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CONTENTS

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Рудська Н.О.
кандидат сільськогосподарських наук,
старший викладач кафедри ботаніки, генетики та захисту рослин,
Вінницький національний аграрний університет
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ЕФЕКТИВНІСТЬ СИСТЕМИ ЗАХИСТУ ПОСІВІВ КУКУРУДЗИ ВІД БУР'ЯНІВ ЗА РІЗНИХ СПОСОБІВ ОБРОБІТКУ ГРУНТУ В УМОВАХ ЛІСОСТЕПУ ПРАВОБЕРЕЖНОГО УКРАЇНИ

Rudska N.O.
Candidate of Agricultural Sciences, Associate Professor,
senior teacher of the Department of Botany, Genetics and Plant Protection,
Vinnitsia National Agrarian University

EFFICIENCY OF THE SYSTEM OF PROTECTION OF MAIZE CROPS FROM WEEDS IN DIFFERENT METHODS OF SOIL TREATMENT IN THE CONDITIONS OF THE RIGH BANK FOREST- STEPPE OF UKRAINE

Анотація.

В даній статі за результатами досліджень підтверджено доцільність та ефективність застосування сучасних гербіцидів на посівах кукурудзи за різних способів обробітку ґрунту.

Встановлено, що в посівах кукурудзи формується змішаний тип забур'яненості, серед який найбільшу частку займають пізні ярі види куряче просо – Echinochloa crus-galli (L.) Roem., мишій сизий – Setaria glauca L., галінсога дрібноквіткова – Galinsoga parviflora Cav., лобода біла – Chenopodium album L., щириця звичайна – Amaranthus retroflexus L.

У варіантах де застосовували гербіцидний захист загибель бур'янів забезпечували на 89–100 % впродовж 30 днів після їх внесення. На час збирання культури зниження кількості бур'янів, порівняно з необробленими ділянками, становило 71–98 %. Найефективнішим виявилось дворазове внесення раундап макс, 2,4 л/га у фазах 3 та 8 листків у кукурудзи.

Доведено, що густота стояння кукурудзи у фазу повних сходів на оранці за дворазового внесення раундап макс, 2,4 л/га знаходилась в межах 78,3–78,6 шт./м^2. За мілкого дискового обробітку, даний показник знижувався до 78,1–78,2 шт./м^2. На період збирання кукурудзи також відмічено відмінності густоти стояння кукурудзи. Так, на оранці за умов гербіцидного захисту густота була найвищою і знаходилась в межах 72,9–73,2 тис. шт./га, в той час як за мілкого дискового – 72,3–72,6 тис. шт./га.

Найвищу урожайність зерна кукурудзи отримали за дворазового застосування гербіциду раундап макс у нормі 2,4 л/га. За полицевого обробітку ґрунту збір складав 9,4 т/га, за мілкого обробітку – 9,2 т/га.

Abstract.

In this article, the results of research confirm the feasibility and effectiveness of modern herbicides in maize crops by different methods of tillage.

It was found that a mixed type of weeding is formed in maize crops, among which the largest share is occupied by late spring species of Echinochloa crus-galli (L.) Roem., Chenopodium album L., Amaranthus retroflexus L.

In embodiments herbicide applications, weed mortality was 89–100% within 30 days of application. At the time of harvest, the number of weeds was 71–98% lower than in the uncultivated areas. The most effective was double application of roundup max, 2.4 l/ha in phases 3 and 8 leaves in corn.

It is proved that the density of standing corn in the phase of full germination on plowing with double application of roundup max, 2.4 l/ha was in the range of 78.3–78.6 pcs/m^2. With shallow disk cultivation, this figure decreased to 78.1–78.2 pc/ m^2. Differences in the density of standing corn were also noted during the corn harvest period. Thus, in plowing under conditions of herbicide protection the density was the highest and was in the range of 72.9–73.2 thus. pcs/ha, while in shallow disk – 72.3–72.6 thus. pcs/ha .

The highest yield of corn grain was obtained with two applications of the herbicide Roundup Max at the rate of 2.4 l/ha. The yield for shelf tillage was 9.4 t/ha, for shallow tillage – 9.2 t/ha.

Ключові слова: *кукурудза, обробіток ґрунту, бур'яни, гербіциди, ефективність, урожайність*
Keywords: *maize, tillage, weeds, herbicides, efficiency, yield.*

Introduction.

