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THE EFFECT OF SOIL HERBICIDES AND PRE-SOWING SEED TREATMENT ON THE CHICKPEA (*CICER ARIETINUM*) GROWTH AND YIELD

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Chickpeas are one of the oldest leguminous crops and are currently widely used both for human consumption and as animal feed. Their biological characteristics, in particular their high resistance to drought, high temperatures and even brief cold spells, make it possible to achieve stable yields in regions with unfavourable climatic conditions.

In terms of nutritional value, chickpea seeds occupy an important place among other crops, as they contain significant amounts of protein, lipids and carbohydrates, and are rich in minerals and bioactive compounds. This makes them a promising source of plant protein and an important component in addressing food security issues. The low yield of this crop is often due to failure to adhere to the basic principles of cultivation technology. A key role is played by the plant protection system, which involves the timely control of harmful organisms, including weeds.

Weed infestation is a common problem for all agricultural ecosystems, and chickpea crops are no exception. In the early stages of development, plants grow slowly, which significantly reduces their ability to compete with weeds. At this time, weeds grow rapidly, utilising available resources more efficiently than the crop plants. The composition and prevalence of weeds in chickpea crops can vary significantly depending on specific growing conditions. This is influenced by climatic factors, soil type, previous crops and the specific agronomic practices employed on the farm.

Soil herbicides play a critical role in weed management in chickpea cultivation. When used judiciously, they can enhance weed control and contribute to increased chickpea yield. The purpose of this study was to investigate the growth, development and productivity of chickpea depending on the treatment with biological preparations and chemical protection against weeds in the conditions of the Vinnytsia region, Ukraine. The highest chickpea seeds yield was noted in 2025 in the variant where chickpea seeds were treated with both inoculant and biofungicide substance before sowing and the soil herbicide Frontier® Optima 72 EC was applied, and the yield was 2.54 (t ha^{-1}). The lowest level of the yield 0.55 (t ha^{-1}) was noted in the control I on average years of experiments. Treatment of chickpea seeds with Rhizobophyte inoculant and biofungicide Biopolycide with the further application of the soil herbicide Frontier® Optima 72 EC provided to obtain the yield of chickpea seeds at the level of 2.28 (t ha^{-1}), which was more than in the control sites at 1.73 (t ha^{-1}). The average yield of chickpeas during the years of experiments was 2.23 (t ha^{-1}), and it did not differ significantly on similar options, but with the use of the soil herbicide Harness® 90 EC.

Key words: *chickpea (Cicer arietinum), acetochlor, dimethenamid P-720, rhizobium strains, herbicide, crop yield.*

Table 5., Lit. 12.

Problem statement. Chickpea (*Cicer arietinum*) is a vital leguminous crop globally recognized for its nutritional value and adaptability to diverse agro-climatic conditions. The cultivation of chickpeas faces several challenges, including weed competition, which can significantly reduce yield if not effectively managed. Weeds are the main biotic factor deteriorating chickpea yield and nutritional quality [1] Soil herbicides have emerged as a common tool for weed control in chickpea cultivation. Weed interference is a major constraint in chickpea cultivation, as it competes with the crop for essential resources such as nutrients, water, and sunlight. Uncontrolled weed growth can reduce chickpea yield by up to 50%, making effective weed management crucial. Soil herbicides, when applied correctly, can effectively control a wide range of weed species that compete with chickpeas. Enhanced weed control leads to reduced competition for resources, which can positively impact chickpea yield.

Analysis of recent research and publications. Like other legumes, chickpeas have the unique ability to form a symbiotic relationship with nitrogen-fixing rhizobium bacteria. This association is crucial for enhancing soil fertility and ultimately influencing chickpea yield. Inoculation involves the introduction of compatible rhizobium strains to chickpea seeds or the soil before planting. These rhizobia establish a symbiotic relationship with the chickpea plant by infecting the root nodules, where they convert atmospheric nitrogen into ammonia, making it available as a nutrient source for the plant.

