].

By absorbing large amounts of nutrients from the soil, weeds impair the normal growth and development of cultivated plants. Due to the lack of appropriate measures to protect crops, weeds are able to absorb 160-200 kg / ha of nitrogen, 55-90 kg / ha of phosphorus and 170-250 kg / ha of potassium [16].

Weed populations are almost ubiquitous in the structure of agrophytocenoses, forming for each field its species composition and number of individual weed species, as well as the potential stock in the soil of their seeds and vegetative reproductive organs. The well-known Ukrainian herbologist Ivashchenko I.I. notes that modern weed populations have acquired a set of features that allow them to withstand intense anthropogenic impact, both mechanical and chemical [14].

The interaction between crops and weeds in soybean crops has its own characteristics. Soybean plants grow very slowly during the first growing season and have little effect on weed growth conditions, so rapid growth of segetal vegetation is observed. Root secretions enriched with nitrogen and other compounds improve the feeding conditions of weeds [7, 11].

Studies have shown that the linear application of new generation soil herbicides based on Harnes acetochlor from the American company Monsato and Trophy of the former British company ICC, and now Zeneca, was 81.5 and 76.1%, respectively, 1 l / ha on the impact on weed crops [5].

Various post-emergence herbicides can effectively control monocotyledonous and dicotyledonous weeds, but there are segetal and ruderal weeds on which post-emergence herbicides have little effect (about 30-40%). The need to use tank mixtures of herbicides with different mechanisms of action is due not only to the expansion of their spectrum of action, but also the ability to reduce the risk of resistance, ie the acquired resistance of weeds to certain chemical compounds. Tank mixtures of herbicides prevent the emergence of resistant weeds. This significantly increases the effectiveness of herbicides while reducing the financial costs of re-application [10].

BASF experts have found that in order to kill weeds in soybean crops, it is advisable to apply herbicides before they reach a certain stage of growth and development. By the time the triple-leaf phase in soybeans occurs, white quinoa can already have up to 6 leaves, on which a wax layer is formed, due to which the herbicides do not work. The effectiveness of application of post-emergence herbicides is significantly increased by the application of weed cotyledons, the use of their tank mixes and the addition of quality adhesives. Some post-emergence herbicides are able to show high activity and selectivity to the culture when applied to the emergence of culture seedlings. Thus, the herbicide "Fabian", applied as a soil, provided a significant reduction in weed crops and increase crop yields [9].

Thus, the intensive technology of soybean cultivation involves the use of chemical plant protection measures, which leads to an increase in pesticide loads on agrocenoses and the environment. To reduce the toxic effects of herbicides, reduce their consumption rates, it is necessary to use herbicide compositions and microfertilizers in soybean cultivation technology, but the main attention should be paid to proper crop rotations and scientifically sound tillage systems.

The aim of the research is to substantiate the feasibility of using soil and post-emergence herbicides to control weeds and foliar application of microfertilizers in soybean agrocenoses.

Research methods. Field - to monitor the growth and development of plants, environmental conditions, assess the agro-technical and economic effect of the studied elements of technology; measuring and weighing - to account for yield.

The research was conducted in the experimental field of VNAU the village of Agronomic. The soil at the experimental site is gray forest medium loam. According to the agrochemical survey, the humus content in the arable layer is low - 3%. The content of easily hydrolyzed nitrogen (according to Cornfield) is low - 7.0-8.0; mobile phosphorus (according to Chirikov) high -16.0-19.4; exchangeable potassium (according to Chirikov) increased - 9.5 mg / 100 g of soil.

Hydrolytic acidity is high and is 4.32 mg-eq./100 g of soil. In terms of metabolic acidity, pH 5.0-5.4 is a medium-acid soil. The soil of the experimental site and its agrochemical parameters are typical for this area and suitable for soybean cultivation. Vinnytsia district is located in the temperate zone. Maximum precipitation occurs in May - July (130-170 mm). The least humid are the winter months. In December - February it falls from 65 to 80 mm. The average annual rainfall is 440-590 mm.

Soil preparation and tillage are generally accepted for the Forest-Steppe Zone of Ukraine, which provides for maximum weed control, accumulation of moisture and creation of favorable conditions for the growth and development of cultivated plants. After harvesting the predecessor (spring barley) stubble was peeled with disc harrows BDN-3A to a depth of 5-6 cm. In the spring cultivation was carried out to a depth of 4-5 cm. Three days before sowing, the soil herbicide Frontier® Optima (1.0 l/ha) was applied with simultaneous earning into the soil. Omega Vinnytsia soybean variety was sown. Before sowing, soybean seeds were treated with rhizotorphin (50 g per hectare sowing rate) and pesticide (Vitavax 200ff) at the rate of 3 l/t of seeds. Sowing was carried out in a narrow row with a row spacing of 15 cm seeder Klon. Harvesting of soybean seeds was carried out in the phase of full maturity, at its humidity of 14-15% by direct combining.

During the growing season of soybean plants, the following observations and records were made: phenological observations of the growth and development of soybean plants; assessment of the effect of herbicides on weeds, crop accounting - sheaf method and weighing from each site. Weed accounting was performed by quantitative-weight method. The essence of this method is to allocate on the plots of permanent accounting plots of a certain size [12].

During the growing season, the condition of plants in the herbicide-treated areas was monitored. Signs of their damage, terms and degree of manifestation of these signs, death of plants are noted.

The influence of herbicides on the emergence of crop seedlings, plant density, timing of growth and development phases, crop structure were determined. Harvest accounting was carried out at each plot separately, from the entire accounting area. The size of the accounting area is 20 m^2, repeated four times.

Mathematical processing of research data was performed on a personal computer with a set of programs such as "Sigma" and Exel.

Presenting main material. Our research has shown that soybean crops have formed a mixed type of weed, where dicotyledonous weed species predominate. Among cereals were present: mouse blue (Setaria glauca (L.) Pal. Beauv.), Chicken millet (Echinochloa cruss-galli (L.) Pal. Beauv.) (Table 1).

Table 1

Weed sctructure of soybean agrocenosis (average for 2019-2020), pcs / m^2

Cereal weeds					Dicotyledonous weeds								
Gramíneae	Setaria pumila	Echinochloa crus-galli	Avena fatua	Other	Dicotyledones	Chenopodium album	Amaranthus retroflexus	Thlaspi arvense	Persicaria hydropiper	Raphanus raphanistrum	Tripleurospermum inodorum	Cirsium arvense	Other
39	16	15	6	2	63	16	14	12	8	5	4	2	2
Total 102													

Crops are characterized by re-weeding in the second half of summer. The spread of quinoa, species of amaranth, chicken millet, yellow bristle-grass and other species reduces the productivity of the crop and complicates the process of harvesting, as well as increases crop losses.

Soybeans grow relatively slowly at the beginning of the growing season, and weeds compete with them for moisture, nutrients, and light. This makes it less competitive than weeds. Yield losses from weeds can range from 30 to 50%. The critical period for weed control is the phase of 1 to 3 true leaves of the crop.

Subject to treatment with herbicides with one active substance or mechanism of action, we obtain a larger number of resistant species that re-form seeds and have increased resistance. With long-term such use, there is a complete replacement of susceptible species with resistant ones.

From soil herbicides, we investigated the effect of the drug Frontier® Optima, which was applied to soybean crops at a rate of 1.0 l / ha. Studies have shown high herbicide and cost-effectiveness of the drug Frontier® Optima.Thirty days after application of the Frontier® Optima herbicide, there were only 11 pieces / m^2 of weed plants in soybean crops. Cereal weeds were completely absent, only stable dicotyledons remained, in particular quinoa, bitters. This amount of weed vegetation is 79% lower compared to the weed control version, where no herbicides were applied. The efficiency of destruction of annual dicotyledonous and cereal weeds 60 days after application of Frontier® Optima was 75% compared to the control. Before harvesting, the weediness of soybean crops increased slightly and was in the range of 26 pcs / m^2. This figure is 72% lower compared to weeds in the control version, where at the time of harvest there were 94 pieces / m^2 of weed plants. From the results of research it can be concluded that the application of soil herbicide Frontier® Optima reliably protects soybean crops during most of the growing season.

As the degree of contamination of the soybean agrophytocenosis was high, especially with dicotyledonous weeds, we decided to use the post-emergence herbicide Corum pk, 1.5 l / ha + surfactant Metholate, 1.0 l / ha in addition to the soil herbicide Frontier® Optima.

The consumption rate of the working solution is 200-250 l / ha. Metholate is a drug that opens the entrance to the internal systems of quinoa, allowing the active components of the product Corum® to effectively destroy it. The metholate contains substances that reduce the surface tension of the working solution, allowing it to adhere firmly to the leaf. Another feature of Metolate is its ability to dissolve wax and facilitate the penetration of the active ingredients of the herbicide into the leaf. The combination of the special formulation Corum® with surfactant Metholate has a high buffering capacity, which allows you to keep the pH of the solution within optimal limits sufficient to dissolve cuticular waxes and penetrate into the tissues of the leaf.

Table 2

Influence of herbicides on weed infestation of soybean agrocenosis (average for 2019-2020)

A variant of the experiment	Technological type of herbicide	Accounting	Weed rates	
			Quantity, pcs / m^2	Reduction of % to control
Control (without processing)	--	1 2 3	102 96 94	-- -- --
Frontier® Optima coefficient., 1.0 l / ha	soil	1 2 3	21 24 26	79 75 72
Corum l.c.,1,5 l/ha + surfactant Metholate, 1,0 l/ha	insurance	1 2 3	102 11 7	- 89 93
Frontier® Optima e.c., 1,0 l/ha + Corum l.c.,1,5 l/ha +surfactant Metholate, 1,0 l/ha	soil + insurance	1 2 3	20 3 1	80 97 99
Frontier® Optima e.c., 1,0 l/ha +Corum l.c., 1,5 l/ha +surfactant Metholate, 1,0 l/ha +Quantum -Molybdenum Chelate (Mo), 0,5 l/ha	soil + insurance + microfertilizer	1 2 3	19 2 1	81 98 99

Due to the high selectivity and soft action, the Corum® application window is very wide - from one to five trifoliate leaves. But the main factor is not the phase of crop development, but the phase of weed development, and we should focus on the most problematic weeds. Dozens of studies across Europe have shown that even a double dose of Corum®, administered with or without Metholate, did not reduce yields. Keep in mind that imazamox, which is contained in the herbicide Corum®, is part of the Clearfield® system, the products of which should not be used more than once every three years.

According to prof. O.O. Ivashchenko, the sensitivity of white quince to the action of herbicides in the cotyledon phase reaches more than 99%, and in phase 4 pairs of true leaves only 38.5%. That is why the recommendations for the use of Corum® on soybean and pea crops should be divided into two parts [16]. The first is the culture in the early stages of development, the weeds are not overgrown (in the cotyledon phase - the first pair of true leaves). For such conditions the norm of Corum® 1,5 l / hectare + surfactant Metholate of 0,75 l / ha will be sufficient. The second - problem weeds, in particular quinoa, overgrow (3 pairs of leaves - the beginning of branching). In this case, the maximum rate of Corum® 2.0 l / ha + surfactant Metholate 1.0 l / ha should be applied.

Our studies showed that the herbicide Corum® 1.5 l / ha, which is used in the experiment, significantly reduced the weediness of soybean crops compared to growing without herbicides and manual weeding. Corum® herbicide 1.5 l / ha was applied to phase 5 of trifoliate soybean leaves (early phases of weed growth). After applying the herbicide for a week was dry cool weather. Weed accounting has shown that when the drug is applied to vegetative plants, its phytotoxicity depends to a lesser extent on the species composition of weeds. Accounting conducted 30 days after spraying the crops showed that the effectiveness of Corum® 1.5 l / ha against the weed complex in soybean crops was 89% compared to the original weed. This drug effectively destroyed cereal weeds (92-97%). The total number of weeds decreased at the time of harvest by 93% compared to baseline, which proves the high efficiency of the drug to eliminate weeds in soybean crops (Table 2).

The effectiveness of the combined use of soil and post-emergence drugs in our experiment was quite high. Thus, the accounting was carried out after the use of the soil preparation Frontier® Optima e.c. showed that its use reduced weed infestation by cereal weeds by 94% compared to controls. After application of the herbicide Korum + surfactant Metholate, the number of cereal weeds in soybean crops decreased to 1 piece / m2, which is 97% less than the original. The use of this method of weed control has allowed to get rid of them almost completely - in soybean crops at harvest time.

Thus, the application of soil herbicides and post-emergence herbicides have quite good results in the destruction of weeds in soybean agrocenoses, and due to foliar application of micronutrients soybean plants grew and developed better and shaded the remaining weeds.

Productivity is the main performance indicator of scientific research. The effect of a set of conditions of growth and development on plants is manifested in changing the parameters of the elements of their productivity.

It should be noted that the introduction of micronutrients promotes better growth and development of soybean plants, which ultimately affects the increase in soybean productivity. Microfertilizers containing molybdenum help to prolong the growing season of soybean plants. Molybdenum (Mo) is a component of nitrate reductase enzymes, which are involved in the reduction of nitrates to ammonia in root and leaf cells. If this element is not enough, a lot of nitrates accumulate in plant tissues, their recovery is delayed, resulting in disruption of normal nitrogen metabolism; after the application of nitrate fertilizers, the need of plants for molybdenum is much higher than ammonia fertilizers. Under the influence of molybdenum for the formation of amino acids and proteins, ammonia is used more intensively by the plant.

Table 3

Soybean seed yield depends on exposure herbicides and microfertilizers, t / ha

Application options	Seed yield, t / ha			Increase in control	
	2019 year	2020 year	Average	t/ha	%
Control (without processing)	1,21	0,82	1,02	-	-
Frontier® Optima e.c., 1,0 l/ha	2,52	1,65	2,09	+ 1,07	105
Corum l.c., 1,5 l/ha + surfactant Metholate, 1,0 l/ha	3,06	2,08	2,57	+ 1,55	152
Frontier® Optima e.c., 1,0 l/ha +Corum l.c., 1,5 l/ha + surfactant Metholate, 1,0 l/ha	3,20	2,35	2,78	+ 1,76	173
Frontier® Optima e.c., 1,0 l/ha + Corum l.c., 1,5 l/ha + surfactant Metholate, 1,0 l/ha + Quantum – Molybdenum Chelate (Mo), 0,5 l/ha	3,34	2,54	2,94	+ 1,92	188
HIP $_{05}$	0,17 0,16				

As can be seen from the above data, the highest soybean yield was in the variant with the introduction of soil Frontier®Optima e.c., 1,0 l/ha – 2,09 t/ha, Corum l.c., 1,5 l/ha + surfactant Metholate, 1,0 l/ha + Quantum - Molybdenum Chelate (Mo), 0.5 l / ha - the level of soybean seed yield was on average for two years - 2.94 t / ha, which is more than in the control areas by 1.92 t / ha or 188 % (Table 4.3).