Maize in world agriculture is one of the most important crops of universal use. In recent years, there has been a clear trend of expanding corn acreage for grain, due to increasing demand for food and organic raw materials, the opening of new promising markets, and the market itself is becoming more active due to rising consumption and consumer opportunities in different countries [2, 11].

In Ukraine, the area under its crops has increased significantly in recent years. Thus, if in 2009 the crops of this crop occupied 1.8 million hectares, then as of 2019.

The area under corn in Ukraine reached 4.97 million hectares, and gross grain production increased to 35 million tons. But, along with the constant increase in gross grain production, the yield of corn in the country remains lower compared to leading producers [3].

Formulation of the problem.

In the practice of agricultural production, there are many factors that directly affect crop productivity. In particular, the choice of the optimal method of tillage, scientifically sound and balanced by nutrients fertilizer system, timeliness and quality of operations for the care of crops. But at the same time, the complex structure of agrocenoses, along with crops, involves the presence of weeds [1].

Weed losses can reach 80% or more due to weeds. Damage caused by weeds exceeds pests and diseases and accounts for 11.5% of world agricultural production [4].

According to some researchers, the constant presence of one plant *Cirsium arvense* per 1 m^2 during the growing season in maize crops causes a decrease in grain yield by 1 c/ha *Setaria glauca* – by 0.50 c/ha, and when weeds crops corn *Amaranthus retroflexus* and white quince *Chenopodium album* – at 0.50–0.60 c/ha [15, 16]. There are also studies that show that with a high degree of weediness of maize crops such perennial species as *Cirsium arvense* and *Convolvulus arvensis*, the yield is reduced to 50–55%. And for weeds weighing more than 5 kg per 1 m^2, in the Forest-Steppe zone, corn does not form generative organs at all [17].

Weeds, like other plants, release biologically active substances into the soil - phytolins, among which we should especially mention knees, substances that are toxic to other plant species, which delay the germination of sown seeds of crops, inhibit their growth and development. In particular, it was found that *Elytrigia repens*, *Acroptilon repens* (L.) DC.), as well as various species of wormwood, inhibit the growth and development of most crops [18].

Weeds also have a high transpiration rate and are therefore strong competitors to cultivated plants for limited moisture reserves. For example, the formation of 1 kg of dry matter *Chenopodium album* requires 800–900 liters of water, *Aventa fatua*, *Thlaspi arve*nse L. and *Cirsium arvense* – up to 1000 l, *Elytrigia repens* (L.) Nevski.) – 1180–1683 l, and for the formation of 1 kg of dry matter corn uses 250–300 l of water [19].

Weeds adapt quickly to changes in the environment, showing high adaptability and plasticity of growth and development. In particular, under adverse environmental conditions, plants form neotenic forms, which are barely visible above the soil surface, and under favorable conditions, strongly branched and reach significant sizes, forming a large number of seeds – the so-called phenomenon of gigantism. Therefore, in agrocenoses of crops with high competitive activity there is a significant decrease in seed productivity of weeds. In particular, it was found that in corn crops for grain seed productivity 1 *Chenopodium album* may decrease to 31 thousand pieces.

A characteristic feature of weed seeds is the long-term germination. In particular, seeds *Chenopodium album* can remain viable up to 39 years, *Amaranthus retroflexus*, *Capsella bursa – pastoris*, *Stellaria media* L. And some other species up to 10–15 years, *Plantago major* L. – up to 9 years, *Sinapis arvensis* L. – up to 7 years. This feature allows weed seeds to remain dormant for a long time, and under favorable conditions to germinate [20, 21]. Another feature of weed seeds is their unfriendly germination. For example *Chenopodium album* gives three types of seeds, the first of which germinates in the year of ripening, the second – the following spring, and the third – only in the third year after shedding. This is due to the fact that the seed coat is unevenly permeable to moisture [21].

The presence of weeds in agrocenoses, in addition to the direct effect on crops is also a major obstacle to the introduction of soil protection technologies, tillage, which is based on reducing the intensity of tillage [5]. Therefore, there is a need for in-depth study of the impact of different tillage methods on the structure and dynamics of weed change in order to select the optimal cultivation technology that would reduce the competitive pressure of weeds on crops with the least material and labor costs.