Numerous studies have demonstrated that inoculation with effective rhizobium strains significantly enhances nitrogen fixation in chickpeas. This process directly contributes to increased plant growth, vigor, and yield. Research by Malik et al. [2] reported a substantial increase in chickpea yield due to enhanced nitrogen fixation following inoculation with selected rhizobial strains.

In addition to nitrogen fixation, inoculation can also improve the availability of other essential nutrients, such as phosphorus and micronutrients, to chickpea plants. This enhanced nutrient uptake positively affects plant health and, consequently, yield. Inoculation not only enhances nutrient uptake but also plays a role in enhancing chickpea's tolerance to various environmental stressors. Studies by Shcatula Yu.M. et al. [3] highlighted that inoculated chickpea plants exhibited greater resilience to drought and salinity, resulting in better yields under adverse conditions. It's important to note that the response to inoculation can vary depending on several factors, including the chickpea cultivar, rhizobial strain used, soil type, and environmental conditions. Therefore, selecting the right rhizobial strain adapted to local conditions is crucial for maximizing the yield benefits [4].

To maximize chickpea yield, there is growing interest in exploring the potential benefits of plant growth-promoting bacteria, such as *Paenibacillus polymyxa*, which have been found to positively impact plant growth and development.

Paenibacillus polymyxa is renowned for its multifaceted mechanisms that promote plant growth. Phosphate solubilization: *Paenibacillus polymyxa* can solubilize inorganic phosphate, making it more accessible to chickpea plants.

This increased phosphate availability supports root development and nutrient uptake. Nitrogen fixation: Some strains of *Paenibacillus polymyxa* have the capacity to fix atmospheric nitrogen, thereby supplementing chickpea plants with an additional source of this essential nutrient. Production of plant growth-promoting substances: the bacterium produces various plant growth-promoting substances, such as indole-3-acetic acid (IAA), which stimulates root development and overall plant growth.

Numerous studies have highlighted the positive impact of *Paenibacillus polymyxa* on chickpea yield. For instance, research by [5] demonstrated a substantial increase in chickpea yield when inoculated with a phosphate-solubilizing strain of *Paenibacillus polymyxa*. Similarly, a study by [6] reported enhanced nitrogen fixation and increased yield in chickpea plants associated with *Paenibacillus polymyxa* inoculation. In addition to promoting growth and yield, *Paenibacillus polymyxa* has been shown to enhance chickpea's resistance to various abiotic stresses, such as drought and salinity [7]. This stress tolerance can further contribute to improved chickpea yield in challenging environments.

Bradyrhizobium japonicum, a nitrogen-fixing bacterium, can have a significant impact on chickpea (Cicer arietinum) yield. One of the primary benefits of *Bradyrhizobium japonicum* for chickpea is its ability to fix atmospheric nitrogen into a form that the plant can use. Chickpeas, like other legumes, have a mutualistic relationship with these bacteria. The bacterium forms nodules on the chickpea roots, where it converts atmospheric nitrogen into ammonia, a nutrient that is essential for plant growth. This additional nitrogen source reduces the chickpea plant's dependence on synthetic nitrogen fertilizers, which can lead to cost savings for farmers.

The nitrogen-fixing capability of *Bradyrhizobium japonicum* also indirectly enhances the availability of other essential nutrients. When chickpeas have access to ample nitrogen, their overall nutrient uptake and utilization are improved, leading to healthier and more productive plants [8].

The increased nitrogen supply from *Bradyrhizobium japonicum* contributes to improved plant growth, including increased vegetative biomass and root development. Stronger and more vigorous chickpea plants are better equipped to produce more pods and seeds, ultimately leading to higher yields. Moreover the use of nitrogen-fixing bacteria like *Bradyrhizobium japonicum* in chickpea cultivation can have environmental benefits. It reduces the need for synthetic nitrogen fertilizers, which can lead to nitrogen runoff and environmental pollution.