Therefore, these drugs are quite effective in soybean crops, as they increase yields and reduce weeds.

An important condition is not only to increase the yield of soybeans, but also to improve the quality of grain, in particular the content of proteins and oils. Therefore, it was important to trace the effect of the studied drugs on the formation of the mass of 1000 seeds, the content of proteins and oils in the grain. Soybean growing conditions affect the chemical composition of soybean grain. Protein accumulates more intensely at high temperatures.

Studies have shown that the mass of 1000 soybean seeds under the action of the herbicide Frontier® Optima e.c., 1.0 l / ha was 145 g and increased against the control by 15 g. 5 l / ha in the budding phase in soybean crops contributed to an increase in the weight of 1000 seeds against the control of 29 g.

Analyzing the content of proteins and oils in soybeans, it was found that in variants with the introduction of post-emergence herbicide Corum l.c at the rate of 1.5 l / ha, the protein content was 32.3%, respectively, for the oil content of 21.3%. With the use of soil herbicide Frontier® Optima e.c., 1.0 l / ha - 2.09 t / ha, Corum l.c., 1.5 l / ha + surfactant Metholate, 1.0 l / ha + Quantum - Molybdenum Chelate (Mo), 0.5 l / ha the protein content was at the level of 33.8%, oil - 22.8% (Table 4).

Table 4

The quality of the harvest with the use of herbicides and microfertilizers (average of 2019–2020)

Experiment options	Weight of 1000 seeds, g	Grain content,% on dry matter	
		proteins	oil
Control (without processing)	130	31,1	19,2
Frontier® Optima e.c., 1,0 l/ha	145	32,1	21,2
Corum l.c., 1,5 l/ha + surfactant Metholate , 1,0 л/га	146	32,3	21,3
Frontier® Optima e.c., 1,0 l/ha + Corum l.c., 1,5 l/ha + surfactant Metholate, 1,0 л/га	157	33,2	22,4
Frontier® Optima e.c., 1,0 l/ha + Corum l.c., 1,5 l/ha + surfactant Metholate, 1,0 l/ha + Quantum – Molybdenum Chelate (Mo), 0,5 l/ha	159	33,8	22,8

The obtained data give grounds to assert that the formation of higher protein and oil content in the variants of the experiment with the use of the studied drugs is the result of creating more favorable conditions for soybean plants in physiological and biochemical processes and microbiological - in plants and soil.

Conclusions.

1. The weed control efficiency 60 days after application of Frontier® Optima was 75% compared to the control. Before harvest, weeds in soybean crops were in the range of 26 pieces / m^2. This figure is 72% lower compared to weeds in the control version, where at the time of harvest there were 94 pieces / m^2 of weed plants.

2. Accounting conducted 30 days after spraying the crops showed that the efficiency of Corum® 1.5 l / ha in soybean crops was 89%. The total number of weeds decreased by 93% at the time of harvest compared to the original, which proves the high effectiveness of the drug to eliminate weeds in soybean crops.

3. The combination of pre-emergence and post-emergence use of the studied drugs had a greater phytotoxic effect on the main weed species in soybean crops. Thus, cereal weeds were destroyed by 100%, Amaranthus retroflexus by 93%, and Chenopódium álbum by 94%. It should be noted in areas where the composition was introduced Frontier® Optima e.c., + Corum l.c. + Metholate + Quantum-Molybdenum Chelate The phytotoxic effect on weeds increased, and soybean plants grew and developed better in the future. Weed control rates for soybean weeds were 94-100% compared to control plots during the soybean harvest period.

4. The highest soybean yield was in the variant with the application of soil herbicide Frontier® Optima e.c., 1.0 l / ha - 2.09 t / ha, Korum l.c., 1.5 l / ha + surfactant Metholate, 1, 0 l / ha + Quantum - Molybdenum Chelate (Mo), 0.5 l / ha - the level of soybean seed yield averaged 2.94 t / ha in two years, which is 1.92 t / ha more than in the control plots. ha or 188%.

5. Studies have shown that the mass of 1000 soybean seeds under the action of the herbicide Frontier® Optima e.c., 1.0 l / ha was 145 g and increased against the control by 15 g. 5 l / ha in the phase of the beginning of budding in soybean crops contributed to the growth of the mass of 1000 seeds against the control of 29 g.

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ВПЛИВ ТЕХНОЛОГІЧНИХ ПРИЙОМІВ ТА УДОСКОНАЛЕННЯ СИСТЕМИ ЗАХИСТУ ПОСІВІВ СОНЯШНИКА ВІД БУР'ЯНІВ

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INFLUENCE OF TECHNOLOGICAL TECHNIQUES AND IMPROVEMENT OF THE SYSTEM OF PROTECTION OF SUNFLOWER CROPS FROM WEEDS

Анотація.

Встановлено шкідливість домінуючих видів бур'янів у посівах соняшника та його конкурентоздатність. На основі удосконалення прогнозу забур'яненості визначені еколого-економічні пороги застосування захисних заходів у посівах соняшника.

Досліджено ефективність комплексного використання агротехнічних заходів догляду за посівами та стрічкове внесення гербіцидів у посівах соняшника. Це забезпечить урожайність соняшника адекватну біокліматичному потенціалу зони, істотному зниженню енергетичних витрат та екологічну безпеку вирощеної продукції і довкілля.

Дослідженнями встановлено, що серед факторів, які стримують підвищення продуктивності соняшника бур'янова рослинність залишається найбільш сильнодіючою. В умовах дослідного поля ВНАУ у посівах цієї культури зустрічається від 35 до 60 видів бур'янів, з яких 8–16 вважаються шкідливими і небезпечними, які формують малорічний тип забур'яненості. Головним чином–це зимуючі бур'яни – 73 % (Echinochloa crus-galli L. та Amaranthus retroflexus L.), ярі – 20 % перевага належала Chenopodium album L. і багаторічні коренепаросткові – 7 %, представником яких були Cirsium arvense L. та Convolvulus arvensis L.

Обґрунтовано вплив різних систем основного обробітку ґрунту на забур'яненість посівів соняшника.

Догляд за посівами соняшника суттєво впливає на кількість бур'янів. Найбільш чистими посіви соняшника були за комбінованого запровадження механічних знищувальних заходів та хімічних (гербіцидів) речовин шляхом проведення досходового і післясходового боронування зубовими боронами у фазу «білої ниточки» бур'янів. Фюзілад форте вносили у фазу 2– 4 листків у малорічних бур'янів і за висоти 10–15 см багаторічних злакових бур'янів у нормі 0,5 л/га. Проведення двох міжрядних обробітків з підгортанням культурних рослин і присипанням проpослих (сходів) бур'янів у рядку соняшника.

Аналіз урожайності соняшника засвідчив, що найбільш сприятливі умови для формування високої продуктивності культурних рослин були за глибокого безполицевого обробітку та комбінованого догляду за посівами. За таких умов урожайність, в середньому за роки досліджень, склала 4,0 т/га.

Abstract.

The harmfulness of dominant weed species in sunflower crops and its competitiveness have been established. Based on the improvement of the weed forecast, the ecological and economic thresholds for the application of protective measures in sunflower crops have been determined.

The efficiency of complex use of agrotechnical measures of crop care and tape application of herbicides in sunflower crops is investigated. This will ensure sunflower yields adequate to the bioclimatic potential of the zone, a significant reduction in energy costs and environmental safety of crops and the environment.

Studies have shown that among the factors that constrain the increase in sunflower productivity, weeds remain the strongest. In the experimental field of VNAU in the crops of this culture there are from 35 to 60 species of weeds, of which 8–16 are considered harmful and dangerous, which form a short-term type of weeds. These are mainly wintering weeds - 73% (Echinochloa crus-galli L. and Amaranthus retroflexus L.), spring – 20% predominance belonged to Chenopodium album L. and perennial rhizomatous weeds – 7%, represented by Cirsium arvense L. and Convolvulus arvensis L.

The influence of different systems of basic tillage on weediness of sunflower crops is substantiated.

Caring for sunflower crops significantly affects the number of weeds. The cleanest sunflower crops were the combined application of mechanical pesticides and chemicals (herbicides) by pre-emergence and post-emergence harrowing with dental harrows in the «white thread» phase of weeds. Fusilade forte was applied to the phase of 2–4 leaves in perennial weeds and at a height of 10–15 cm of perennial cereal weeds at the rate of 0.5 l/ha. Carrying out two inter-row cultivations with hilling of cultivated plants and sprinkling of sprouted (seedlings) weeds in a row of sunflowers.

Analysis of sunflower yield showed that the most favorable conditions for the formation of high productivity of cultivated plants were with deep shelfless cultivation and combined crop care. Under such conditions, the yield, on average over the years of research, was 4.0 t/ha.

Ключові слова: *соняшник, бур'яни, гербіциди, обробіток ґрунту, урожайність.*
Keywords: *sunflower, weeds, herbicides, tillage, yield.*

Introduction.

Sunflower (*Helianthus annuus* L.) is the most important oil crop of Ukraine and the World in terms of distribution, universality of use and energy value. It is sunflower that provides the highest oil yield per unit area, its production is profitable in all growing areas of Ukraine [1, 2].

According to the State Statistics Service of Ukraine, over the past 30 years, Ukrainian farmers have significantly increased the area under sunflower. Thus, in 1990 the area under sunflower was 1.6 million hectares, while in 2019 – 6.2 million hectares, ie, the area increased by almost 4.0 times. In 2019, world production of sunflower seeds amounted to 46.3 million tons, in Ukraine more than 12 million tons, which is 26% of world production. Thus, Ukraine is the world leader in the production of sunflower oil – 4.9–5.5 million tons, for the needs of the latter for the domestic market about 0.5 million tons.

Formulation of the problem. Modern science knows more than 500 thousand species of higher plants that grow in different parts of the planet. Among this diversity of nearly 20,000 used to grow in culture and about 30,000 up weeds. The wild flora of Ukraine numbers more than 3.5 thousand species, of which about 700 species are found as weeds.

In the process of evolution, certain complexes of weeds have developed that develop in field crops. It is extremely difficult to disturb and change the phytocenotic situation in favor of cultivated species.

The history of agriculture is a constant struggle of man with the presence in the fields of unwanted vegetation. This task requires a lot of physical effort (up to 25% of total labor costs) and material resources. However, mankind has not solved the problem of weed infestation [4].

In large areas, man destroyed natural vegetation and by sowing and planting created artificial agrocenoses, which lost the ability to self-regulate, but retain the characteristics of plant communities [3, 5]. Weeds are part of man-made agrocenoses. They cause significant damage to crops, but are equal members of the agrocenosis that develops in the field. They occupy an ecological niche and are an integral part of nature. Therefore, at the present stage of development of protection of cultivated plants from weeds, the main task is to reduce their number in agrocenoses to a level safe for cultivated plants, and not to destroy them completely [6, 7].

In the agrocenosis there is a constant competition between weeds and cultivated vegetation for nutrients, moisture, solar energy. During their existence, weeds have acquired many biological features that allow them to successfully withstand adverse environmental conditions and grow among cultivated plants. First of all, it is high plasticity of development, high fertility and long shelf life of vegetative and seed germs in the soil. [9]. Thus, the potential contamination of the cultivated soil layer in different regions of Ukraine differs significantly in structure, but is traditionally very high. In the steppe zone, it averages 1.47 billion units. ha, in the Forest-Steppe – 1.71 and Polissya – 1.24 billion. ha of seeds [8].

Competitive relations between weeds and crops for nutrients is also strained. It is established that at the current level of weediness of agricultural lands, weeds annually remove 17.3 million tons of nutrients from the soil [6, 12]. Even with weak weeds of crops, weeds remove from the soil up to 15 kg of nitrogen, 10 kg of phosphorus and 40 kg of potassium, while for the formation of one ton of grain cultivated plants spend 25 kg of nitrogen, 15 kg of phosphorus and 15 kg of potassium [14, 15].

The harmful effects of weeds can be assessed by the difference between the magnitude of the potential and actual yields, which are expressed by biological and economic thresholds. The biological threshold of weed harmfulness is understood as the level of weed infestation of crops from which a significant decrease in yield begins [11, 13].

World scientific experience testifies to the multivariate possibility of adaptive processes in terms of protection of crops from weeds, and the undeniable improvement of technological measures in synchronized mode with the phenomena of variability of agrocenoses and trends of potential soil contamination and weeds.

The current qualitative composition of weed phytocenoses is a consequence of long-term natural selection, which is reflected in climate change, the transition to short-rotation crop rotations using a limited number of field crops, the introduction of soil protection systems as a forced measure against water and wind erosion, drought. All this has led to a gradual increase in the infestation of fields with perennial and perennial weeds. The accumulation of experimental data on the patterns of formation of the weed component of agrocenoses in zonal soil protection technologies for growing crops becomes a theoretical basis for improving existing and developing new measures of the weed component.

Therefore, given the objective capabilities of Ukraine, it is very important to develop and implement an integrated system of protection of cultivated plants from weeds. An integrated protection system is part of an overall pest management system for growing crops. The system should be based on the rational use of existing, development and implementation of new measures and means of protection aimed at reducing the number of weeds and maintaining harmful vegetation at a level below the ecological and economic threshold of harmfulness. Our research is aimed at solving these issues.

Relevance of the research topic.

Weeds are the main factor that significantly reduces yields, degrades product quality, promotes the spread of pests and diseases, inhibits the introduction of advanced technologies, increases the cost of production. It is estimated that weeds do not produce 25–30% of the crop, and in many cases the losses reach 50% or more. Therefore, the urgent problem of modern agriculture is to improve existing and develop effective measures to control the number of weeds.

The main destructive measures of harmful vegetation in crops, including sunflower, are mechanical, physical, chemical and biological. However, these measures and tools are not always effective and have not found wide practical application, as they are often implemented separately, in isolation from each other, with little regard for soil, climatic and environmental conditions of each farm. Reducing crop weeds below the economic threshold is possible through integrated (integrated) use of precautionary, mechanical, physical, chemical and biological measures.

Therefore, there is an objective need to improve the existing effective, environmentally friendly measures and systems to protect sunflower crops from weeds and on this basis to increase yields.

The purpose of the study is to determine the composition of weeds in sunflower crops and to establish the harmfulness and periods of competition of the most common species. On this basis, theoretically justify and improve the existing comprehensive measures and weed control systems in sunflower crops.

Analysis of recent research and publications.

Scientific developments on theoretical and methodological bases for the improvement of existing and development of new effective environmentally safe measures and systems for protection of sunflower crops against weeds have been devoted to such outstanding domestic scientists as I.V. Veselovsky, S.I. Matushkin, O.O. Ivashchenko, A.M. Malienko, Y.P. Manko, S.P. Tanchik, V.M. Zherebko, Y.I. Tkalich, V.S. Zadorozhny, A.I. Babenko and others [9, 12, 16, 19].

Research methodology.

During 2019–2020, we conducted research to determine the impact of weediness on crop yields of sunflower seeds, as well as to establish a critical period of competitive relations of crops with weeds.