Currently, several methods of tillage are used in the cultivation of cultivated plants. The most common is shelf or traditional cultivation. As early as the beginning of the 19th century, many scientists recommended shelf cultivation in the form of plowing to a depth of 18–22 cm as an effective solution to various problems in growing different crops. To date, this method of basic tillage has not undergone fundamental changes. Shelving involves the use of a shelf plow, which provides complete or partial reversal of the chips. The technology of plowing is to separate the slices, grind them into lumps and rotate it so that the top layer of soil with disturbed dusty structure and vegetation is placed on the bottom of the furrow, and the bottom – in place of the top. Organic and mineral fertilizers, as well as weed seeds, are plowed together with plant remains. The movement of layers is accompanied by loosening of the soil, which is especially important for heavy soils [22].

Long-term studies of the impact of shelf tillage on soil fertility have shown that along with the positive impact, the use of plowing in the system of basic tillage also has negative consequences, in particular, the impact of this tillage on humus mineralization and erosion [23]. It was also found that intensive tillage with the inversion of soil layers increases the sequestration of carbon dioxide. This phenomenon is a consequence of intensive mineralization of organic matter, which occurs during aeration caused by the movement of layers and the destruction of soil structure. Another disadvantage of traditional cultivation is the high energy consumption [24, 25].

Therefore, the issue of reducing the negative impact of tillage on the soil is relevant. One of the options for solving this problem is the use of minimum and soil protection systems of tillage, the theoretical basis of which is the ability of the soil to recover to a state of equilibrium density, which corresponds to a certain type in the absence of mechanical impact. This is the density that is acquired after some time after exposure to natural factors (soil mass, precipitation, temperature changes, etc.).

Over the past decades, advances in technological equipment have contributed to the further development of soil-saving tillage systems, the most common of which is mini-till. The basis of this technology is to reduce energy and time costs by reducing the number and depth of treatments and combining several operations in one workflow. Tillage can be both surface (up to 8 cm) and shallow (8–16 cm), with the obligatory abandonment of shelf tillage tools. Due to shallow tillage, rain and melt water runoff is regulated, as well as the resistance of the field surface to deflation is increased by preserving soil lumps and part of crop residues [26]. Due to the presence of plant residues on the soil surface, there is an increase in water permeability initially due to loose structure, and over time with the transition of water permeability to the filtration stage more water is absorbed due to more stable cracks and capillaries of soils. Some researchers have found that due to the presence of organic matter there is an increase in soil microbiological activity in the layer of 0–10 cm. According to many authors, the introduction of minimal tillage reduces mineralization, enhances humus accumulation, improves plant supply of mobile forms of phosphorus and mineral compounds of nitrogen in the upper soil layer, and due to the presence of mulch, it is possible to reduce soil temperature. 58–67 °C). At the same time, the increase in density and slow warming of the soil in the spring may be the reason for insufficient supply of seedlings with nutrients, in particular, phosphorus. Studies have also established the possibility of acidification of the upper soil layer due to long-term use of dumpless tillage [27]. And some researchers provide data on the reduction of the activity of bacteria that absorb nitrogen in the layer of 0–20 cm when using minimal tillage [28, 29].

Despite the significant amount of research on improving the weed protection system for maize crops with different tillage methods, these issues regarding the Right-Bank Forest-Steppe of Ukraine are covered only partially and incompletely, so they require additional research on the feasibility of mini-till technology in conditions of gray forest soils, as well as determining the optimal control system for weediness of corn crops by different methods of tillage. Therefore, the improvement of the weed protection system for permanent crops of corn for grain by different methods of tillage, determine the feasibility of conducting research on gray forest soils of the Right Bank Forest-Steppe of Ukraine.

Relevance of the research topic.

Growing corn by traditional technologies involves the use of intensive mechanical tillage, which leads to deterioration of agrophysical properties and dehumidification and degradation of soils due to erosion processes, which necessitates the introduction of soil protection and minimal tillage methods. High weediness of crops is one of the main reasons for low realization of biological potential of corn, weediness of crops is especially relevant, as effective weed protection measures are excluded from the cultivation technology.

Therefore, determining the effectiveness of corn weed protection systems for different treatments is a topical issue.

The purpose of the study.

To improve the systems of protection of maize crops from weeds by different methods of tillage in the Right-Bank Forest-Steppe of Ukraine.

Analysis of recent research and publications.