It's essential to note that the response to *Bradyrhizobium japonicum* inoculation can vary depending on various factors, including the specific bacterial strain used, soil conditions, chickpea cultivar, and environmental factors. Therefore, optimizing the inoculation process and bacterial strain selection is crucial for maximizing yield benefits.

Thus, although a sufficient number of works are devoted to the problems of increasing the yield of chickpeas due to the use of inoculation and soil herbicides in the scientific literature, there is still a need to adapt these measures to specific conditions and characteristics of the soil and climate.

Since the purpose of this study was to investigate the growth, development and productivity of chickpea depending on the treatment with biological preparations and chemical protection against weeds in the conditions of the Vinnytsia region, Ukraine, the following tasks had to be solved:

1. to determine field germination and number of plants depending on the use of herbicides and inoculants;
2. to identify the most numerous weed species, depending on the applied herbicides and chickpea seed inoculation;
3. to assess the effect of herbicides on the weed plants amount in the chickpea agrocenosis;
4. to calculate chickpea yield depending on the action of herbicides and inoculants.

Conditions and methods of conducting research. Field experiments were conducted at the research sites of Agronomichne village 49°11'27.1"N 28°20'51.4"E of Vinnytsia National Agrarian University, Ukraine during 2019-2021 years. All technological elements of chickpea cultivation were typical for the soil-climate conditions of Vinnytsia region, Ukraine, excepting the factors taken for the investigation (table 1).

Table 1

Key technological chickpea growing technology aspects, used in the experiment

Predecessor	winter wheat
Sowing method	close row spacing
Seeder	"Grain 5.4V"
Row spacing	30 (cm)
Sowing depth	4 (cm)
Sowing time	April 5th 2019; April 7th 2020; April 8th 2021
Sowing rate	160 (kg ha^{-1})
Inoculation:	"Rhizobophyte" liquid (*Bradyrhazobium japonicum)*
Rate	1 mL kg^{-1}
Biofungicide substance for pre-sowing treatment:	"Biopolycide" (*Paenibacillus polymyxa)*
Rate	100 (mL) per 160 (kg)
Pre-emergence Weed Control. Herbicide 1:	Harness® 90 EC (acetochlor 900 g L^{-1})
Rate	3 (L ha^{-1})
When	April 9th 2019; April 12th 2020; April 13th 2021
Herbicide 2:	Frontier® Optima 72 EC (dimethenamid 720 g L^{-1})
Rate	1.2 (L ha^{-1})
When	April 9th 2019; April 12th 2020; April 13th 2021
Insecticide (*used during the budding phase*):	synthetic pyrethroid Decis® 2.5 EC (deltamethrin 25 g L^{-1})
Rate	0.2 (L ha^{-1})
When	June 11th 2019; June 15th 2020; June 20th 2021
Harvesting machine	"Sampo 500"

The source is based on my own research

Herbicides application**.** Harness® 90 EC, active substance acetochlor 900 g L-1, consumption rate 3.0 (L ha-1), and Frontier® Optima 72 EC, active substance dimethenamid 720 (g L-1), consumption rate 1.2 (L ha-1) were used individually. Herbicides were administered using a knapsack sprayer at a working fluid consumption rate of 250 L ha-1. The testing area was 10 square meters.

Herbicides efficiency evaluation. Evaluated the effectiveness of pesticides in chickpea crops. Weeds species evaluation. Weeds in the chickpea field were counted after the majority of their species had emerged, when the weeding structure had evolved and stabilized. The calculations were carried out in 0.25 m2 frames that were overlaid diagonally across the plots four times. Herbariums and markers with color photographs were utilized to determine weed species affiliation. Weeds were counted twice: 30 days after spraying and during chickpea harvest.

Insecticides application. To guard against pests, the chickpea crop was sprayed once with Decis® 2.5 EC at a rate of 0.2 L ha-1 during the budding phase against *Bruchus pisorum* and *Contarinia pisi Winn*.

Harvest calculation. Chickpea seed yield was measured throughout the complete maturity phase using the sub-plot threshing method with a "Sampo 500" combine and weighing from each recording plot.