Sunflower hybrid – Torino, Nuseed USA, the duration of the growing season is 113–115 days. The sown area was 50 m^2, accounting 30 m^2.

The main tillage in all fields was carried out according to the experimental scheme. The scheme of the two-factor stationary experiment provided for the study of the systems of basic tillage and the system of post-sowing (crop care) tillage.

Scheme of two-factor stationary field experiment:

Factor A – the system of basic tillage.

1. Shelf tillage (plowing) by 25–27 cm (control).
2. Tillage-free tillage 25–27 cm.
3. Shallow tillage 12–14 cm.

Factor B – system of soil and post-emergence application of herbicides, as well as tillage system for crop care

1. Without herbicides and weeding (control).
2. Harness (acetochlor) – 2.0 l/ha.
3. Fusilade forte (fluazifop-P-butyl) – 1.5 l/ha.
4. Harness (acetochlor) – 2.0 l/ha + Fusilade forte (fluazifop-P-butyl) – 1.5 l/ha.
5. Mechanized.
6. Combined.

The system of post-sowing (crop care) tillage in the variants of the experiment (factor B) provided for the following measures:

1. Without herbicides and mechanical weeding (control) – after sowing of sunflower did not carry out any agrotechnical (mechanical) measures.

2. Harness (acetochlor) – 2.0 l/ha. The drug was applied before sowing sunflowers.

3. Fusilade forte (fluazifop-P-butyl) – 1.5 l/ha. The drug was applied to vegetative crops in the phase of 2–4 leaves in perennial and at a height of 10–15 cm perennial cereal weeds.

4. Harness (acetochlor)– 2.0 l/ha. The drug was applied before sowing sunflower and Fusilade forte (fluazifop-P-butyl) – 1.5 l/ha, the drug was applied to vegetative crops in the phase of 2–4 leaves in perennial and at a height of 10–15 cm perennial cereal weeds.

5. Mechanized care of crops – one pre-emergence and one post-emergence harrowing, two inter-row cultivations.

6. Combined – one pre-emergence and one post-emergence harrowing with toothed harrows in the «white thread» phase of weeds, Fusilade forte was introduced into the phase of 2–4 leaves in annual and at a height of 10–15 cm perennial cereal weeds at the rate of 0, 5 l/ha with a tape up to 15 cm wide+two inter-row cultivations with hilling of plants in a row.

To achieve the set goals and objectives according to the research program, accounting, observation and analysis were performed according to generally accepted methods [16, 18].

Results of the research.

The intensification of agricultural production has not reduced the weediness of field crops, and in some cases it has increased. The main reasons for this are the significant deterioration of tillage and crop care, non-compliance with the rational rotation of crops, and sometimes complete neglect of crop rotations, excessive areas of some row crops (sunflower, corn), ineffective use of preventive and exterminating measures to control weeds. cultures [8, 17, 20].

In the process of evolution, weeds have acquired a number of biological properties that allow them to successfully withstand adverse environmental conditions and grow with cultivated plants. They have high plasticity of growth and development, high fertility, a long period to maintain the viability of seeds and vegetative germs in the soil [20].

Among the factors that constrain the increase in sunflower productivity, weeds remain the strongest. In the zone of the Right-Bank Forest-Steppe of Ukraine in crops of this culture there are from 40 to 80 species of weeds, of which 8–16 are considered the most harmful and dangerous – late spring and perennial rhizomatous [21, 23]. They dramatically worsen water, nutrient and light regimes in crops, resulting in the loss of 27–35% or more of the expected sunflower yield with fluctuations from 10–15 to 70–80% and up to the complete death of cultivated plants [7, 22, 24].

According to the results of research, it is established that during 2019-2020, a short-term type of weed formation is formed in sunflower crops. Mainly – it is wintering weeds – 73% (*Echinochloa crus-galli* L. and *Amaranthus retroflexus* L.), spring weeds – 20% advantage belonged to *Chenopodium album* L. and perennial root weeds) – 7%, represented by *Cirsium arvense* L. and *Convolvulus arvensis* L. (Fig. 1).

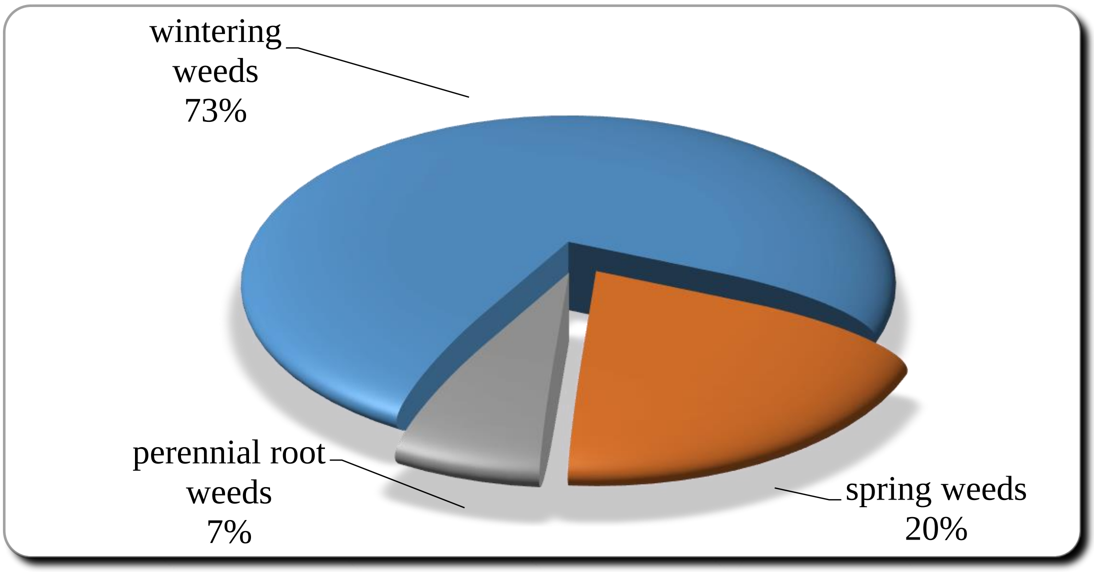

Fig. 1. Biological groups of weeds in sunflower crops (for 2019)

The intensity of the appearance of a particular type of weed in sunflower crops varies significantly both in intensity and in calendar terms. Depending on weather conditions, the average indicators of the dynamics of seedling emergence can be mixed in calendar terms for 7–12 days from the average.

In order to establish the dynamics of emergence of seedlings of different species in sunflower crops, starting from May 1 and every 10 days, surveys were conducted on areas recorded throughout the growing season. Sprouted weed plants were recorded after counting and counted again after the next 10 days. Summarizing the data obtained for 4 years of research to establish the characteristics of the emergence of the most common weeds in sunflower crops, certain patterns have been established [25].

The dynamics of germination of a complex of weed species in sunflower crops shows that the most intensive process of seed germination occurs from the second decade of May to the second decade of June. Hence, it is during this growing season that the most intensive control of the number of weeds in sunflower crops belongs. Control measures should take into account the biological characteristics and dynamics of each weed species. Different species in sunflower crops germinate in their own way.

It is established that the first shoots of *Chenopodium album* L. in sunflower crops appear in late April – early May. The intensity of new plants of this species gradually increased until the end of the second decade of May. In the third decade of May – the first decade of June, the intensity of seedlings has doubled compared to mid–May. Subsequently, there was a gradual composition of the intensity of the emergence of seedlings (Fig. 2).

In *Amaranthus retroflexus* L. of appeared before May 10. Data simultaneously with the increase in air temperature and the top layer of soil, the intensity increased rapidly. This trend did not change until the end of the first decade of June, when the intensity of new plants reached its peak. After that, a gradual decline in the germination activity of the seeds of the *Amaranthus retroflexus* L. Both *Chenopodium album* L. plants and new shoots of *Amaranthus retroflexu* L, under favorable conditions of moisture, heat and light in sunflower crops, appeared before the end of the growing season.

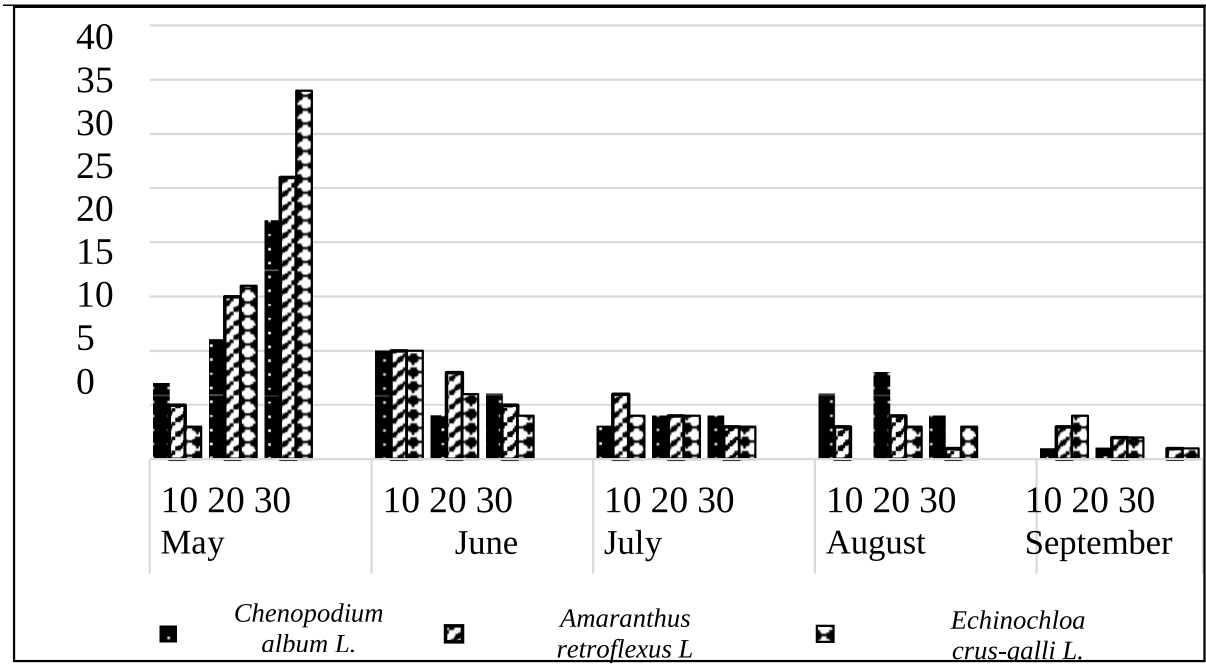

Fig. 2. Dynamics of weed emergence in sunflower crops, % (average for 2019–2020)

Echinochloa crus-galli L. is a typical representative of late spring weeds. For weeds to germinate, this weed needs good soil warming and high air temperatures. It is established that the first shoots of this organic weed from the family Poaceae appear at the end of the first decade of May. Over the next one or two decades, the emergence of seedlings grows slowly. The maximum intensity of germination of seeds of this species reached in early June and lasted until the formation of baskets of sunflower. During this period, the light regime in crops is significantly deteriorated, the young shoots of the *Echinochloa crus-galli* L. plant fall into unfavorable conditions, their energy (light) supply is weakened, and as the leaf surface of sunflower grows to a minimum. It is extremely difficult for young plants to survive with a small amount of diffused light. Some of them died of energy starvation, some survived, but acquired neotenic forms and, accordingly, could not compete with cultivated plants. Only a small part of them, which grew in places free of sunflower plants, could grow and develop normally. This typical pattern of secondary weed control of sunflower crops can often be observed in July-August. In the intervals between sunflower plants on liquefied crops young plants of *Echinochloa crus-galli* L, *Setaria glauca* L. and *Setaria viridis* L., *Chenopodium album* L., *Amaranthus retroflexus* L. and others that germinated after protective measures in the fields.

The improvement of sunflower growing technology is associated with the development and implementation of environmentally friendly energy-saving and soil protection measures. It is known that this involves the widespread use of highly effective herbicides, their differentiated application depending on the type and degree of weeding and soil properties of each field. The application of such herbicides makes it possible to keep crops free of weeds throughout the growing season. However, this measure requires additional costs, which are 10–12% of the costs for growing sunflower.

One of the ways to reduce the cost of purchasing herbicides, increase their arable land, reduce production costs and residual amount of drugs in plant products, significantly reduce the level of environmental pollution is the introduction in combination with mechanical measures in the care of crops. The use of mechanical working bodies (cultivators with hiking legs, rotary working bodies), improving the process of weeding in the rows of sunflower plants reduces the death of cultivated plants from pruning, destroys weeds, prevents erosion, reduces the cost of herbicides by 50–60%, facilitates the working conditions of machine operators.

Studies have shown that in the phase of 6–7 leaves of sunflower, on average over the years of research (Table 1.), the least weed seedlings were after plowing to a depth of 25–27 cm. In the version without herbicides and mechanical control of weeds during the growing season there were 83 pcs/m^2 of wild plants. Against the background of chisel cultivation, at the same depth, the number of weeds increased 2.3 times and amounted to 195 pcs/m^2.

Protecting sunflower crops against weeds has significantly reduced their numbers. Thus, with the introduction of herbicides on the background of plowing, their number decreased by 87–92%. The highest efficiency of chemicals was with the application of Harnes at a rate of 2.0 l/ha for pre-sowing cultivation and Fusilade forte at a rate of 1.5 l/ha in the phase of 2–4 leaves in weeds, reducing the number of weeds was 92%.

Applying separately Harnes at a rate of 2.0 l/ha and Fusilade forte at a rate of 1.5 l/ha reduced the effectiveness of these drugs, reducing the number of weeds was 87 and 89%, respectively. Against the background of shelf-free treatment with herbicides, the number of weeds in the phase of 6–7 leaves of sunflower decreased by 62–86%, including in the case of application of Harnes for pre-sowing cultivation at a rate of 2.0 l/ha and Fusilade forte, 5 l/ha) the number of weeds decreased by 82–83%.

Table 1

Effect of basic soil tillage and crop care on weediness of sunflower crops (phase 6-7 leaves, average for 2019–2020), pcs/m²

Basic soil tillage	Care of crops					
	Without herbicides and mechanical weeding	Harness, 2.0 l / ha	Fusilade forte, 1.5l / ha	Harness, 2.0 l / ha + Fusilade forte, 1.5 l / ha	Mechanized cultivation	Combined
Shelf tillage (plowing)	83 / 0	11 / -87	9 / -89	7 / -92	12 / -86	2 / -98
Tillage-free tillage by 25–27 cm	195 / +135	19 / -77	15 / -82	12 / -86	17 / -80	3 / -90
Shallow tillage by 12–14 cm	217 / +161	27 / -68	18 / -78	14 / -83	21 / -75	5 / -94

* – numerator – number of weeds, pcs/m2
* – denominator – ± to control, %

The lower efficiency of herbicides against the background of no-tillage cultivation, compared to plowing, is explained by the placement of a significant part of crop by-products in the upper soil layer, which adsorbs chemicals, including herbicides. The amount of absorbed chemicals of herbicides depends on the unit surface area and soil moisture.