Maize is one of the crops for which the protection of crops from weeds through the use of herbicides is one of the key elements in the technology of their cultivation [5]. However, the stagnation of herbicides requires a comprehensive environmental and economic justification [1, 9]. Therefore, there is a need to find ways to optimize the chemical method of weed control in maize crops. The use of herbicides in various tillage methods is important in improving the effectiveness of the chemical weed control method. The following domestic scientists, O.O. Ivashchenko [2], M.P. Kosolap [1], B.P. Borona [4], V.M. Zherebko [10], V.S. Zadorozhny [13]. Numerous studies have shown that the species composition, dynamics and harmfulness of the most common weed species in maize crops depend on soil and climatic conditions and need constant improvement. It is also noted that herbicides, which differ in origin and chemical structure, affect the efficiency of different tillage methods in different ways.

Research methodology.

The study of the influence of different methods of tillage on the formation of weed cenoses and improvement of the system of protection of corn crops for grain from weeds in the experimental field of VNAU was carried out in a two-factor experiment. The predecessor of the culture is soybeans.

Methods of tillage.

Plowing was carried out with a plow PLN 3–35 to a depth of 20–22 cm after harvesting the predecessor. In the spring, after the emergence of weeds, cultivation was carried out to a depth of 10–12 cm. Pre-sowing tillage involved cultivation to a depth of 5–6 cm.

Shallow tillage involved autumn peeling in 2 tracks with a disc harrow AG–1.8 to a depth of 10–12 cm. In the spring, after the emergence of weeds, cultivation was carried out to a depth of 10–12 cm. Pre-sowing tillage involved cultivation to a depth of 5–6 cm

In 2018, sowing was carried out on May 6, in 2019 – on May 14.

Weed control options.

The weed control system used herbicides with different mechanisms of action. Variants with inter-row application of roundup max were included in the experimental scheme in order to model the possibility of growing glyphosate-tolerant maize hybrids.

When studying the effectiveness of chemical weed control measures, the area of the plot was 25 m^2, the experiment was repeated four times. Location of plots – randomized.

Herbicides were applied with a knapsack sprayer with a working fluid consumption rate of 250 l/ha. In the version with the introduction of the drug harness, 90% k.e. at a rate of 1.3 l/ha to the seedlings of corn, in the phase of 3 leaves in corn used additional inter-row application of herbicide roundup max, 45% v.r. normal 2.4 l/ha. Protective aprons were used for inter-row application of roundup herbicide in order to prevent the drug from getting on cultivated plants. In order to eliminate the influence of weeds on cultivated plants, manual weeding was performed in the rows. Double roundup max, 45% v.r. normally 2.5 l/g was carried out in phases 3 and 8 leaves in corn. Stellar, 21% v.r. at a rate of 1.25 l/ha, according to the recommendations, used in combination with surfactants metholate, 1.25 l/ha and made in the phase of 3 leaves of corn.

Sowing was carried out with a direct sowing seeder, aggregated with a tractor to a depth of 4–5 cm. The sowing density was 80–83 thousand units / ha. Fertilizers were applied at the rate of $N_{100}P_{70}K_{70}$ for early spring cultivation by uniform spreading on the surface. When sowing made $N_{20}P_{20}K_{20}$.

During all years of research, the experiment was grown medium-high-yielding hybrid of corn DKS 3511, FAO – 330.

To perform the tasks planned by the program, records, observations and analyzes were conducted according to generally accepted methods:

- crop weed accounting was performed in phase 3, 8 leaves of corn (before application of post-emergence herbicides), 30 days after application of post-emergence preparations, 30 and 60 days after application of soil preparations and before harvesting;
- crop density was determined by the method of counting plants along the length of the plot in 3 places in the phase of full germination and before harvest, followed by recalculation per hectare;
- grain yield accounting was performed in the phase of full ripeness by the method of continuous harvesting from the accounting plots with reduction to 100% purity and standard humidity (14%) from each variant in all repetitions separately;
- statistical analysis of experimental data – according to the method described by Dospekhov B.A. using the mathematical apparatus Excel [7, 8].

Results of the research.

According to the results of research, during 2018–2019, a mixed type of weeds is formed in corn crops for grain. Cereal weeds were represented by the following species: *Echinochloa crusgalli* L. Roem., *Setaria glauca* L. and *Elytrigia repens* L.. Among the dicotyledons were found: *Galinsoga parviflora* Cav., *Plantago lanceolata* L., *Plantago major* L., *Viola arvensis* Murr., *Thlaspi arvense* L., *Matricaria perforata* Merat., *Capsela bursa pastoris*. L. Medic., *Stellaria media* L., *Amaranthus retroflexus*, *Chenopodium album* L., *Cirsium arvense* L. Scop., *Sonchus arvensis* L., *Artemisia vulgaris* L., *Convolvulus arvensis* L.