Research results. The most effective and efficient technique to control weeds in chickpea fields is to use soil herbicides. As a result, the use of soil pesticides allows weeds to appear 30-40 days later.

Chickpea final germination percentage (%) varied according to the quality of pre-sowing tillage, seed treatment with biological preparations, applied soil herbicides, and weather conditions. Unstable meteorological conditions were noted during the study years, including a significant increase in average daily temperatures and uneven precipitation. The spring of 2020 was the driest and most unfavourable for agricultural crop cultivation, resulting in a considerable fall in field germination indicators for chickpea seeds in all variants of the experiment. The spring-summer period of 2021 was distinguished by the most favorable temperature indicators of atmospheric air and precipitation during the chickpea growth season [9] found that dimethenamid successfully suppresses weed populations, lowering competition for nutrients, water, and light, which can improve chickpea plant germination and growth [10] found that acetochlor, like dimethenamid, effectively suppresses weed growth. Reduced weed competition can help chickpeas germinate and grow [11, 12].

Over the years, research has shown that seed treatment with bacterial preparations improves field germination of chickpea seeds, as well as the completeness and evenness of seedlings of cultivated plants. So, in the control plots without treatment, the field germination rate of the Rosanna chickpea variety was 86 (%), and the number of plants in the seedling phase was 60 (pcs m-2). After inoculating chickpea seeds with Rhizobophyte before sowing and applying the herbicide Harness® 90 EC at a rate of 3.0 (L ha-1), field germination of chickpea seeds increased to 91 (%), which is 5 (%) higher than at the control sites, and the number of chickpea plants was within 64 (pcs m-2).

The areas where chickpea seeds were treated with the complex microbiological preparations Rhizobophyte and the biofungicide substance Biopolycide before sowing, as well as the soil herbicide Frontier® Optima 72 EC, showed the greatest increase in field germination. So, the number of chickpea plants in the seedling phase was within 66 (pcs m-2), and the field germination was 94 (%), which is about 8 (%) greater than in the control plots without treatments (Table 2).

Table 2

Field germination (%) and the number of chickpea plants in the seedling phase depending on the pre-sowing treatment by inoculants and soil herbicides (average for 2023-2025)

Pre-sowing seed treatment	Herbicides	Plants amount (pcs m^{-2})	+ / - to control (variant without treatment)	Final seed germination (%)	+ / - to control (variant without treatment)
Without inoculation	Without treatment (I)	60	-	86	-
Without inoculation	Without treatment (II) (hand weeding)	59	-1	84	-2
Rhizobophyte	Harness® 90 EC	64	+4	91	+5
	Frontier® Optima 72 EC	65	+5	93	+7
Biopolycide	Harness® 90 EC	63	+3	90	+4
	Frontier® Optima 72 EC	64	+4	91	+5
Rhizobophyte + Biopolycide	Harness® 90 EC	65	+5	93	+7
	Frontier® Optima 72 EC	66	+6	94	+8

The source is based on my own research

Systematic accounting measures of weed intensity emerging in chickpea fields revealed several characteristics of such processes. Weed seedlings from the early spring biological group, *Sinapis arvensis* and *Galium aparine L.*, emerge first in chickpea fields. After 8-10 days, *Polygonum convolvulus, Polygonum scabrum Moench, Chenopodium album* and *Polygonum aviculare L.* appeared. During the next 10 days of vegetation, the intensity of segetal flora emergence peaked since the environmental conditions were favorable and the culture plants had not yet created a sufficient projective covering of the soil surface. Seedlings of late spring species, including *Amaranthus retroflexus*, *Echinochloa crus-galli*, and *Setaria* species, were discovered around this period.

Weeding in chickpea fields was structured as follows: there were 158 (pcs m-2), including 97 *Poaceae* and 61 *Dicotyledoneae* species in the developing period of 2-5 leaves (Table 3).