In the variant with mechanical measures to protect sunflower crops from weeds (before seedling and post-emergence harrowing 2 inter-row treatments with hilling of sunflower plants) there was a decrease in the phase of 6–7 leaves in sunflower from 75 to 86%. The cleanest sunflower crops were in a variant with a combination of mechanical and chemical protection measures (combined), where one pre-emergence and one post-emergence harrowing with dental harrows, tape application of Fusilade forte at the rate of 0.5 l/ha with two inter-row treatments and hilling of sunflower plants were carried out. The number of weeds was reduced by 93–98%, regardless of the methods and depth of the main tillage.

Accounting for weediness of sunflower crops in the flowering phase showed that on average over two years of research in the version without herbicides and mechanical weeding (control) the number of weeds decreased compared to the account in the phase of 6–7 leaves of sunflower by 24% and amounted to 63 pcs/m². This decrease is explained by both intraspecific and interspecific competition of plants for life factors, as well as for spatial distribution. Carrying out shelf-free treatments contributed to an increase in the number of weeds in the flowering phase of sunflower compared to the control (Table 2).

The introduction of only mechanical care for sunflower plants has shown that it is not possible to solve the problem of weed damage by pre-emergence, post-emergence and inter-row treatments. Against the background of plowing in the flowering phase of sunflower, the number of weeds increased, compared to the phase of 6–7 leaves by 42% and amounted to 17 pieces/m². Shelfless cultivation helped to place the bulk of weed seeds in upper 0–10 cm layer of soil, which led to increased weediness of sunflower crops. During the entire growing season, this increase was 1.0–1.3 times compared to the control. The cleanest sunflower crops throughout the growing season were when using mechanical and chemical crop care products (combined option). The number of weeds in the flowering phase of sunflower ranged from 4 to 11 pcs/m², regardless of the method and depth of the main tillage. This number of weeds did not significantly reduce crop productivity.

Table 2

Effect of basic soil tillage and crop care on the actual weediness of sunflower crops (flowering phase, average for 2019–2020), pcs/m²

Basic soil tillage	Care of crops					
	Without herbicides and mechanical weeding	Harness, 2.0 l / ha	Fusilade forte, 1.5 l / ha	Harness, 2.0 l / ha + Fusilade forte, 1.5 l / ha	Mechanized cultivation	Combined
Shelf tillage (plowing)	63 / 0	11 / -83	9 / -86	7 / -89	17 / -73	4 / -94
Tillage-free tillage by 25–27 cm	119 / +89	19 / -70	17 / -73	13 / -79	24 / -62	9 / -86
Shallow tillage by 12–14 cm	131 / +108	21 / -67	15 / -76	15 / -76	26 / -59	10 / -84

* – numerator – number of weeds, pcs/m²
* – denominator – ± to control,%

An integrated indicator of the studied measures to optimize weed control of sunflower crops is its yield and seed quality. These indicators depend on many factors, namely: the type of soil and its fertility, the number and in the optimal ratios of plant life factors, weather conditions, cultivation technology, etc. [4]. However, weeds are a factor that significantly affects the competitive relationship of cultivated plants with weeds, the number and weight of them increases, and yields decrease and, conversely, the shorter the period of presence of weeds in sunflower crops, the number and weight they do not exceed the threshold of harmfulness. On average, over the years of research, it was found that the highest yield of sunflower seeds was obtained by tillage and arable to a depth of 25–27 cm for combined care of crops. In these variants, the yield of sunflower seeds was 4.0 t/ha (Table 3).

The problem of protecting crops from crop losses is global in nature for countries with different levels of development. The main weed control measures in field crops, including sunflower, are mechanical, phytocenotic and biological. Unfortunately, the latter are still insufficiently studied and are insufficiently used in Ukraine. However, chemical weed control measures are the most common and are one of the elements of agricultural chemicalization.

For the problem of chemical protection of crops, including sunflower, it is necessary to know two main issues – the impact of weeds on crop productivity and crop quality, as well as the role of herbicides in changing physiological processes that cause deterioration.

Table 3.

Yield of sunflower seeds, t/ha

Basic tillage	Care of crops	2019	2020	Average for 2019–2020 pp.	± to control	
					t/ha	%
Shelf tillage (plowing) at 25–27 cm	Without herbicides and mechanical weeding (control)	1,2	1,0	1,1	0	0
	Harness, 2.0 l/ha	3,4	3,2	3,3	+2,2	+200
	Fusilade forte, 1.5 l/ha	3,4	2,8	3,1	+2,0	+182
	Harness, 2.0 l/ha + Fusilade forte, 1.5 l/ha	4,0	3,4	3,7	+2,6	+236
	Mechanized cultivation	3,5	3,1	3,3	+2,2	+200
	Combined	4,2	3,6	4,0	+2,9	+264
Tillage-free tillage (AGR-1,7) by 25-27 cm	Without herbicides and mechanical weeding (control)	1,0	0,8	0,9	-0,2	-18
	Harness, 2.0 l/ha	3,5	3,2	3,2	+2,1	+190
	Fusilade forte, 1.5 l/ha	3,4	2,7	3,0	+1,9	+172
	Harness, 2.0 l/ha + Fusilade forte, 1.5 l/ha	3,8	3,4	3,5	+2,4	+218
	Mechanized cultivation	3,3	2,5	2,9	+1,8	+164
	Combined	4,3	3,7	4,0	+2,9	+264
Shallow tillage (BDT-3) by 12–14 cm	Without herbicides and mechanical weeding (control)	1,2	1,1	1,0	-0,1	-9
	Harness, 2.0 l/ha	3,6	2,8	3,2	+1,9	+172
	Fusilade forte, 1.5 l/ha	3,1	2,7	2,9	+1,8	+164
	Harness, 2.0 l/ha + Fusilade forte, 1.5 l/ha	3,7	3,3	3,5	+2,4	+218
	Mechanized cultivation	3,2	3,0	3,1	+2,0	+182
	Combined	3,9	3,7	3,8	+2,7	+245

To develop patterns of formation of quality indicators of sunflower seeds, this crop is the most convenient object in the study, which is characterized by the highest yield losses from weeds and a fairly wide range of herbicides.

Studies by many scientists [7, 8] found that the chemical composition of many crops, including sunflower seeds, depends on the morphological characteristics of varieties and hybrids, and the conditions of their cultivation. It is known that the value of agricultural measures not only increases the yield, but also increases the content of protein and carbohydrates in cereals and legumes, fat content in sunflower seeds and more.

In our studies, the reduction in yield and quality of sunflower seeds occurred with the introduction of only mechanical weed control measures. With a high level of weeds, controlling the amount, especially the mass of weeds, below the hazard threshold by mechanical means alone is not possible.

The combination of mechanical and chemical (herbicides) contributed to the best growth and development of the crop, obtaining high yields of seeds with high oil content. A generally accepted theory is the relationship between yield and quality of crop products. It is proved that with the growth of crop yields there is a decrease in production.

Our research has shown that this statement is valid only in cases where there are disparities between the factors of plant life. Decreased yields of sunflower seeds under the influence of competitive weeds is a special case of this conclusion. Indeed, weeds limit resources such as moisture, nutrients and light. On the other hand, weed control improves the growth and development of crops, which cause not only the growth of the crop, but also its quality.

Thus, weed vegetation is the most potent factor in restraining sunflower seed yields.

Conclusions.

According to the results of experimental research in the master's thesis, a comprehensive system of protection of sunflower crops from weeds in the experimental field of VNAU is substantiated.

1. Species diversity of weeds in sunflower crops in the experimental field of VNAU was formed under the influence of climatic and soil conditions, anthropogenic factors and their interaction. The dominant type of weed control in agriculture in this area is.

2. Decreased yield and gross yield of sunflower seeds due to the low competitiveness of this crop to weeds and high weeds of soil and crops with harmful and difficult to eradicate weeds. The seed yield of the medium-early Torino sunflower hybrid (the growing season is 113–115 days) is reduced by 67%.

3. The cleanest sunflower crops were the combined care of crops by pre-emergence and post-emergence harrowing with toothed harrows in the «white thread» phase of weeds. Fusilade forte was applied in the phase of 2–4 leaves in perennial and at a height of 10–15 cm perennial cereal weeds at the rate of 0.5 l/ha with a tape of up to 15 cm. in a row of sunflowers.

4. The combination of deep (25–27 cm) shelfless tillage (chisel deep cultivator AGR–1.7) of the soil and combined care of crops by mechanical measures and chemicals provides the highest rates of growth and preservation of sunflower yield. The yield of sunflower seeds, on average over the years of research, was 4.0 t/ha.

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ФОРМУВАННЯ ФОТОСИНТЕТИЧНОЇ ТА НАСІННЄВОЇ ПРОДУКТИВНОСТІ СОЇ ПІД ВПЛИВОМ ІНОКУЛЯЦІЇ ТА МІНЕРАЛЬНИХ ДОБРИВ В УМОВАХ ЛІСОСТЕПУ ПРАВОБЕРЕЖНОГО УКРАЇНИ

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PHOTOSYNTHETIC AND SEED PRODUCTIVITY FORMATION OF SOYBEANS UNDER THE INFLUENCE OF INOCULATION AND MINERAL FERTILIZERS IN THE CONDITIONS OF THE RIGHT-BANK FOREST-STEPPE OF UKRAINE

Анотація.
У статті показано вплив агротехнічних прийомів вирощування на формування фотосинтетичної та насіннєвої продуктивності сої. Визначено, що найбільш ефективним є внесення мінеральних добрив у нормі $N_{30}P_{60}K_{60}$ + N_{15} *та проведення інокуляції насіння препаратом на основі штамів бульбочкових бактерій (Br. japonicum) і фосфатмобілізуючих мікроорганізмів (B. mucilaginosus).*

Abstract.
The article shows agronomic methods of cultivation influence the photosynthetic and seed productivity formation of soybeans. It was determined that the most effective is the mineral fertilizers application in the dose $N_{30}P_{60}K_{60}$ *+ N15 and seeds inoculation by a drug based on strains of nodule bacteria (Br. Japonicum) and phosphate-mobilizing microorganisms (B. mucilaginosus).*

***Ключові слова**: соя, мінеральні добрива, інокуляція, фотосинтетичний потенціал, чиста продуктивність фотосинтезу, суха речовина, урожайність.*
***Keywords**: soybean, mineral fertilizers, inoculation, photosynthetic potential, net productivity of photosynthesis, dry matter, yield.*

Основою створення і накопичення органічної речовини зеленими рослинами є фотосинтез, в результаті якого формується до 90-95 % сухої маси урожаю. Саме тому, продуктивність фотосинтезу – головний фізіологічний показник, який відображає реакцію рослинного організму на умови зовнішнього середовища, в тому числі, на технологію вирощування [5, 2].

Вченими доведено [1, 3, 4, 5], що агротехнічні прийоми, спрямовані на зростання врожайності сої, вважаються ефективними, якщо вони сприяють швидкому наростанню площі листя до оптимальних розмірів і збереженню його в активному стані впродовж тривалого часу; якщо вони підвищують продуктивність роботи асиміляційного апарату і коефіцієнт використання рослинами сонячної енергії, а також, якщо вони покращують використання продуктів фотосинтезу. Одними з таких агротехнічних заходів є мінеральні добрива та інокуляція насіння [2, 3, 6].

Метою досліджень було виявити вплив інокуляції насіння у поєднанні з внесенням мінеральних добрив на формування фотосинтетичної та насіннєвої продуктивності сої в умовах Лісостепу правобережного України.

Польові дослідження проводились впродовж 2013-2015 рр. на дослідному полі Інституту біоенергетичних культур і цукрових буряків НААН України на базі ДПДГ «Саливонківське». Ґрунт дослідної ділянки – чорнозем типовий малогумусний середньосуглинковий за гранулометричним складом. Вміст гумусу в шарі 0-20 см – 4,56 %. Погодні умови в роки проведення досліджень були різними. У 2013 році середньодобова температура впродовж вегетації рослин становила 19,1-19,8 ºС, сума опадів – 251,4-334,0 мм, сума активних температур (>10, ⁰С) – 2019,5-2258,7 ºС. У 2014 році значення цих показників становили, відповідно 18,6-19,5 ºС, 308,7-337,2 мм та 2003,7-2216,7 ºС; у 2015 році – 21,1-21,6 ºС, 135,3-166,5 мм та 2040,5-2324,4 ºС.

Закладенням польового досліду передбачалось вивчення дії та взаємодії трьох факторів: А – сорт («Вільшанка», «Сузір'я»); Б – передпосівна обробка насіння (без інокуляції, «Фосфонітрагін»); В – удобрення (без добрив (контроль); $P_{60}K_{60}$; $N_{15}P_{60}K_{60}$; $N_{30}P_{60}K_{60}$; $N_{45}P_{60}K_{60}$; $P_{60}K_{60}$ +N_{15}; $N_{15}P_{60}K_{60}$ + N_{15}; $N_{30}P_{60}K_{60}$ + N_{15}). Повторність досліду – чотириразова. Розміщення варіантів – систематичне. Площа облікових ділянок – 25 м^2. Попередник – пшениця озима. Норма висіву – 700 тис. насінин на 1 га.

Дослідження свідчать, що на покращення умов живлення рослини сої обох сортів реагували зростанням площі листкової поверхні (табл. 1).

Таблиця 1

Показники фотосинтетичної продуктивності сої залежно від інокуляції та норм мінеральних добрив, у середньому за 2013-2015 рр.