Maize crops were dominated by late spring species, which accounted for 71.8% of the total number of weeds that appeared during the growing season. These included: *Echinochloa crus-galli* L. Roem. – 16.1%, *Setaria glauca* L. – 30.4%, among dicotyledons there were: *Galinsoga parviflora* Ca v. – 18.4%, *Amaranthus retroflexus* L. – 5.4%. (Fig. 1).

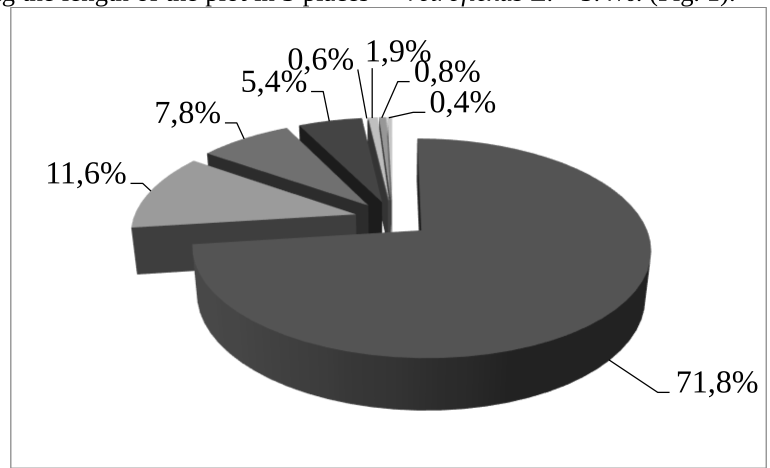

Fig. 1. *The ratio of weeds in maize crops for grain in the experimental field of VNAU, % (average for 2018–2019): 1 – Late spring: 71.8%; 2 – Wintering: 11.6%; 3 – Early spring: 7.6%; 4 – Ephemerals: 5.3%; 5 – Perennial root sprouts: 1.9%; 6 – Perennial rhizomes: 0.8%; 7 – Perennial rhizomatous: 0.6%; 8 – Perennial taproot: 0.4%.*

Early spring was 7.6%, including *Chenopodium album* L. – 7.5% and *Polygonuum convolvulus* L. – 0.1%. Among the wintering species prevailed *Capsela bursa pastoris* L. Medic. – 3.9%, *Matricaria perforata* Merat. – 3.2%, *Thlaspi arvense* L. – 2.5%, *Viola arvensis* Murr. – 2.0%, from ephemerals – *Stellaria media* L. – 5.3%.

There were also perennial root weeds *Cirsium arvense* L. Scop. – 0.9%, *Sonchus arvensis* L. – 0.1%, *Convolvulus arvensis* L. – 0.9%, of perennial rhizomatous weeds – *Elytrigia repens* L. – 0.8%. A small share of the species composition of weeds was occupied by perennial taproots: *Artemisia vulgaris* L. – 0.1% and *Plantago anceolata* L. – 0.2%, of perennial rhizomatous – *Plantago major* L. – 0.6%.

Thus, it was found that a mixed type of weeding is formed in maize crops, among which the largest share is occupied by late spring species of *Echinochloa crus-galli* L. Roem., *Setaria glauca* L., *Galinsoga parviflora* Cav., *Chenopodium album* L., *Amaranthus retroflexus* L. The main number of weeds appears during the period 30.05–20.06.

Due to the high degree of weed infestation, there is a need for a reliable system of integrated protection of maize against weeds, which should provide high efficiency regardless of the method of tillage. At the same time, the use of herbicides is an integral part of the technology of growing this crop. And it is due to chemicals that it is possible to significantly reduce the difference between tillage systems based on energy and resource-saving approaches, including traditional tillage methods [9, 10, 30].

During 2018–2019, we studied the biological effectiveness of the soil herbicide harness, 90% k.e. at the rate of 2.5 l/ha for different methods of tillage. In plowing, harnesses was used to effectively control the growth and development of weeds during the herbaceous period of maize. The biological efficiency of this drug under the conditions of shelf treatment 30 days after application was 99% (Table 1).