Soil herbicides are an effective means of controlling undesirable plants in diverse crop fields. A diverse range of products containing various active chemicals from various chemical compound families ensures effective weed control even before seeds are sowed, and cultivated plants grow in clean fields, avoiding competition with weeds. Soil herbicides Harness® 90 EC and Frontier® Optima 72 EC were used in the experiment after chickpeas were sown but before seedlings emerged.

Table 3

Weeds species and amount detected in the chickpea fields (average for 2023-2025)

Poaceae plants				Dicotyledoneae plants								
Setaria viridis	Echinochloa crus-galli (L.)	Unidentified species	Total	Cirsium arvense	Chenopodium album	Amaranthus retroflexus	Thlaspi arvense	Polygonum species	Raphanus raphanistrum	Tripleurospermum inodorum (L.)	Unidentified species	Total
59	34	4	97	1	16	11	10	8	6	5	4	61
TOTAL												158

The source is based on my own research

On experimental plots where chickpea seeds were treated separately with biological inoculant Rhizobophyte and biofungicide substance Biopolycide before sowing, and the herbicide Harness® 90 EC was applied at a rate of 3.0 (L ha-1) before the appearance of chickpea seedlings, a significant decrease in weed vegetation was noted a month after herbicide application, up to 87-88% compared to control areas, where natural weed population was observed (table 4).

During the chickpea harvesting season, the number of weeds per 1m^2 was 20-22, but in the control plots (control I), this indication was within 141 (pcs/m-2). This herbicide's protective function was primarily manifested in the reduction of weed population and ability to acquire raw mass. Harness® 90 EC, a soil herbicide, was less effective against annual dicotyledonous weeds by 75-77% compared to control I. Accounting a month after spraying revealed that the quantity of Poaceae weeds was 4 (pcs m-2), whereas Dicotyledoneae weeds were 14-15 (pcs m-2). Simultaneously, the herbicide had a considerable harmful effect on the plants of perennial weed species (*Cirsium* genus) growing in the chickpea fields, allowing them to grow, develop, and amass mass without difficulty.

The favorable role of the treatments was observed at sites where, in addition to applying the soil herbicide Harness® 90 EC, chickpea seeds were treated with the microbiological inoculant Rhizobophyte and the biofungicidal treatment Biopolycide prior to sowing. First, the chickpea plants thrived and looked better than the control plots, and they faced less competition from weeds. The number of weeds was found to be lower in these areas than in sites where chickpea seeds were treated separately with biological inoculant, biofungicide substance, and soil herbicide Harness® 90 EC prior to sowing.

Weed counts were carried out a month after the introduction of herbicides in the sites: where inoculation with bacterial treatments was carried out, there were 14 (pcs m-2), including Poaceae weeds 4 (pcs m-2) and Dicotyledoneae weeds 10 (pcs m-2), and the weediest level in comparison with control sites decreased by 91 (%), and during the chickpea harvesting period by 90 (%).

Table 4

The amount of the weeds species after inoculants and herbicides application in the chickpea experimental fields (average for 2023-2025)

Treatment	The amount of weeds (pcs m^{-2})						
	One month after herbicides application			The percent of weed reduction to control (%)			Five days before harvesting
	Total	Poaceae	Dicotyledoneae	Total	Poaceae	Dicotyledoneae	
Without treatment (I)	158	97	61	-	-		141
Without treatment (II) (hand weeding)	-	-	-	-	-	-	-
Rhizobophyte + Harness® 90 EC	18	4	14	87	96	77	20 (86%)
Rhizobophyte + Frontier® Optima 72 EC	11	3	8	93	97	87	13 (90%)*
Biopolycide + Harness® 90 EC	19	4	15	88	96	75	22 (84%)
Biopolycide + Frontier® Optima 72 EC	12	3	9	92	97	85	15 (89%)*
Rhizobophyte + Biopolycide + Harness® 90 EC	14	4	10	91	96	84	14 (90%)
Rhizobophyte + Biopolycide + Frontier® Optima 72 EC	8	2	6	95	98	90	12 (91%)