Удобрення	Інокуляція	Площа листя, тис.м^2/га	Фотосинтетичний потенціал, млн м^2 ·днів/га	Чиста продуктивність фотосинтезу, г/м^2 добу		Накопичення сухої речовини, т/га
		наливання бобів	повні сходи - початок фізіологічної стиглості	повні сходи – початок цвітіння	кінець цвітіння – повне наливання бобів	фізіологічна стиглість
Вільшанка						
Без добрив (контроль)	б/і	34,8	2,097	2,10	1,45	3,81
	і	37,3	2,609	2,65	1,57	4,93
$P_{60}K_{60}$	б/і	37,0	2,327	2,43	1,51	4,47
	і	39,6	2,832	3,07	1,79	5,40
$N_{15}P_{60}K_{60}$	б/і	37,8	2,546	2,75	1,58	4,64
	і	40,1	3,039	3,42	1,89	5,52
$N_{30}P_{60}K_{60}$	б/і	39,1	2,621	3,02	1,67	4,85
	і	42,0	3,167	3,78	2,02	5,66
$N_{45}P_{60}K_{60}$	б/і	40,4	2,716	3,22	1,72	4,97
	і	42,7	3,249	4,01	2,16	5,71
$P_{60}K_{60}$ +N_{15}	б/і	38,7	2,563	2,52	1,61	4,69
	і	41,6	3,102	3,27	1,92	5,56
$N_{15}P_{60}K_{60}$ + N_{15}	б/і	41,1	2,817	2,83	1,77	5,39
	і	43,7	3,378	3,51	2,23	6,32
$N_{30}P_{60}K_{60}$ + N_{15}	б/і	42,5	3,027	3,11	1,85	5,51
	і	45,1	3,481	3,85	2,31	6,51
Сузір'я						
Без добрив (контроль)	б/і	35,7	2,182	2,29	1,58	4,34
	і	37,9	2,614	2,81	1,78	5,19
$P_{60}K_{60}$	б/і	38,3	2,416	2,71	1,80	5,02
	і	40,6	2,865	3,36	1,98	5,60
$N_{15}P_{60}K_{60}$	б/і	39,5	2,623	3,08	1,91	5,16
	і	41,8	3,098	3,79	2,10	5,76
$N_{30}P_{60}K_{60}$	б/і	40,8	2,731	3,39	1,98	5,32
	і	43,2	3,161	4,15	2,24	6,11
$N_{45}P_{60}K_{60}$	б/і	42,0	2,843	3,42	2,06	5,34
	і	44,1	3,281	4,21	2,30	6,21
$P_{60}K_{60}$ +N_{15}	б/і	40,3	2,649	2,82	1,95	5,20
	і	42,7	3,117	3,61	2,17	5,86
$N_{15}P_{60}K_{60}$ + N_{15}	б/і	42,9	2,984	3,18	2,15	5,94
	і	45,5	3,496	3,91	2,36	6,84
$N_{30}P_{60}K_{60}$ + N_{15}	б/і	44,2	3,156	3,40	2,23	6,21
	і	46,8	3,647	4,17	2,48	7,15
$НІР_{0,05}$		2,2	-	-	-	1,17

***Примітка**: б/і – насіння без інокуляції; і – інокульоване насіння.

Найбільших розмірів асиміляційна поверхня досягала у фазі наливання бобів, коли рослини в більшій мірі потребують продуктів фотосинтезу для їх накопичення у насінні та становила 34,8-45,1 тис.м^2/га у сорту Вільшанка і 35,7-46,8 тис. м^2/га – у сорту Сузір'я. За рахунок лише інокуляції насіння препаратом на основі штамів бульбочкових бактерій (*Br. japonicum*) і фосфатмобілізуючих мікроорганізмів (*B. mucilaginosus*) площа листя в посівах сої на неудобреному варіанті зростала на 7,2 % у сорту Вільшанка та на 6,2 % – у сорту Сузір'я. Внесення мінеральних добрив обумовлювало більш інтенсивне наростання листової поверхні – на 6,3-23,8 %, залежно від сорту та норми і строків внесення мінеральних добрив. Причому, збільшення норми азотних добрив та внесення їх роздрібним способом, порівняно з одноразовим, сприяло інтенсивнішому приросту площі листя на посівах обох сортів сої. Максимальну площу асиміляційної поверхні посіви сої формували на варіантах, що передбачали сумісну дію інокулянту та внесення мінеральних добрив у нормі $N_{30}P_{60}K_{60}$ + N_{15} – 45,1 тис. м²/га у сорту Вільшанка та 46,8 тис. м²/га у сорту Сузір'я.

Одним з показників, що дозволяють оцінити ефективність діяльності листкової апарату рослин є фотосинтетичний потенціал посіву, який відображає тривалість активної роботи листя на одиниці площі та більш повно, ніж розмір листкової поверхні характеризує реальні можливості посіву щодо синтезу органічної речовини [2]. Визначено, що найвищий фотосинтетичний потенціал – на рівні 2,097-3,647 млн м²×діб/га посіви сої формували за період повні сходи- початок фізіологічної стиглості, досягаючи максимальних значень (у сорту Вільшанка – 3,481 млн м²×діб/га, у сорту Сузір'я – 3,647 млн м²×діб/га) на варіантах, на яких насіння перед посівом обробляли фосфонітрагіном та вносили $N_{30}P_{60}K_{60}$ + N_{15} у фазі бутонізації.

Динаміка формування чистої продуктивності фотосинтезу (ЧПФ), як і в дослідженнях інших авторів [2, 5], мала синусоїдний характер. Найвищі значення ЧПФ у сорту Вільшанка (2,10-3,85 г/м² за добу) та сорту Сузір'я (2,29-4,17 г/м² за добу) формувалися за період від повних сходів до початку цвітіння, що з одного боку обумовлювалось інтенсивними темпами наростання вегетативної маси, з іншого – завдяки ще незначній площі асиміляційної поверхні рослин, взаємозатінення рослин було відсутнє, що сприяло проходженню фотосинтезу в листках нижнього і верхнього ярусів з однаковою інтенсивністю. З кінця фази цвітіння до повного наливання бобів ЧПФ досягала свого другого максимуму – 1,45-2,48 г/м² за добу, залежно від варіанту досліджень.

Накопичення сухої речовини в рослинах обох сортів сої продовжувалось до фази фізіологічної стиглості насіння, досягаючи найвищих значень на варіантах, що передбачали поєднання бактеризації насіння та внесення мінеральних добрив, внаслідок чого вихід сухої речовини, відносно контролю, зростав на 41,7-70,9 % у сорту Вільшанка та 29,0-64,7 % у сорту Сузір'я. Найбільш ефективними (Вільшанка 6,51 т/га та Сузір'я 7,15 т/га) виявились ділянки, де вносили $N_{30}P_{60}K_{60}$ в основне удобрення та N_{15} у підживлення в фазі бутонізації і проводили оброблення насіння фосфонітрагіном.

За результатами кореляційно-регресійного аналізу встановлено, що сила зв'язку рівня урожайності насіння сої є значною та тісно корелює із накопиченням сухої речовини – коефіцієнт кореляції для сорту Вільшанка становив r =0,958, для сорту Сузір'я – r =0,970 (рис. 1).

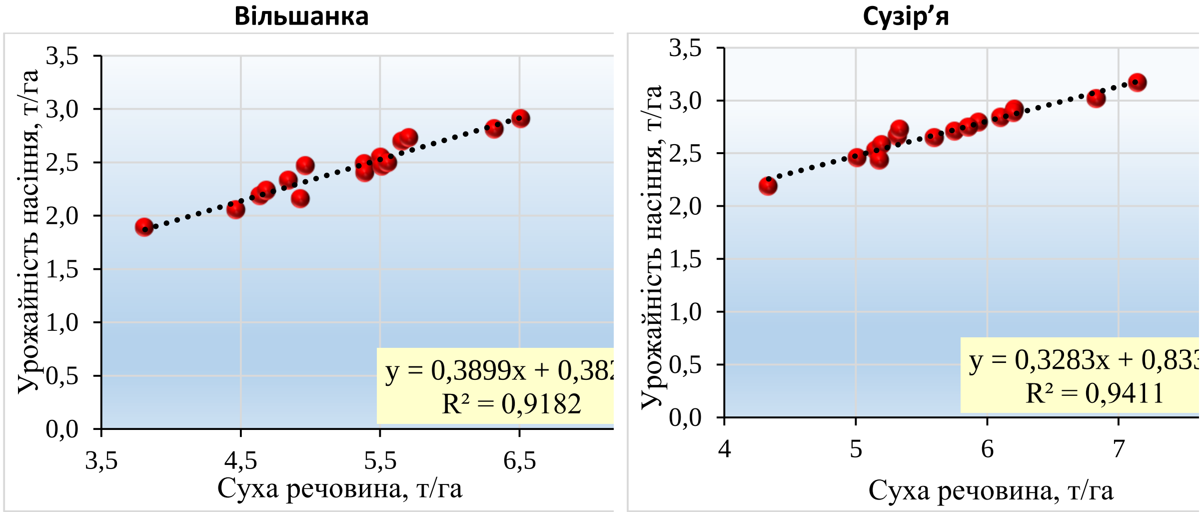

Рис. 1. Залежність урожайності насіння сої (у) від рівня накопичення сухої речовини (х), (у середньому за 2013-2015 рр.)

Основним критерієм оцінки роботи фотосинтетичного апарату є рівень урожайності насіння сої (табл. 2).

Таблиця 2

Урожайність насіння сої залежно від інокуляції та норм мінеральних добрив, т/га (у середньому за 2013-2015 рр.)

Удобрення	Інокуляція	Вільшанка			Сузір'я		
		урожайність, т/га	прибавка до контролю		урожайність, т/га	прибавка до контролю	
			т/га	%		т/га	%
Без добрив (контроль)	б/і	1,89	-	-	2,19	-	-
	і	2,16	0,27	14,3	2,43	0,24	11,0
$P_{60}K_{60}$	б/і	2,05	0,16	8,5	2,46	0,27	12,3
	і	2,40	0,51	27,0	2,65	0,46	21,0
$N_{15}P_{60}K_{60}$	б/і	2,18	0,29	15,3	2,53	0,34	15,5
	і	2,46	0,57	30,2	2,71	0,52	23,7
$N_{30}P_{60}K_{60}$	б/і	2,33	0,44	23,3	2,66	0,47	21,5
	і	2,70	0,81	42,9	2,84	0,65	29,7
$N_{45}P_{60}K_{60}$	б/і	2,47	0,58	30,7	2,73	0,54	24,7
	і	2,73	0,84	44,4	2,88	0,69	31,5
$P_{60}K_{60}$ +N_{15}	б/і	2,23	0,34	18,0	2,58	0,39	17,8
	і	2,50	0,61	32,3	2,74	0,55	25,1
$N_{15}P_{60}K_{60}$ + N_{15}	б/і	2,48	0,59	31,2	2,79	0,60	27,4
	і	2,81	0,92	48,7	3,02	0,83	37,9
$N_{30}P_{60}K_{60}$ + N_{15}	б/і	2,54	0,65	34,4	2,91	0,72	32,9
	і	2,91	1,02	54,0	3,17	0,98	44,7
$НІР_{0,05}$ (АБВ)		0,54	-	-	0,54	-	-

Примітка: б/і – насіння без інокуляції; і – інокульоване насіння.

Максимальний урожай сорти сої Вільшанка (2,91 т/га) та Сузір'я (3,17 т/га) формували на ділянках, які характеризувались найвищою фотосинтетичною продуктивністю. Порівняно з абсолютним контролем приріст урожаю на цих варіантах становив 54,0 та 44,7 %.

Отже, в умовах Лісостепу правобережного України на чорноземі типовому малогумусному середньосуглинковому внесення мінеральних добрив у нормі $N_{30}P_{60}K_{60}$ + N_{15} та проведення інокуляції насіння фосфонітрагіном сприяє формуванню максимальної фотосинтетичної продуктивності посівів та забезпечує рівень врожайність насіння у сорту Вільшанка 2,91 т/га, у сорту Сузір'я – 3,17 т/га.

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THE INFLUENCE OF MINERAL FERTILIZERS AND BIOPREPARATION ON THE GROWTH AND DEVELOPMENT OF SOYBEAN PLANTS

Abstract.

According to the results of research and their analysis, it was found that the maximum height of 112,2 cm soybean plants are formed during pre-sowing treatment of seeds with biological product Organic-Balance (1,5 l/t) in combination with foliar fertilization with the same drug (2,0 l/ha) against the background of mineral fertilizers in the dose of $N_{30}P_{45}K_{45}$. The largest average daily linear gain was also observed for this cultivation technology. Thus, the results of our research indicate that for the formation of the maximum leaf surface area – 46,5 thousand m^2/ha, the best conditions are created by providing plants with mineral fertilizers at a dose of $N_{30}P_{45}K_{45}$, and at the same time improving the processes of photosynthesis due to seed treatment before sowing with the biological product Organic-Balance (1,5 l/t) and foliar fertilization in the budding phase with the same drug (2,0 l/ha). It is established that a systematic approach to soybean nutrition, namely its cultivation on the background of optimal doses of mineral fertilizers $N_{30}P_{45}K_{45}$ and the use of biological product Organic-Balance for seed treatment in combination with foliar feeding creates the best conditions for growth, development and preservation of maximum plants full ripeness, which is the basis for obtaining high grain yields.

Keywords: *seed treatment, foliar feeding, biological products, legumes.*

Formulation of the problem. To create a highly productive soybean crop, it is important to form the optimal density of standing plants and ensure their good growth and development. The initial period of plant development is crucial, because at this time the density of standing plants, their subsequent growth and yield potential of sowing is determined [36]. For the formation of highly productive crops, it is important to obtain the optimal number of plants per unit area, taking into account the variety, nutrition background, water supply, etc. [41].

According to the results of research, the recommended soybean sowing rates have been determined. For the soil-climatic zone of the Forest-Steppe for early-ripening varieties the norm is 700 - 800 thousand/ha of similar seeds, for medium-early-ripening - 600 - 700 thousand/ha, and for varieties of later-ripening group of maturity - 500 - 550 thousand/ha of similar seeds [9]. One of the most important problems of plant growth and development in the technology of crops, including soybeans, is their growth processes. In terms of scientific support and practical significance, a significant amount of field research in crop production aims to learn the hypothesis of complex mechanisms of the stages of organogenesis of culture and on the basis of this knowledge and patterns to create favorable conditions for plant growth, development and productivity. Therefore, the formation of leaves and inflorescences, the height of plants and the height of attachment of the lower bean significantly influenced the formation of stems and soybean yields [15, 16]. The highest and best quality crops of agricultural plants can be obtained in crops with the optimal size of the leaves, the optimal course of its formation and structure [5, 20]. The optimal growth of the leaf surface and the formation of high photosynthetic potential of the leaves largely depend on the validity of cultivation technologies that provide longer operation of the leaf apparatus [8, 12].

An integral condition for obtaining high soybean yields is the presence of an optimal leaf surface area and an increase in the organic matter synthesized by it. In the formation of the leaf surface area of crops and the efficiency of their use, the sowing rate and sowing methods play an important role. Providing a more uniform distribution of plant area of nutrition and optimizing the area of nutrition of each plant can achieve maximum efficiency of its functioning and absorption of a larger share of photosynthetic active radiation [7,10]. The small area of the leaf surface is the cause of insufficient use of photosynthetically active radiation, at the same time too large area leads to mutual shading of the leaves and, therefore, a significant part of them in the lower tier falls [54].

Presentation of the main research material. Twice during the growing season of the culture was determined by the density of plants in fixed areas, which were fixed after emergence. At the onset of the full germination phase, the first plant density calculation was performed, and it was counted a second time before harvest. Field germination of seeds is possible to determine by conducting the first record at a known seeding rate, and the second record makes it possible to determine the survival for the harvest period. At the time of full germination, the density of soybean plants ranged from 481 thousand/ha to 527 thousand/ha, while the field germination was, respectively, 87,4 – 95,7% on average over the years of research (2019 - 2020 years), (Tab. 1).

Table 1

Influence of fertilizer level and application of microelement complex on field germination and preservation of soybean plants, on average for 2019–2020.