Table 1

The effectiveness of herbicides for different methods of tillage on maize crops in 30–50 days after application, the average for 2018-2019, %

Methods of tillage	Weed protection options	Weed death,%		
		total	cereal	dicotyledonous
30 days after application				
Plowing	Harness 2.5 l/ha	99	99	99
	Roundup max, 2.4 l/ha + roundup max, 2.4 l/ha	100	100	100
	Stellar, 1.25 l/ha	91	91	89
Shallow disk tillage	Harness 2.5 l/ha	96	98	91
	Roundup max, 2.4 l/ha + roundup max, 2.4 l/ha	99	99	100
	Stellar, 1.25 l/ha	89	90	88
50 days after application (before harvesting)				
Plowing	Harness 2.5 l/ha	81	84	76
	Roundup max, 2.4 l/ha + roundup max, 2.4 l/ha	98	97	100
	Stellar, 1.25 l/ha	71	70	72
Shallow disk tillage	Harness 2.5 l/ha	78	82	71
	Roundup max, 2.4 l/ha + roundup max, 2.4 l/ha	93	94	92
	Stellar, 1.25 l/ha	72	71	73

Source: formed on the basis of own research [14].

Before application of herbicides in a phase 3 leaves of corn, sites had the mixed type of weeding. The number of weeds in uncultivated areas in phase 3 of corn leaves reached 137–170 pcs./m^2, among which mouse blue – 43–56 pcs./m^2 and chicken millet – 58–70 pieces / m^2 dominated.

Among the dicotyledonous species, the most numerous were such species as: white quince – 8–10 pcs./m^2 and common quince – 2–7 pcs./m^2. Perennial species were represented by creeping wheatgrass – 1–3 pcs./m^2 and field birch – 2–4 pcs/m^2. This option provided the highest level of efficiency for all studied methods of tillage. In particular, in plowing 30 days after re-introduction of 8 leaves of corn, the rows were free of weeds. Against the background of shallow disk processing, the efficiency reached 99%.

Of the post-emergence herbicides used the drug Stellar with an application rate of 1.25 l/ha in combination with surfactant methylate at a rate of 1.25 l/ha. It was found that the effectiveness of this drug, on the 30th day after application to plowing was 91%. For shallow cultivation, the efficiency was at the level of shelf cultivation and amounted to 89%.

For plowing, in areas treated with maize seedlings with harness, 2.5 l/ha due to effective weed control over a long period, the efficiency before harvesting reached 81%.

Due to the effective control of weeds in the initial stages of development, when maize is particularly sensitive to the presence of weeds, areas where double application of roundup max, 2.4 l/ha in phase 3 and 8 maize leaves had a low level of weeds until the end of the growing season. Thus, for the period of harvesting there was a reduction of weeds by 90–98% compared to the control. The most effective was the double application of roundup max, 2.4 l/ha on plowing.

During the growing season, there was also a gradual decrease in the herbicidal action of stellar, 1.25 l/ha, as a result of which during the harvest period the efficiency of this herbicide averaged 71–72% in 2018–2019, compared to control plots. It should be noted that the effectiveness of this drug depended on climatic conditions.

Thus, all herbicide protection options ensured 88–100% weed death within 30 days of application. At the time of harvest, the reduction in weeds was 71–98% compared to untreated areas. The most effective was the double application of roundup max, 2.4 l/ha in phase 3 and 8 leaves in maize.

When assessing the impact of different tillage systems should use a diverse assessment of vegetation indicators, among which a special place is occupied by crop density, as this indicator is a reflection of the potential of hybrids [11].

The effectiveness of the weed control system can also affect crop density, as the competition that occurs in the crops of most crops, and especially in the crops of broad-leaved crops, can lead to the suppression and, in some cases, even the loss of crops. plants [6, 11, 12].

According to the results of research conducted in 2018–2019, it was found that the density of standing corn in the phase of full germination in plowing was in the range of 78.3–78.6 pcs/m^2. With shallow disk cultivation, this figure decreased to 78.1–78.2 pcs/m^2. In our opinion, the difference in the density of standing crops is a consequence of creating optimal conditions for the development of corn in the initial stages of organogenesis and is due to pre-sowing tillage during plowing and shallow disc cultivation (Table 2).