The source is based on my own research

Frontier® Optima 72 EC herbicide was applied before the appearance of chickpea seedlings at sites where the chickpea seeds were separately inoculated with Rhizobophyte and treated with the biofungicide Biopolycide, resulting in weed death in an average of 92-93 (%) a month after application. The primary protective impact of this herbicide was a reduction in the amount of Poaceae weeds that dominated the chickpea fields. In comparison to the control locations, the quantity of Poaceae weeds reduced by 97 percent and Dicotyledoneae weeds by 85-87%. It was discovered that the C. album, T. arvense, and Polygonum species were depressed.

The best treatment effects were observed at areas where chickpea seeds were treated with Rhizobophyte inoculant and biofungicide Biopolycide prior to planting, followed by Frontier® Optima 72 EC herbicide application. The number of weeds before harvesting chickpeas in this variation was 12 (pcs m-2), and the weediest level dropped by 91 (%) as compared to the control plots (no treatments).

The highest chickpea seed yield was observed in 2021 in the version when chickpea seeds were treated with both an inoculant and a biofungicide chemical prior to sowing, and the soil herbicide Frontier® Optima 72 EC was administered, yielding 2.54 (t ha-1). On average, the control I had the lowest yield of 0.55 (t ha-1) across the years of experimentation.

Treatment of chickpea seeds with Rhizobophyte inoculant and biofungicide Biopolycide, followed by application of the soil herbicide Frontier® Optima 72 EC, resulted in a chickpea seed yield of 2.28 (t ha-1), which was higher than the control sites' yield of 1.73 (t ha-1). The average chickpea production during the experiment years was 2.23 (t ha-1), and it did not differ substantially from similar choices except for the use of the soil herbicide Harness® 90 EC (table 5).

Table 5

Chickpea grain yield depending on the effect of treatments

Pre-sowing seed treatment	Herbicides	Years					
		2023	2024	2025	Mean ± SE_{χ}	Tukey HSD Q statistic	+/- to control
Grain yield (t ha^{-1})							
Without inoculation	Without treatment (I)	0,53	0,44	0,68	$0,55^{\pm 0.07A}$	-	-
Without inoculation	Without treatment (II) (hand weeding)	2,08	1,98	2,33	$2,13^{\pm 0.10B}$	16.0528^{AB}	+1,58
Rhizobophyte	Harness® 90 EC	1,95	1,82	2,08	$1,95^{\pm 0.07C}$	14.2240^{AC}	+1,40
	Frontier® Optima 72 EC	1,98	1,86	2,19	$2,01^{\pm 0.09D}$	14.8336^{AD}	+1,46
Biopolycide	Harness® 90 EC	1,88	1,79	2,09	$1,92^{\pm 0.08E}$	13.9192^{AE}	+1,37
	Frontier® Optima 72 EC	1,93	1,85	2,10	$1,96^{\pm 0.07F}$	14.3256^{AF}	+1,41
Rhizobophyte + Biopolycide	Harness® 90 EC	2,15	2,06	2,48	$2,23^{\pm 0.12G}$	17.0688^{AG}	+1,68
	Frontier® Optima 72 EC	2,18	2,12	2,54	$2,28^{\pm 0.13H}$	17.5768^{AH}	+1,73
Tukey HSD p-value							0.0010
Tukey HSD inference							**p<0.01

*Means with different letters are significantly different at **p<0.01*

The source is based on my own research

During the trial, chickpea seeds were treated with the biopreparations Rhizobophyte and Biopolycide, which prolonged the action of herbicides.

To summarize the effectiveness indicators for the protective effect of herbicides on chickpea plants, the most effective measures were seed treatment with biopreparations before sowing and application of Frontier® Optima 72 EC herbicide before sowing at a consumption rate of 1.2 (L ha-1). This composition allowed grown chickpea plants to be protected against weeds for a longer amount of time than other varieties that used preparations.