Fertilizer level	Biopreparation treatment	Density of standing plants, thousand/ha		Field similarity,%	Plant conservation rate,% to the number of seedlings
		Full shoots	Full maturity		
without fertilizers	1	481	414	87,4	86,2
	2	508	441	92,2	86,9
	3	483	426	87,7	88,2
	4	509	453	92,5	89,0
$P_{45}K_{45}$	1	486	431	88,3	88,6
	2	513	461	93,3	90,0
	3	488	447	88,6	91,7
	4	515	476	93,6	92,4
$N_{30}P_{45}K_{45}$	1	489	450	88,8	92,1
	2	525	485	95,4	92,5
	3	492	465	89,4	94,6
	4	527	503	95,7	95,5

Note: 1. Without processing; 2. Seed treatment Organic-Balance; 3. Foliar feeding Organic-Balance; 4. Seed treatment + foliar feeding Organic-Balance.

It was found that the application of mineral fertilizers did not have a significant effect on the growth of field germination rates. An increase in the field germination index by 0,9 % was observed in the variant of application of mineral fertilizers in the dose of $P_{45}K_{45}$, and in the case of application of $N_{30}P_{45}K_{45}$, respectively by 1,4 % in comparison with the control variant without application of fertilizers.

It was found that a significantly better increase in the field germination of soybean seeds provided pre-sowing treatment with the biological product Organic-Balance. Depending on the level of mineral nutrition, pre-sowing seed treatment provided an increase in field germination by 4,8 – 6,6 % on average over the years of research. The highest rate of field germination of seeds on average over the years of research was recorded in the variants of the experiment where mineral fertilizers were applied at a dose of $N_{30}P_{45}K_{45}$ and pre-sowing treatment of seeds with biological product Organic-Balance was 95,7%.

The results of research indicate that the rate of field germination of soybeans increased during pre-sowing seed treatment, while the implementation of foliar fertilization had a positive effect on the preservation of plants during the growing season.

The results of observations of the dynamics of plant density of soybean varieties during the growing season indicate that it decreases slightly as it grows and develops. This phenomenon occurs due to the loss of plants from crops as a result of a number of factors, in particular, hydrothermal, biotic, soil and to a lesser extent anthropogenic. As a result, in the phase of full maturity of plants, their density in all variants of the experiment was at the level of 414 to 503 thousand/ha.

It was found that as a result of the research the most favorable conditions for growth and development, and as a result the highest survival rate of soybean plants, were recorded in the variants of the experiment where mineral fertilizers were applied at a dose of $N_{30}P_{45}K_{45}$ and combined pre-sowing seed treatment with foliar fertilization in budding Organic Balance. The conservation rate of soybean plants in this variant of the experiment was 95,5 %. The survival rate of plants decreased by 9,3% in the control version of the experiment where no fertilizers were used and no treatment with biological product was used.

The coefficient of preservation of soybean plants at the time of the phase of full maturity was lower in the variants of the experiment, where seed treatment and foliar fertilization were carried out with the application of mineral fertilizers at a dose of $N_{30}P_{45}K_{45}$ and amounted to 92,5 – 94,6 %, respectively. That is why it is established that a systematic approach to soybean nutrition, namely its cultivation on the background of optimal doses of mineral fertilizers $N_{30}P_{45}K_{45}$ and the use of biological product Organic-Balance for seed treatment in combination with foliar fertilization creates the best conditions for growth, development and preservation of maximum plants at the time of full ripeness, which is the basis for obtaining high grain yields.

The height of the plant, its lodging and the height of attachment of the lower beans are one of the main features of soybeans, which determine its suitability for full mechanized cultivation from sowing to harvesting. The height of plants varies depending on the variety, year of cultivation, soil and climatic conditions and agronomic techniques used [3]. Due to the height of plants, the number of productive nodes may increase (varieties with incomplete type of growth - indeterminate), but this feature is undesirable due to shading of the lower tiers, while reducing the flow of solar insolation to the plant [7].

The stem height of soybean plants, according to the results of the research, largely depended on the hydrothermal conditions of the year and the factors that were studied and analyzed (doses of mineral fertilizers and methods of treatment with biological products).

During the observations in the experiment it was found that in the initial period soybean plants develop quite slowly. The soybean stalk begins to branch with the development of the first - third true leaf.

From this moment the process of vegetative phases of growth and development begins, the stem begins to grow actively until flowering, after which the generative stage begins, during which the growth of the stem almost stops, and the formation of leaves is completed.

In general, during the years of research (2019 - 2020) the highest indicator of soybean plant height was formed in the phase of full maturity at the level of 112,2 cm in those variants of the experiment where mineral fertilizers were applied at a dose of $N_{30}P_{45}K_{45}$ and seeds were treated with Organic Balance (1,5 l/t) in combination with the use of foliar fertilization in the budding phase of this drug at a rate of 2,0 l/ha, which is 24,4 cm more than in the control version (without mineral fertilizers and Organic Balance) (Tab. 2).

Table 2

Influence of the level of fertilizer and biological preparation treatment on the height of soybean plants, on average for 2019–2020, cm

Fertilizer level	Biopreparation treatment	The third trifoliate leaf	The beginning of flowering	End of flowering	Full maturity
without fertilizers	1	11,7	30,3	67,6	87,8
	2	13,6	32,1	69,2	89,7
	3	11,7	35,4	71,6	91,9
	4	13,5	36,1	73,5	93,5
$P_{45}K_{45}$	1	13,0	34,7	77,9	98,7
	2	14,7	37,3	80,3	101,0
	3	13,2	39,0	82,1	103,5
	4	15,3	40,8	83,6	104,7
$N_{30}P_{45}K_{45}$	1	14,0	39,3	82,1	104,1
	2	16,1	42,3	85,5	106,2
	3	13,5	44,8	87,5	109,1
	4	15,8	46,0	88,9	112,2

Note: 1. Without processing; 2. Seed treatment Organic-Balance; 3. Foliar feeding Organic-Balance; 4. Seed treatment + foliar feeding Organic-Balance.

The study of stem height indicators in soybean plants in the dynamics of growth and development shows that the use of intensification factors contributed to their significant growth. Thus, the use of mineral fertilizers and complex treatment with biological products has led to more active plant growth and an increase in stem height since the beginning of plant vegetation. Improving the mineral nutrition of soybean plants due to the introduction of $P_{45}K_{45}$ contributes to the growth of their height of 98,7 cm, which is 10,9 cm more than the control.

Seed treatment and foliar feeding with Organic-Balance had a positive effect on the formation of plant height. In those variants of the experiment, where pre-sowing treatment of seeds with a biological product was performed, the height index in soybean plants was 1,9 – 2,3 cm higher at the time of full maturity.

According to the results of research and their analysis, it was found that the maximum height of 112,2 cm soybean plants are formed during pre-sowing treatment of seeds with biological product Organic-Balance (1,5 l/t) in combination with foliar fertilization with the same drug (2,0 l/ha) against the background of mineral fertilizers in the dose of $N_{30}P_{45}K_{45}$. The largest average daily linear gain was also observed for this cultivation technology.

According to the results of many studies, the optimal leaf surface area, which forms the highest yield of soybean seeds, is 40-50 thousand m^2/ha. The level of this indicator depends on the morphobiotype of varieties, weather conditions of vegetation, the nature of the distribution of plants by sown area [13, 31].

If the leaf surface area is smaller, then the optical-biological structure of the crop is not optimized and therefore the headlights are not used rationally. However, a larger leaf surface area is undesirable, because as a result of mutual shading, a significant part of the leaves in the lower tier falls off, and the rest does not work effectively [5, 17].

According to the research of scientists, the best indicators of photosynthetic productivity of soybean varieties of different maturity groups in the southern part of the Western Forest-Steppe of Ukraine were found against the background of mineral fertilizers in the norm $N_{30}P_{45}K_{45}$ [24]. Intensive vegetative growth in soybean plants begins after the emergence of shoots and primordial leaves, and along with this there is an increase in leaf area.

According to the results of the observations, it was found that the doses of mineral fertilizers and methods of treatment with the biological product Organic-Balance had a significant impact on the formation of the leaf surface area. The lowest indicator of leaf area on average during the years of research in the phase of seed filling (2019 - 2020), was recorded in the control version of 30,9 thousand m^2/ha. (tab. 3).

Table 3

Dynamics of the leaf surface area growth of soybean plants varieties depending on the level of fertilizer and biological product treatment, on average for 2019-2020, thousand m^2/ha

Fertilizer level	Biopreparation treatment	Phases of plant growth and development				
		the third trifoliate leaf	the beginning of flowering	end of flowering	pouring seeds	the beginning of physiological maturity
Without fertilizers	1	6,6	17,6	28,8	30,9	16,7
	2	8,5	19,0	30,7	33,0	17,8
	3	6,4	19,9	31,6	34,4	20,0
	4	9,0	21,4	32,7	35,5	21,2
$P_{45}K_{45}$	1	9,9	23,8	35,3	37,8	22,8
	2	12,1	25,7	37,4	40,2	24,2
	3	9,5	26,9	38,6	41,0	25,5
	4	12,0	28,8	40,2	42,4	27,3
$N_{30}P_{45}K_{45}$	1	11,6	27,0	37,1	39,4	23,6
	2	13,9	29,8	40,7	42,2	25,5
	3	11,7	31,1	42,4	44,6	27,3
	4	14,5	33,3	45,0	46,5	28,5

Note: 1. Without processing; 2. Seed treatment Organic-Balance; 3. Foliar feeding Organic-Balance; 4. Seed treatment + foliar feeding Organic-Balance.

The cessation of vegetative growth during the beginning of the generative phase of growth when the beans are formed and the seeds begin to pour leads to a decrease in the growth rate of the leaf surface. The studied elements of soybean growing technology contributed to the lengthening of the process of leaf surface area formation. The largest indicator of leaf surface area on average over the years of research was formed in the phase of pouring seeds on all variants of the experiment.

It is worth noting the effect of mineral fertilizers on the leaf surface area. According to the results of the research presented in the table, it can be concluded that mineral fertilizers play both a leaf-preserving and a regulatory role. Due to the intensive action not only on the growth processes associated with the leaf apparatus, but also with the growth of other parts of plants, fertilizers increase the total weight of the plant and this is the regulatory role of mineral fertilizers.

Fertilization with phosphorus-potassium mineral fertilizers in the dose of $P_{45}K_{45}$ on the corresponding variants of the experiment contributed to the increase of the leaf surface area by 19,0–22,4% or 5,8 – 6,9 thousand m^2/ha in comparison with the control variant, use for fertilization of complete mineral fertilizer $N_{30}P_{45}K_{45}$, the leaf surface area increased by 24,6–27,7% or by 7,5 – 8,5 thousand m^2/ha relative to the control. Thus, the control indicator of the leaf surface area in the seed filling phase was at the level of 30,9 thousand m^2/ha, and for the application of $P_{45}K_{45}$ and $N_{30}P_{45}K_{45}$ this indicator was recorded, respectively, 37,8 and 39,4 thousand m^2/ha.

Not only mineral fertilizers had a positive effect on the growth of the leaf surface, but also pre-sowing seed treatment with Organic-Balance and foliar fertilization with the same drug had a stimulating effect. In the phase of seed filling on the variants of the experiment where pre-sowing treatment with the biological product Organic-Balance was carried out, the leaf surface area was higher in comparison with the variants without the use of the biological product by 6,3–7,1 %. An increase in the leaf surface area by 8,5–13,2 % was also observed in the variants of the experiment with the use of foliar feeding with the biological product Organic-Balance in the budding phase. But it should be noted that as a result of research it was found that pre-sowing treatment of seeds with the biological product Organic-Balance in combination with foliar feeding with the same drug in the budding phase was the most effective technological method. In these variants of the experiment, the indicator of the leaf surface area exceeded the variants without treatment by 12,2 – 18,1%. It should be noted that the largest increase in leaf surface was recorded with the application of complete mineral fertilizer $N_{30}P_{45}K_{45}$.

Conclusions. According to the results of research and their analysis, it was found that the maximum height of 112,2 cm soybean plants are formed during pre-sowing treatment of seeds with biological product Organic-Balance (1,5 l/t) in combination with foliar fertilization with the same drug (2,0 l/ha) against the background of mineral fertilizers in the dose of $N_{30}P_{45}K_{45}$. The largest average daily linear gain was also observed for this cultivation technology. Thus, the results of our research indicate that for the formation of the maximum leaf surface area – 46,5 thousand m^2/ha, the best conditions are created by providing plants with mineral fertilizers at a dose of $N_{30}P_{45}K_{45}$, and at the same time improving the processes of photosynthesis. due to the treatment of seeds before sowing with the biological product Organic-Balance (1,5 l/t) and foliar feeding in the budding phase of the same drug (2,0 l/ha). It is established that a systematic approach to soybean nutrition, namely its cultivation on the background of optimal doses of mineral fertilizers $N_{30}P_{45}K_{45}$ and the use of biological product Organic-Balance for seed treatment in combination with foliar fertilization creates the best conditions for growth, development and preservation of maximum plants full ripeness, which is the basis for obtaining high grain yields.

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THE EFFECT OF DRY EXTRACT OF ECHINACEA PALLIDA ON THE PRODUCTIVITY AND FEED CONSUMPTION OF QUAILS

Abstract.

The aim of the experiment was to investigate the effect of dry echinacea extract on the productivity and feed consumption of Pharaoh meat quails.

The dry extract of the underground part of Echinacea pallida in the form of a homogeneous brown powder is the researched feed additive. The additive contains biologically active substances, i.e., polysaccharides (fructosans) and phenolic compounds (hydroxycinnamic acids), which have immune, antimicrobial and anti-inflammatory effects.

The research of the effectiveness of the Echinacea pallida extract feed additives application in the quails feeding were conducted at a research farm of Vinnytsia National Agrarian University. Scientific experiments were carried out on poultry according to generally accepted methods. Four groups of experimental birds were formed, each group had 50 heads selected by the method of analogous groups. The experiment lasted for 56 days.

Additional feeding by different doses of Echinacea pallida extracts as a part of complete feed had a positive effect on the live weight of the experimental quails. Thus, the additional feeding by the average dose of the researched additive in the amount of 12 mg per kg of live weight increases live weight, average daily and absolute growth of females by 13.3% (P <0.001), 14.3% and 13.5% (P <0.001) and males by 19.7% (P <0.001), 23.1% and 20.3% in comparison with control analogues.

Quails consuming a phytobiotic supplement of Echinacea pallida dry extract has reduced feed consumption per 1 kg of growth by 14.9%, relative to control.

It has been found that the use of Echinacea pallida extract in the feeding of quails increases the safety of livestock by 4%.

Keywords: *Echinacea pallida extract, fodder, quail, growth, live weight.*

Statement of the problem. In the European Union, as in world practice, the antibiotics application in animal and poultry feed is prohibited because they degrade the products quality. Therefore, the issue of involving plant biostimulators in solving this problem is currently relevant [6, 8, 9].