Table 2

Standing density of corn, average for 2018–2019, thous. pcs./ha

Methods of tillage	Weed protection options	Density of standing corn, thous. pcs./ha					
		Phase full ladder			Before harvesting		
		2018	2019	average	2018	2019	average
Plowing	Control	77,8	79,2	78,5	70,6	72,0	71,3
	Harness 2.5 l/ha	78,0	78,6	78,3	72,2	73,8	73,0
	Roundup max, 2.4 l/ha + roundup max, 2.4 l/ha	78,4	78,8	78,6	72,2	73,8	73,2
	Stellar, 1.25 l/ha	78,3	78,7	78,5	72,1	73,7	72,9
Shallow disk tillage	Control	77,6	78,6	78,1	69,6	71,8	70,7
	Harness 2.5 l/ha	77,9	78,5	78,2	71,7	72,9	72,3
	Roundup max, 2.4 l/ha + roundup max, 2.4 l/ha	77,4	78,8	78,1	71,9	73,3	72,6
	Stellar, 1.25 l/ha	77,9	78,5	78,2	71,6	73,2	72,4

Differences in the density of standing corn for different tillage methods were also noted for the period of maize harvesting. Thus, in plowing under conditions of herbicide protection the density was the highest and was in the range of 72.9–73.2 thous. pcs/ha, while in shallow disk – 72.3–72.6 thous. pcs/ha.

Pre-harvest surveys showed a negative effect of weed infestation on maize density.

Thus, during plowing, in control areas due to competition, during the period of corn harvesting, the stocking density decreased by 1.6–1.9 thous. pcs/ha in comparison with plots where herbicides were applied and amounted to 71.3 thous. pcs/m^2. In the areas where the soil preparation Harnes was applied, 2.5 l/ha, the density in this period averaged 73.0 thous. pcs/m^2 at the same time, with double application of the drug Roundup max, 2.4 l/ha. density 2.5 l/ha density in this period averaged 73.0 thous. pcs/m^2 at the same time, with double application of the drug roundup max, 2.4 l/ha density was 73.2 thous. pcs/ha. When applied to plowing herbicide Stellar, 1.25 l/ha, the density was 72.9 thous. pcs/m^2. It should be noted that the difference in the density of standing corn plants under herbicide treatments was within the statistical error.

With shallow disk tillage, the decrease in the density of corn in the control plots reached 2.1 thous. pcs/ha compared to the treated plots and averaged 70.7 thous. pcs/ha. Among the variants on which herbicides were applied, the density difference was 0.2–0.3 thous. pcs/ha, which does not exceed the statistical error. Thus, with pre-emergence application of the herbicide harnes, 2.5 l/ha, the density of standing plants was 72.3 thous. pcs/ha. Under the conditions of combination of pre-application application of harness herbicide, 1.3 l/ha followed by application of roundup max, 2.4 l/ha in phase 3 of corn leaves, the density was 72.6 thous. pcs/ ha, a similar density was observed with double application of roundup max, 2.4 l/ha. With the application of the herbicide Stellar, 1.25 l/ha, the density before harvest was 72.4 thous. pcs/ha.

One of the links in the technology of growing corn is the choice of tillage method, as determined primarily by its response to changes in fertility elements caused by various tillage methods and growth and development conditions that develop in the agrophytocenosis under certain weather conditions. At the same time, due to the sensitivity of corn to weeds, a reliable condition for obtaining high yields is their reliable control. Therefore, the generalized quantitative expression of the reaction of corn to the studied factors is the level of grain yield.

Different methods of tillage and crop care measures have some differences in their effect on the yield of corn grain. The data in the table show that in 2018–2019, the average yield of corn per grain was 7.9–9.40 t/ha (Table 3).

Table 3

Influence of different tillage methods and weed control methods on corn productivity, t/ha

Methods of tillage (Factor A)	Weed protection options (Factor B)	Yield, t/ha			Saved harvest	
		2018	2019	Average	t/ha	%
Plowing	Control	5,40	5,77	5,59	–	–
	Harness 2.5 l/ha	9,05	9,2	9,13	3,54	63
	Roundup max, 2.4 l/ha + roundup max, 2.4 l/ha	8,80	10,0	9,40	3,81	68
	Stellar, 1.25 l/ha	7,98	8,00	8,00	2,41	43
Shallow disk tillage	Control	5,35	5,76	5,55	–	–
	Harness 2.5 l/ha	8,05	8,02	8,04	2,50	45
	Roundup max, 2.4 l/ha + roundup max, 2.4 l/ha	8,29	10,0	9,20	3,65	66
	Stellar, 1.25 l/ha	7,68	8,12	7,90	2,35	42
lsd $_{0,5}$, t/ha	*A*	*0,10*	*0,11*	*0,12*	-	-
	B	*0,13*	*0,15*	*0,14*	-	-

The highest level of yield over the years of research was observed for shelf tillage. Depending on the herbicide protection variant, the yield was 8.0–9.40 t/ha. The use of herbicides on the background of shelf cultivation ensured the preservation of the yield at the level of 43–68% relative to uncultivated control.