Conclusions. Given the mixed nature of weeding on chickpea crops, which have recently dominated the crops of the Forest-Steppe zone, individual herbicides are unable to control the entire range of weed species; thus, it is necessary to use biological preparations that stimulate chickpea plants to form a strong root system, resulting in better growth and development of chickpea plants.

Yield is an integral effectiveness indicator of all measures in agricultural crop cultivation, in particular, a set of microbiological, physiological, and biochemical processes in plants and soil, with the use of drugs with various physiological and chemical effects, are reflected in the amount of chickpea seed yield achieved. The major way to boost chickpea seed output is to control weed growth in agrocenoses.

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АНОТАЦІЯ
ВПЛИВ ҐРУНТОВИХ ГЕРБІЦИДІВ ТА ПЕРЕДПОСІВНОЇ ОБРОБКИ НАСІННЯ НА РІСТ І ВРОЖАЙНІСТЬ НУТУ (CICER ARIETINUM)

Нут є однією з найдавніших зернобобових культур, яка на сьогодні широко використовується як у продовольчій сфері, так і для кормових потреб. Його біологічні особливості, зокрема висока стійкість до посухи, високих температур і навіть короткочасного похолодання, забезпечують можливість отримання стабільного врожаю в регіонах із несприятливими кліматичними умовами. За поживною цінністю насіння нуту займає важливе місце серед інших культур, оскільки містить значну кількість білка, ліпідів і вуглеводів, а також багате на мінеральні елементи й біологічно активні речовини. Це робить його перспективним джерелом рослинного білка та важливим компонентом у вирішенні проблем продовольчої безпеки. Недостатній рівень урожайності цієї культури часто зумовлений недотриманням основних елементів технології вирощування.

Особливу роль відіграє система захисту рослин, яка передбачає своєчасне обмеження чисельності шкідливих організмів, у тому числі бур'янів. Забур'янення є характерною проблемою для всіх агроценозів, і посіви нуту не є винятком. У початковий період розвитку рослини ростуть повільно, що значно знижує їх здатність конкурувати з бур'яновою рослинністю.

У цей час бур'яни активно розвиваються, використовуючи доступні ресурси швидше за культурні рослини. Склад і рівень поширення бур'янів у посівах нуту можуть суттєво змінюватися залежно від конкретних умов вирощування. На це впливають кліматичні фактори, тип ґрунтів, попередні культури та особливості агротехнічних заходів, що застосовуються в господарстві.

Ґрунтові гербіциди відіграють важливу роль у боротьбі з бур'янами при вирощуванні нуту. При розумному застосуванні вони можуть посилити боротьбу з бур'янами та сприяти збільшенню врожайності нуту. Метою цього дослідження було вивчення росту, розвитку та врожайності нуту залежно від обробки біологічними препаратами та хімічного захисту від бур'янів в умовах Вінницької області, Україна. Найвища врожайність насіння нуту була відзначена в 2023 році у варіанті, де насіння нуту перед посівом обробляли інокулянтом і біофунгіцидом, а також застосовували ґрунтовий гербіцид Frontier® Optima 72 ЕС, і врожайність становила 2,54 (т/га). Найнижчий рівень врожайності 0,55 (т/га) був відзначений у контролі I в середньому за роки експериментів. Обробка насіння нуту інокулянтом Rhizobophyte і біофунгіцидом Biopolycide з подальшим внесенням ґрунтового гербіциду Frontier® Optima 72 ЕС забезпечила отримання врожаю насіння нуту на рівні 2,28 (т/га), що було більше, ніж у контрольних ділянках – 1,73 (т/га). Середня врожайність нуту за роки експериментів становила 2,23 (т/га) і істотно не відрізнялася на аналогічних варіантах, але з використанням ґрунтового гербіциду Harness® 90 ЕС.

***Ключові слова**: нут (Cicer arietinum), ацетохлор, диметенамід Р-720, штами ризобію, гербіцид, урожайність.*

Табл. 5., Літ. 12.

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