Many Ukrainian scientists and practitioners focus on the application and implementation of new biologically active feed additives of natural origin, which improve metabolic processes, increase immunity and do not accumulate in livestock products [10, 11].

Analysis of recent research and publications. The new category of natural growth stimulants derived from herbs, spices and plant extracts needs special attention. After all, phytogenics (phytobiotics) are extremely heterogeneous in composition and biologically active substances level [5, 7].

According to Ya.V. Diakonova researches [1], it was established for the first time that the grass and roots of Echinacea pallida contain 16 amino acids. In particular, free asparagic, glutamic acid and proline dominate in free grass, and aspartic, glutamic acid, proline, arginine, phenylalanine and threonine are found in the roots. Cystine is found in the fruits of Echinacea pallida. However, there is no cystine in the grass and roots. Aspartic acid has an immunomodulatory effect, increases physical endurance, normalizes the balance of excitation and inhibition in the central nervous system (CNS), and glutamic acid is a neurotransmitter amino acid, it regulates metabolic processes in the CNS, increases the body's resistance to hypoxia.

The aim of the experiment was to investigate the effect of dry echinacea extract on the productivity and feed consumption of Pharaoh meat quails.

Materials and methods of research. The experiment of the effectiveness of the Echinacea pallida extract feed additives application in the quails feeding were conducted at a research farm of Vinnytsia National Agrarian University

Scientific experiments were conducted on poultry according to generally accepted methods [2, 3]. According to the results of weighing carried before feeding in the morning, the absolute, average daily and relative gains of live weight during the experiment were calculated.

Feed consumption was recorded daily, weekly and for the entire growing period. At the end of the experiment, the feed consumption per 1 kg of live weight gain was calculated.

Four groups of Pharaoh meat quails were selected for the experiment. According to the principle of analogues, 50 heads were formed in each group [2]. The experiment lasted for 56 days. At 30 days of age, the poultry was divided into females and males (25 females and 25 males). The first control group consumed the basic diet, i.e., complete feed TM Multigain, and quails of the experimental groups were additionally fed by different doses of feed additives of Echinacea pallida dry extract (Table 1).

Table 1

Feeding patterns

Group	Number of animals in the group, heads	Duration of the experiment, days	Feeding characteristics
1 - control	50	56	BD (complete feed)
2 - experimental	50	56	BD + Echinacea pallida (6 mg / kg live of weight)
3 - experimental	50	56	BD + Echinacea pallida (12 mg / kg live of weight)
4 - experimental	50	56	BD + Echinacea pallida (18 mg / kg live of weight)

*BD – basic diet

The investigated feed additive is dry extract of the underground part of Echinacea pallida in the homogeneous brown powder. The additive contains biologically active substances, i.e., polysaccharides (fructosans) and phenolic compounds (hydroxycinnamic acids), which have immune, antimicrobial and anti-inflammatory effects.

The researched dry extract from the roots of Echinacea pallida was made on the basis of LLC Research Plant in Kharkiv [5].

Biometric data processing was performed using MS Excel software using statistical functions. Statistical evaluation of differences was performed using Student test at three levels of probability: P <0,05; P <0.01; P <0.001 (marked in the text respectively *, **, ***) [4].

Research results. It was found that on the 7th and 14th day poultry of the third experimental group consumed the average dose of dry extract of Echinacea pallida in the amount of 12 mg kg there is a probable increase in live weight, respectively, by 2.4 g, or by 10.4% (P <0.05) and by 8.2 g, or by 12.9% (P <0.001) (Table 2).

Table 2

Live weight of quails, g (M ± m, n =50)

Age of quails, days		Group			
		1-control	2-experimental	3- experimental	4- experimental
1		8.0 ± 0.08	8.1 ± 0.07	8.1 ± 0.07	8.1 ± 0.07
7		23.0 ± 0.60	24.0 ± 0.60	25.4 ± 0.68*	23.8 ± 0.43
14		63.2 ± 1.37	66.6 ± 1.76	71.4 ± 1.45***	65.6 ± 0.92
21		105.0 ± 1.36	118.0 ±1.73***	123.8 ± 2.04***	115.0 ±1.76***
28		154.8 ± 2.91	170.5 ±3.29***	176.8 ± 1.04***	163.2 ± 2.15*
35	Females (n=25)	206.9 ± 2.53	216.4± 2.63**	231.4 ± 2.50***	221.0 ±1.56***
	males (n=25)	173.2 ± 1.16	183.0 ±2.51***	198.2 ± 0.72***	174.7 ± 2.07
42	Females (n=25)	262.0 ± 3.14	268.2 ± 1.16	291.2 ± 2.53***	276.1 ± 3.24**
	males (n=25)	200.9 ± 1.75	205.3 ± 1.73	238.2 ± 2.74***	204.4 ± 2.08
49	females (n=25)	300.5 ± 4.41	317.1 ± 4.09**	348.2 ± 1.96***	309.1 ± 2.97
	males (n=25)	221.8 ± 2.27	228.7 ± 2.16*	265.1 ± 1.58***	235.4 ±2.59***
56	females (n=25)	322.8 ± 2.64	333.1 ± 3.15*	365.8 ± 1.40***	335.6 ±2.38***
	males (n=25)	231.0 ± 2.23	242.9 ± 2.58**	276.5 ± 1.94***	254.5 ±3.36***
Survival, %	females (n=25)	95	97	99	98
	males (n=25)	95	97	99	98

On the 21st day, the poultry of the second, third and fourth experimental groups significantly increased live weight by 12.4%, 17.9% and 9.5% (P <0.001) than the control group. Similar changes in live weight are observed in young animals on the 28th days, in particular, the quails of the experimental groups predominate in the first control group by 10.1%, 14.2% (P <0.001) and 5.4% (P <0.05), respectively.

30-day poultry was divided by sex into females and males. Thus, 35-days females of the second, third and fourth experimental groups had an increase in live weight by 9.5 g or 4.6% (P <0,01), by 24.5 g or by 11.8% (P <0.001) and by 14.1 g, or by 6.8% (P <0.001). The males of the second and third groups outperformed their control counterparts by 9.8 g or by 5.6%, and by 25 g or by 14.4% (P <0.001).

Fed by the average and maximum dose of the researched feed additive 42-day poultry had the highest live weight in females in the third and fourth experimental groups by 11.1% (P <0.001) and 5.4%, respectively (P<0.01). The males of the third group prevailed by 18.5% (P <0.001) in live weight.

On 49th day live weight of females in the second group was greater by 16.6 g or 5.5% (P<0.01) and by 47.7 g, or 15.9% (P <0.001) in the third group than its control counterparts. In addition, males of the second, third and fourth experimental groups significantly increased live weight by 6.9 g or 3.1% (P <0.05), 43.3 g or 19.5%, and 13.6 g or 6.1% (P <0.001) than their control counterparts.

It was found that at the end of the experimental period (56 days) the poultry fed by different doses of dry extract of Echinacea pallida prevailed over the live weight. Thus, the largest weight was recorded in females and males of the second, third and fourth experimental groups; it was respectively higher by 3.2% (P

<0.05), 13.3%, 3.9% <0.001) and 5.2% (P <0.01), 19.7%, 10.2% (P <0.001).

It was also found that the survival of the population was higher by 2%, 4% and 3% in the second, third and fourth experimental groups.

There is an increase in absolute growth in the third experimental group by 2.2 g, or by 14.6% (P <0.05) and by 5.8 g, or 14.4% (P <0.01) compared with the control group (Table 3) at the age of 1 to 7 and from 8 to 14 days.

It was found that there is the highest absolute increase in the second, third and fourth experimental groups, which is respectively 22.9%, 25.3% and 18.2% (P<0.01) in young quails from 15 to 21 days of age.

It should be noted that the 22-28-day experimental poultry the absolute gains were the lowest in the fourth group by 1.6 g or 3.3%.

The 29-35-day females of the second experimental group tended to decrease in absolute growth by 6.2 g. The males of the second and fourth experimental groups lost in absolute weight in 5.9 g (P <0.01) and 6.9 g (P <0.001).

The highest live weight was characterized by females and males of the third experimental group, they exceeded the quails of the control group by 8.5% and 44.4% (P <0.001) for the next growing period (36–42 days).

Table 3

Absolute increase in live weight of quails, g (M ± m, n =50)

Age of quails, days		Group			
		1-control	2-experimental	3- experimental	4- experimental
1-7		15.0 ± 0.62	15.9 ± 0.59	17.2 ±0.69*	15.6 ± 0.43
8-14		40.2 ± 1.57	42.6 ± 2.00	46.0± 1.59**	41.8 ± 1.03
15-21		41.8 ± 2.17	51.4±2.11**	52.4±2.42**	49.4 ±2.03**
22-28		49.8 ± 3.09	52.5 ± 3.28	53.0 ± 2.16	48.2 ± 2.92
29-35	females (n=25)	52.1 ± 2.90	45.9 ± 2.03	54.6±2.72	57.8 ± 2.88
	males (n=25)	18.4 ± 1.75	12.5 ± 1.15**	21.4 ± 1.79	11.5±0.89***
36-42	females (n=25)	55.1 ± 3.87	51.8 ± 2.98	59.8 ± 3.12	55.2 ± 3.55
	males (n=25)	27.7 ± 2.34	22.3 ± 2.40	40.0±2.64***	29.7 ± 2.56
43-49	females (n=25)	38.5 ± 3.46	48.9 ± 4.16	56.9±2.62***	33.0 ± 4.43
	males (n=25)	20.8 ± 2.41	23.4 ± 2.08	26.9 ±1.69*	31.0±3.32*
50-56	females (n=25)	22.3 ± 2.45	16.0 ± 2.10	17.6 ± 1.93	26.5 ± 3.15
	males (n=25)	9.2 ± 0.98	14.2 ±1.76*	11.4 ± 1.23	19.1±1.72***
Average for the experiment	females (n=25)	315.0 ± 2.60	325.2 ± 3.15*	357.7±1.43***	327 ±2.37**
	males (n=25)	222.9 ± 2.21	234.6±2.51**	268.2±1.95***	246.2±3.33***

43-49-day poultry had the increased rates of absolute growth in the third experimental group, in particular in females by 47.7% (P <0.001) and in males by 29.3% (P <0.05) compared to analogues from control. At the same time, in males of the 4th experimental group this indicator was higher by 49.0% (P <0.05) than in the first group.

At the end of the experimental period (50-56 days) the absolute growth decreased by 6.3 g or 28.2% and 4.7 g, or 21.1% under the influence of phytobiotics in females of the second and third experimental groups. However, no significant difference with control was found. These indicators are likely to increase by 5.0 g (P <0.05) and 9.9 g (P <0.001) for males of the second and fourth experimental groups, respectively, compared to the control group.

Thus, the highest absolute gains in live weight of females and males were recorded in the third experimental group, respectively, by 13.5% and 20.3% (P <0.001) compared to control analogues. These animals were additionally fed by the researched feed additive in the amount of 12 mg per kg of body weight.

Feeding by dry extract of Echinacea pallida increased the average daily gain in the experimental groups (Table 4).

It was found that quails that consumed the average dose (third group) of Echinacea pallida extract with compound feed in the growth period from 1 to 7 and from 8 to 14 days of age had the highest average daily gains of 14.3% (P <0.05) and 15.8% (P <0.01) compared with the control group.

15–21-day experimental poultry had a probable growth increase. Thus, the average daily gains were higher by 23.7%, 27.1% (P <0.001) and by 20.3% (P <0.01) in the second, third and fourth groups than the control group.

There is a tendency to reduce the average daily increase among quails of the fourth experimental group by 2.8% compared to the control.

Among 29-35-day poultry, the highest average daily gain was recorded in females of the fourth experimental group, it was 10.8%. However, in the second and fourth groups the growth decreased slightly by 30.7% and by 38.4% (P <0.05), according to control counterparts.

Among 36-42-day poultry the average daily gains were largest in the third experimental group (both for females and males) by 8.9% and 46.2% (P <0.001), respectively, compared with the control group.

Thus, on 43-49 day the average daily gains probably increased by 47.2% (P <0.001) and 31.0% (P <0.05) in the third experimental group (both for females and males) compared to the control. The same tendency is observed in the fourth experimental group for males, respectively, by 51.7% (P <0.05).

Table 4

The average daily increase in live weight of quails, g (M ± m, n =50)

Age of quails, days		Group			
		1-control	2 -experimental	3- experimental	4 - experimental
1-7		2.1 ± 0.08	2.3 ± 0.08	2.4 ± 0.09*	2.2 ± 0.06
8-14		5.7 ± 0.22	6.0 ± 0.28	6.6 ± 0.23**	5.8 ± 0.15
15-21		5.9 ± 0.31	7.3±0.30***	7.5 ± 0.35***	7.1 ± 0.29**
22-28		7.1 ± 0.44	7.5 ± 0.47	7.6 ± 0.31	6.9 ± 0.42
29-35	females (n=25)	7.4 ± 0.52	6.5 ± 0.41	7.8 ± 0.39	8.2 ± 0.50
	males (n=25)	2.6 ± 0.32	1.8 ± 0.31	3.2 ± 0.25	1.6 ± 0.31*
36-42	females (n=25)	7.8 ± 0.55	7.5 ± 0.43	8.5 ± 0.44	7.9 ± 0.51
	males (n=25)	3.9 ± 0.33	3.2 ± 0.34	5.7 ± 0.38***	4.2 ± 0.36
43-49	females (n=25)	5.5 ± 0.49	7.0 ± 0.59	8.1 ± 0.37***	4.7 ± 0.63
	males (n=25)	2.9 ± 0.34	3.3 ± 0.29	3.8 ± 0.24*	4.4 ± 0.47*
50-56	females (n=25)	3.1 ± 0.51	2.3 ± 0.30	2.5 ± 0.28	3.7 ± 0.45
	males (n=25)	1.3 ± 0.15	2.0 ± 0.25*	1.6 ± 0.18	2.7±0.25***
Average for the experiment	females (n=25)	5.6 ± 0.78	5.8 ± 0.85	6.4 ± 0.95	5.9 ± 0.81
	males (n=25)	3.9 ± 0.79	4.2 ± 0.92	4.8 ± 0.90	4.4 ± 0.81

In the last week of growth (50-56 days) the application of different doses of Echinacea pallida extract increases the average daily gain 0.7 g (P <0.05) for males of the second experimental group and by 1.4 g for males of the fourth group (P <0.001). Females of the second and third experimental groups tend to decrease the average daily gain.

The highest average daily increase in live weight was recorded in females and males of the third experimental group, respectively, by 0.8 g, or 14.3% and 0.9 g, or 23.1% greater than in control.

According to research results, it is revealed that quails feeding by various doses of the forage additive influences their growth; it also decreases expenses of forages per 1 kg of live weight gain (Table 5).

