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CONTENTS

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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 проростлих (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).

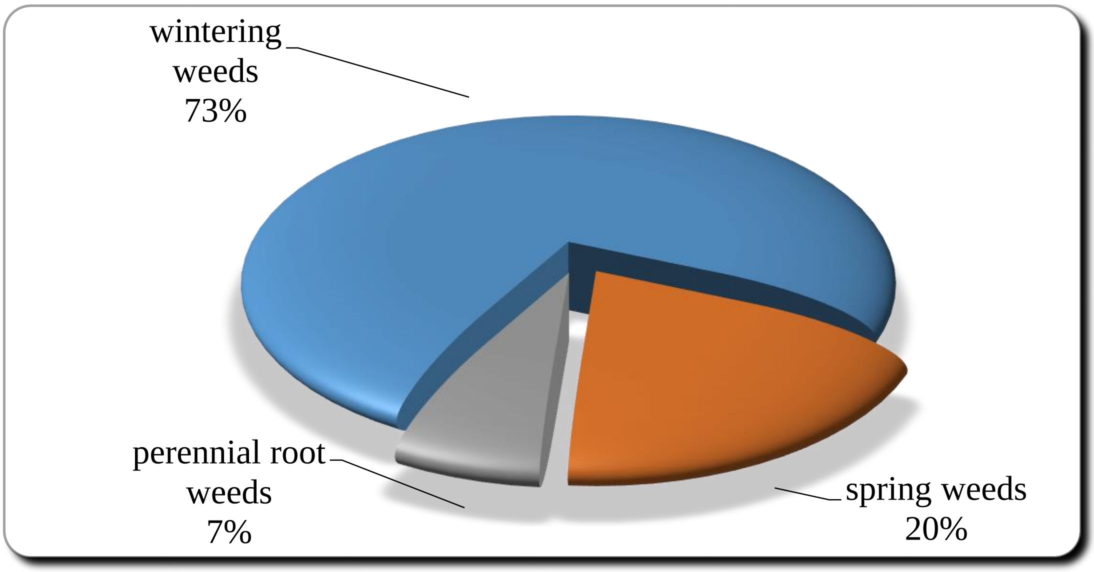

Fig. 1. Biological groups of weeds in sunflower crops (for 2019)

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.

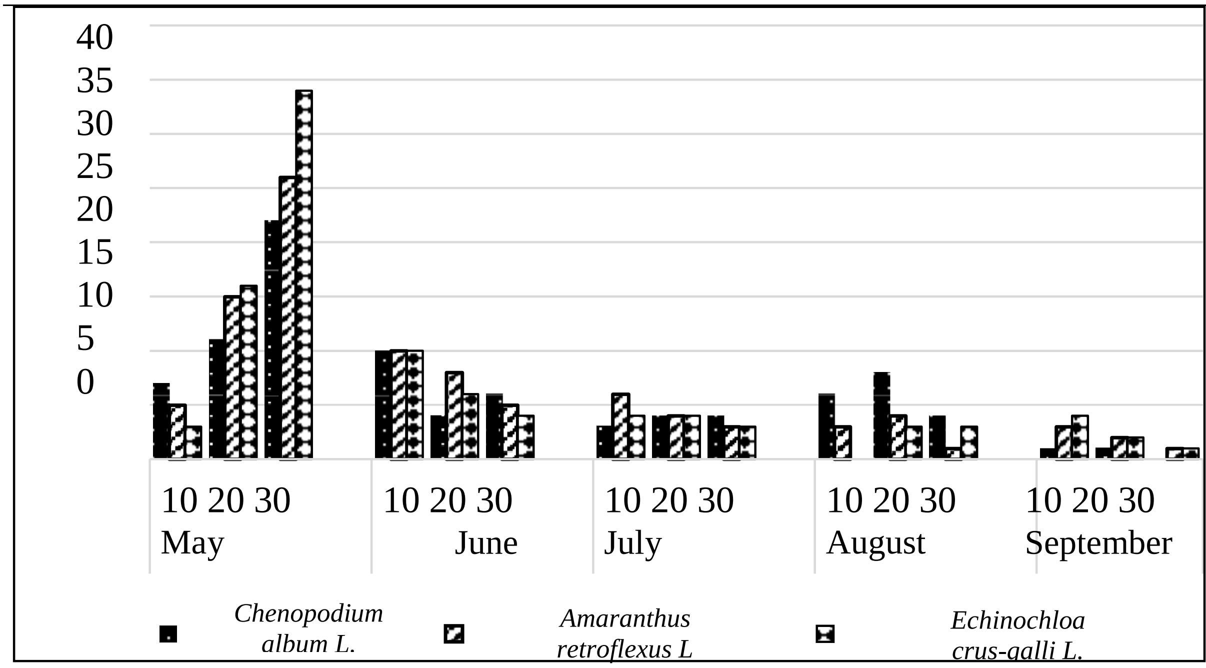

Fig. 2. Dynamics of weed emergence in sunflower crops, % (average for 2019–2020)

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 °С, сума опадів – 251,4-334,0 мм, сума активних температур (>10, °С) – 2019,5-2258,7 °С. У 2014 році значення цих показників становили, відповідно 18,6-19,5 °С, 308,7-337,2 мм та 2003,7-2216,7 °С; у 2015 році – 21,1-21,6 °С, 135,3-166,5 мм та 2040,5-2324,4 °С.