The highest average yield was observed with double application of roundup max, 2.4 l/ha in phases 3 and 8 leaves of corn – 9.40 t/ha, the maximum yield of this option was observed in 2019 – 10.0 t/ha. With shallow disc tillage, a decrease in yield was observed compared to shelf tillage by 0.06–0.16 t / ha, depending on the herbicide protection variant. The level of preserved yield when applying herbicides on the background of shallow tillage was 42–66% compared with the control.

The highest yield, as in plowing, was observed with double application of the herbicide roundup max, 2.4 l / ha – 9.2 t / ha, which exceeded the indicators of other options for herbicide protection.

Conclusions.

The results of many years of research on the study of different systems of weed protection by different methods of tillage in corn crops for grain in the experimental field of VNAU give grounds for the following conclusions:

It is established that a mixed type of weeding is formed in maize crops, among which the largest share is occupied by late spring species – *Echinochloa crus-galli* (L.) Roem., *Setaria glauca* L., *Galinsoga parviflora* Cav., *Chenopodium album* L., *Amaranthus retroflexus* L.

The main number of weeds appears during the period 30.05–20.06.

Herbicide protection options provided 89–100% weed death within 30 days of application. At the time of harvest, the number of weeds was 71–98% lower than in the uncultivated areas. The most effective was double application of roundup max, 2.4 l/ha in phases 3 and 8 leaves in corn.

The highest yield of corn grain was obtained with double application of the herbicide Roundup Max at the rate of 2.4 l/ha. The yield for shelf tillage was 9.4 t/ha, for shallow tillage – 9.2 t/ha.

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Biliavtseva V.
Candidate of Agricultural Sciences
Vinnytsia National Agrarian University, Vinnytsia, Ukraine
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METHODS OF WASTEWATER TREATMENT WITH THE HELP OF AQUATIC ORGANISMS.

Abstract.

One of the promising areas for the introduction of innovative water treatment technologies is the use of biological methods. In this case, the aquatic environment is not made of uncharacteristic substances, technological processes mimic natural, the efficiency of which is enhanced by tens and hundreds of times by a special organization of biological processes.

Almost 80% of Ukraine's drinking water supply is provided by surface water. Pools and rivers, according to the hygienic classification of water bodies according to the degree of pollution, can be classified as polluted and highly polluted. The composition of treatment facilities and water treatment technologies have not actually changed in recent years.

Keywords: *aquatic organisms, plankton, water, organisms, purification*

Topicality.

The uncontrolled rapid development of water mains (largely blue-green hydrogen) is a clear example of the treatment of contaminated surface waters in the waters of Ukraine. Due to the pollution of the hydrosphere of human products - compounds of phosphorus and nitrogen, algae received unfavorable conditions for development.

As a result of the construction of artificial reservoirs on the rivers of Ukraine, the number of shallow areas that are well warmed by the sun has increased. Algae cause significant damage to the environment at the stage of extinction, creating secondary pollution (release of toxic substances into the air and into the aquatic environment), but at the same time absorbing pollution contribute to water purification.

Analysis of recent research and publications.

A large number of studies have been devoted to the treatment of polluted wastewater with the use of aquatic organisms.

Hydrobionts are salt and freshwater organisms that live permanently (obligatorily) or temporarily (optionally) in the aquatic environment [9]. Many of them have adapted to living in a variety of conditions over millions of years of evolution.

A large number of researchers have studied the factors influencing the development of coenobacteria on the example of cyanobacteria from the genera Anabaena, Aphanizomenon, Cylindrospermopsin, Nodularia, Lyngbya, Oscillatoria, Microcystis, Planktothrix [17].

Among other factors that shape the conditions for the development of cyanobacteria, they focused in their research on salinity, temperature, pH, lighting, hydrodynamics of the environment.

Depending on the way of staying and moving in the respective layers of the aquatic environment, the following main ecological groups are distinguished among aquatic organisms: nekton, plankton and benthos.

Nekton (nektos - floating) - large animals that move actively and are able to overcome long distances and strong currents: fish, squid, pinnipeds, whales. Necton in freshwater includes both amphibians and many insects [13,15].

Plankton (planktos - wandering) - a set of plants (phytoplankton: diatoms, green and blue-green algae, etc.) and small animals (zooplankton: small crustaceans, winged mollusks, finfish, jellyfish, some worms), which are not capable of active movement and resistance to currents, but live at different depths.

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