Table 5

Feed consumption and feed payment by quail growth, kg

Group		Feed consumption, kg				Per 1 kg of gain		Payment by quail growth	
		for experiment		per one head					
		total	± control	total	± control	total, kg	± control	Total, feed units	± control
1-control	females (n=25)	36.4	-	1.45	-	4.62	-	0.21	-
	males (n=25)	32.2	-	1.28	-	5.77	-	0.17	-
2–experimental	females (n=25)	35.9	-0.5	1.43	-0.02	4.41	-0.21	0.22	+0.01
	males (n=25)	32.8	0.6	1.31	0.03	5.59	-0.18	0.18	+0.01
3– experimental	females (n=25)	35.2	-1.2	1.40	-0.05	3.93	-0.69	0.25	+0.04
	males (n=25)	35.0	2.8	1.40	0.12	5.21	-0.56	0.19	+0.02
4– experimental	females (n=25)	36.0	-0.4	1.44	-0.01	4.39	-0.23	0.22	+0.01
	males (n=25)	33.6	1.4	1.34	0.03	5.45	-0.32	0.18	+0.01

According to our research, the average dose (third group) of Echinacea pallida extract was the most effective in the quails' diets, which reduces feed consumption by 1 kg increase by 0.69 kg and 0.56 kg and increases feed payments by 19.0% and 11.8% for both males and females.

Conclusions and prospects for further research.

It was found that the additional use of the average dose of the Echinacea pallida extract in the amount of 12 mg / kg live weight increases live weight by 13.3% (P <0.001), daily average growth by 14.3% and absolute growth of females by13.5% (P <0.001) and males by 19.7% (P <0.001), 23.1% and 20.3%, respectively than control counterparts. It should be noted that for quails fed a phytobiotic supplement from the dry extract of Echinacea pallida feed costs per 1 kg increase by 14.9% compared to the control group. It was also found that the use of Echinacea pallida extracts in the quails feeding increases the safety of livestock by 4% relative to control.

Thus, it was found that additional feeding of plant supplements from the extract of Echinacea pallida increases productivity and reduces feed costs for quails.

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PRODUCTIVITY OF MEAT QUAILS FED BY BETAINE FEED ADDITIVE AS A PART OF DIETS

Abstract.
It was found that the betaine application for quails feeding causes an increase in live weight of 42-day females by 8.2% and males by 6.0%, female gain per kg of growth decreased by 0.38 kg, and male gain per kg of growth decreased by 0.29 kg of feed. Slaughter rates were characterized by an increase in chest muscle weight of 11.4% and thigh muscles by 7.9% with the use of betaine feed supplement. Increased metabolism with an increase in hemoglobin by 2.9% was also found.

Keywords*: quails, feeding, compound feed, productivity, slaughter parameters, morphological and biochemical parameters of blood.*

Introduction

Many researchers are constantly looking for effective growth stimulants of natural origin [2-4, 11, 13, 14]. Betaine should be noted among such feed additives, it is insufficiently researched in animal husbandry [5-7].

It was found that the replacement of choline with betaine led to an increase in breast weight and a decrease in internal fat in broilers. A research conducted by Colorado Quality Research, USA, confirmed improved feed conversion in broilers and increased breast meat yield when choline was replaced by betaine and unchanged methionine levels. In laying hens, betaine helped to reduce the number of eggs that were too large in the later stages of laying [9].

Korean researchers Sun Jin Hur, Han Sul Yang, Gu Boo Park and Seon Tea Joo Asian-Aust. J. [7] conducted an experiment to determine the effect of dietary glycine betaine on the quality of pork in different muscle types. It has been studied that in the fatty acid composition dietary glycine betaine helps to increase the ratio of saturated fatty acids (SFA) and reduce unsaturated fatty acids (USFA) in the pigs thighs.

Material and methods of research

The aim of the experiment was to determine the effect of feed additive Betaine on productivity, slaughter quality and hematological parameters of quails.

Zootechnical, statistical, physiological and economic research methods were used to solve these problems.

The use of Betaine in premixes and concentrates significantly improves the preservation of vitamins, increases the shelf life of feeds, concentrates and premixes. Betaine is a donor of methyl groups and acts as an osmoprotector.

One-day quails of the Pharaoh breed were selected on the principle of analogue groups [10], where the breed, age and live weight were taken into account. Two groups were formed, each group included 20 heads.

Quails consumed basic diet (BD) of the Multigain trademark. Betaine was additionally fed to the experimental group of poultry.

The experiment lasted 42 days. The equalization period is 5 days and the main period is 37 days (Table 1).

Table 1

Feeding patterns

Group	Duration of the period, days		Number of quails, heads	Feeding characteristics
	equalization	main		
1-control	5	37	20	BD (complete feed)
2-experimental	5	37	20	BD+ Betaine (1 kg / t of feed)

The quail population was weighed, and feed consumption was monitored every week, starting from the first day to forty-second day of rearing. The following indicators were determined, i.e., safety, live weight dynamics, average daily, absolute and relative live weight gain, feed consumption per 1 kg of growth according to generally accepted methods.

Biochemical and morphological parameters of blood were researched according to the relevant guidelines, i.e., hemoglobin (using a Sally hemometer); total protein (refractometrically); leukocytes (using of Horiaev's camera), etc.

Biometric processing of research results was performed using appropriate techniques [12] and software MS EXCEL, 2010 at three levels of probability: *P<0.05; ** P <0.01; *** P <0.001.

Research results and discussion. Live weight is one of the indicators of meat quail productivity. We have researched the dynamics of live weight of poultry fed additionally by feed additives (Table 2).

It was found that the consumption of the researched feed additive Betaine by 28-day quails of the second group live weight increased by 8.3% (P <0.001) than control counterparts.

Table 2

Live weight and safety of meat quails, g (M ± m, n =20)

Age of quails, days		Group	
		1–control	2 – experimental
1		8.7 ± 0.16	8.8 ± 0.12
7		21.4 ± 0.32	22.5 ± 0.51
14		52.0 ± 0.75	54.1 ± 0.86
21		93.2 ± 1.14	98.0 ± 2.19
28		145.4 ± 1.64	157.5 ± 1.82***
35	females (n=10)	225.6 ± 2.48	239.1 ± 2.34**
	males (n=10)	198.2 ± 1.75	205.4± 1.72*
42	females (n=10)	282.5 ± 2.64	305.7 ± 2.58***
	males (n=10)	232.5 ± 3.14	246.6 ± 3.25*
Safety, %	females (n=10)	98	100
	males (n=10)	98	100

35-day quails were divided into females and males. Thus, females of the second group prevail in live weight by 5.5% (P <0.01) and males by 3.6% (P <0.05) their counterparts. At the end of the experiment the live weight of female quails was bigger by 8.2% (P <0.001) and males quails was bigger by 6.0% (P <0.05) than in the control group.

However, the second group quails have higher survival by 2% than their control counterparts.

We studied the average daily increase in live weight of meat quails under the action of Betaine feed additive (Table 3).

It was found that additional feeding by feed additive increases the average daily gain of the second group of meat quails by 6.7% (P <0.05) than the control analogues.

Table 3

Average daily gain of meat quails, g (M ± m, n =20)

Age of quails, days		Group	
		1 – control	2 – experimental
1 – 7		1.8 ± 0.06	1.9 ± 0.04
8 –14		4.4 ± 0.18	4.5 ± 0.19
15 – 21		5.9 ± 0.21	6.3 ± 0.23
22 – 28		7.4 ± 0.24	8.5 ± 0.26*
29 – 35	females (n=10)	11.5 ± 0.42	11.7 ± 0.45
	males (n=10)	7.5 ± 0.53	6.8 ± 0.56
36 – 42	females (n=10)	8.1 ± 0.28	9.5 ± 0.30**
	males (n=10)	4.9 ± 0.26	5.9 ± 0.24*
Average by experiment periods	females (n=10)	6.5 ±0.72	7.1 ± 0.88
	males (n=10)	5.3 ± 0.62	5.7 ± 0.54

36-42-day quails of the 2nd group under the action of "Betaine" in the average daily gain is higher in females by 17.2% (P <0.01) and in males by 20.4% (P <0.05), compared with control analogues.

It was found that the Betaine application increases the absolute growth of females by 8.4% and males by 2.1% compared with the control group.

Feeding by Betaine supplement increases the relative growth of quail (Table 4).

On 36th -42nd day, quails of the second group, had the relative increase in females by 2.0%, and males by 2.3% (P <0.05) than control.

Table 4

Relative growth of quails, % (M ± m, n =20)

Age of quails, days		Group	
		1 – control	2 – experimental
1 – 7		84.4 ± 2.09	87.5 ± 2.11
8 – 14		83.4 ± 2.23	82.5 ± 2.28
15 – 21		56.7 ± 1.91	57.7 ± 1.84
22 – 28		43.8 ± 1.75	46.6 ± 1.68
29 – 35	females (n=10)	43.2 ± 1.53	41.1 ± 1.54
	males (n=10)	30.7 ± 1.44	26.4 ± 1.82
36 – 42	females (n=10)	22.4 ± 0.72	24.4 ± 0.64*
	males (n=10)	15.9 ± 0.76	18.2 ± 0.85*

The Betaine feed additive application for feeding meat quails allows to reduce feed costs by 1 kg of growth (Table 5).

It was recorded that the Betaine reduces feed losses per 1 kg of growth, i.e., females by 7.1% and males by 4.5% than control.

The main indicators of meat productivity of animals and poultry are live and slaughter weight and their slaughter output.

Table 5

Feed consumption by quails, kg

Group		Feed consumption, kg					
		for experiment		per 1 kg		per 1 kg of gain	
		total	± control	total	± control	total	± control
1–control	females (n=10)	14.5	-	1.45	-	5.29	-
	males (n=10)	14.2	-	1.42	-	6.34	-
2–experimental	females (n=10)	14.6	+0.1	1.46	+0.01	4.91	-0.38
	males (n=10)	14.4	+0.2	1.44	+0.02	6.05	-0.29

Additional feeding of experimental quails by feed additive Betaine increased pre-slaughter live weight by 7.2% (P <0.05), increased the weight of gutted carcass by 6.8% (P <0.05) and gutted carcass by 9.2% (P <0.05) than the control indicator (Table 6).

Table 6

Slaughter indicators of quails, g (M ± m, n = 4)

Indicator	Group	
	1– control	2 – experimental
Pre slaughter weight	257.5 ± 6.24	276.2 ± 5.46*
Weight of ungutted carcass	242.6 ± 5.16	259.2 ± 4.34*
Weight of semigutted carcass	215.7 ± 5.21	224.8 ± 6.26
Weight of gutted carcass	174.5 ± 4.24	190.6 ± 5.48*
Output of gutted carcass	67.7 ± 1.78	69.0 ± 1.64
Weight of separate edible parts pectoral muscles	45.6 ± 1.26	50.8 ± 1.28*
thigh muscles	26.5 ± 1.15	28.6 ± 1.12

It was found that the feed additives application in the second group increases the weight of pectoral muscles by 11.4% (P <0.05). There is a tendency to increase the weight of the thighs by 7.9% than the control group.

We also researched the effect of Betaine feed additive on the internal organs of quails (Table 7).

Table 7

Weight of quails' internal organs, g (M ± m, n = 4)

Organ	Group	
	1–control	2– experimental
Liver	4.8 ± 1.26	5.1 ± 1.38
Pancreas	0.77 ± 0.124	0.80 ± 0.127
Spleen	0.18 ± 0.125	0.19 ± 0.118
Kidneys	1.4 ± 0.32	1.5 ± 0.26
Heart	2.0 ± 0.18	2.2 ± 0.14
Lungs	1.6 ± 0.22	1.7 ± 0.19
Esophagus	1.8 ± 0.34	1.9 ± 0.28
Gizzard	4.1 ± 0.56	4.3 ± 0.34
Glandular stomach	1.0 ± 0.12	1.1 ± 0.15

There is a tendency to increase the weight of internal organs, i.e., liver by 6.2%, heart by 10.0% and gizzard by 4.8% in the second experimental group than control samples.

Blood responds to any changes in the body and supports metabolism and homeostasis.

The effect of feed additives on the biochemical parameters of quail blood was also researched (Table 8).

The blood of the second group quails additionally fed by a feed additive is characterized by the increased content of total protein, glucose, and calcium levels.

Table 8

Biochemical parameters of quail blood (M ± m, n = 4)

Indicator	Group	
	1– control	2 – experimental
Total protein, g / l	35.5 ± 3.25	36.3 ± 2.42
Albumins, g / l	17.3 ± 1.62	17.9 ± 1.38
Globulins, g / l	18.2 ± 1.28	18.4 ± 1.36
ALT, units / liter	4.4 ± 1.45	4.5 ± 1.58
AST, units / liter	221.5 ± 22.54	232.6 ± 19.35
Total bilirubin, mmol / l	3.4 ± 0.62	3.3 ± 0.58
Alkaline phosphatase, units / l	1112.5 ± 104.62	1029.5 ± 125.24
Cholesterol, mmol / l	3.1 ± 1.02	3.0 ± 0.72
Triglycerides, mmol / l	2.7 ± 0.74	2.9 ± 0.65
Glucose, mmol / l	5.8 ± 1.05	6.5 ± 1.08
Creatinine, μmol / l	6.2 ± 2.64	6.4 ± 2.42
Urea, mmol / l	1.4 ± 0.27	1.5 ± 0.32
Calcium, mmol / l	2.1 ± 0.42	2.4 ± 0.46

It was found that the application of Betaine feed additive for feeding meat quails of the second group increased the content of erythrocytes by 9.5%, leukocytes by 4.3% and hemoglobin by 2.2%. However, no significant changes with control were found (Table 9).

Table 9

Morphological parameters of the experimental poultry blood (M ± m, n = 4)

Group	Erythrocytes, T / l	Leukocytes, G / l	Hemoglobin, g / l	ESR, mm / hour
1– control	2.3 ± 0.24	33.2 ± 1.56	115.2 ± 2.57	1.7 ± 0.45
2 – experimental	2.4 ± 0.28	34.3 ± 1.42	118.6 ± 2.68	1.8 ± 0.54

Thus, the Betaine application in the quails feeding does not cause probable changes in the blood composition of quails of the second group, the indicators are within the physiological norm.

Conclusions:

1. It was found that the live weight of experimental quail females is higher by 8.2% (P<0.001) and males is higher by 6.0% (P <0.05) than in the control group.
2. The Betaine feed additive application increases the absolute growth of females by 8.4% and males by 2.1% compared to the control group.
3. It was recorded that the Betaine application reduces feed consumption per 1 kg of growth of females by 7.1% and male quails by 4.5% compared to control counterparts.
4. Additional feeding quails of the second group by Betaine increases pre-slaughter live weight by 7.2% (P <0.05), the weight of ungutted carcass by 6.8% (P <0.05), gutted carcass by 9.2% (P <0.05) and pectoral muscles by 11.4% (P <0.05) relative to the control indicator.
5. No probable changes in the internal organs weight and hematological parameters under the action of the researched factor were found.

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