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IMPACT OF HERBICIDES ON THE FORMATION OF CHICKPEA YIELD

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One of the main reasons for the decline in the yield of chickpea seeds is the high weediness of crops. It is determined by the potential stock of weed seeds in the soil and its long-term viability. The presence of large amounts of weed seeds in the soil creates significant problems for growing chickpeas. Therefore, the assessment of weed efficiency of any farming system or its component should be based on quantitative changes in potential soil weeds. The interaction between crops and weeds in chickpea crops has its own characteristics, because in the first period of the growing season they grow very slowly and have little effect on the conditions of weed growth, so there is a rapid growth of segetal vegetation. In the technology of growing chickpeas in the plant protection system traditionally use the chemical method. However, even with high efficiency, this method does not always give the desired results, there is a violation of ecological balance in agrocenoses, reduction of species biodiversity, contamination of soil and plants with chemicals, reducing product quality. Observance of agrotechnologies, constant phytosanitary monitoring, effective diagnostics and forecast of development and spread of harmful organisms in chickpea crops are important in ensuring proper phytosanitary condition.

Regulation of weeds and their harmful effects in agrophytocenoses of chickpea drawing them to an economically harmless level is a significant condition in the technology of its cultivation. The main control of weeds is done at the beginning of the growing season, because at this time chickpeas grow very slowly, and are in the rosette phase for a long time, and therefore cannot withstand competition from weeds. To increase the yield of chickpea seeds, an important place in the technology of cultivation belongs to the use of herbicides and biological products. Inoculation of chickpea seeds with Rhizobophyte at a rate of 1 l / t and a biofungicide Biopolicide at a rate of 100 ml / t and application of soil herbicide Frontier Optima, 72% e. c., at a rate of 1.2 l / ha help to reduce weeds up to 91%, and the capacity to obtain a yield of chickpea seeds at 2.12 t / ha.

Key words: *chickpeas, agrocenosis, technology, weeds, herbicides, biologicals, yield.*
Table 2. Lit. 14.

Formulation of the problem. Chickpea is enough drought-resistant legume, which can withstand short-term heat, drought and dry winds. Having the strong root system and economical consumption of moisture, chickpeas are more adapted to such weather conditions and are suitable for growing in areas which often suffer from drought in summer. In this regard, chickpeas are the most promising legumes for arid regions of Ukraine.

Chickpea is a light-loving plant, has small leaves, so it competes poorly with weeds throughout the growing season. It is particularly affected in the first half of the growing season, which is associated with slow initial growth. The presence of weeds in chickpea crops significantly affects both productivity and crop quality [10].

The level of weediness of chickpea crops is one of the factors reducing its productivity. In this regard, the study of the effectiveness of herbicides and biological products applied both separately and in tank mixes, on the formation of the chickpea grain yield is quite relevant.

Analysis of recent researches and publications. The interaction between crops and weeds in legume crops has its own characteristics, because in the first period of the growing season they grow very slowly and have little effect on the growth conditions of weeds, so there is a rapid growth of segetal vegetation. Root secretions enriched with nitrogen and other compounds improve the feeding conditions of weeds [2].

The main reason of the decline in cultivated plants yields, including chickpeas, is the high weediness of crops. It is determined by the potential stock of weed seeds in the soil and its long-term viability. The presence of large amounts of weed seeds in the soil poses significant problems for most crops. Therefore, it should be considered that the assessment of weed effectiveness of any farming system or its component should be based on quantitative changes in potential soil weeds. Deviation from this method of assessment is caused by errors which can result in significant crop losses and environmental problems [8, 9].

One of the main agronomic measures for controlling the harmfulness of weeds in crops is their proper alternation over time, on the basis of biological characteristics of plant growth and development. Reducing the amount of weeds in crops to an economically acceptable level is achieved only in crop rotations, where a scientifically sound sequence of crop changes limits the spread of specialized weeds in subsequent years. In their researches many scientists have shown that crop rotation is the main preventive measure that can dramatically limit the harmfulness, or even completely neutralize a large group of potential, mostly specialized pests, diseases and weeds [6].

In terms of developing effective measures of weed technologies it is essential to monitor the weediness of agrophytocenoses of cultivated plants regularly and efficiently, especially considering the current agricultural trends to change tillage systems and minimize them.

The concept of modern integrated protection of cultivated plants from weeds includes: prevention of replenishment of the seed bank of weeds in the soil by reducing their seed productivity and inflow from the outside; decreasing the intensity of weed seed germination from the existing bank in the soil to natural death; provocation and friendly germination of weed seeds in the pre-sowing and post-harvest periods with the subsequent destruction of their seedlings by tillage tools; strengthening the competitiveness of cultivated plants against weeds, that eliminates or significantly reduces the formation and entry of weed seeds into the soil [9].

The chemical method is traditionally used for plant protection in the technologies of growing chickpeas. However, even with high efficiency, this method does not always provide the desired results, unable to ensure long-term stabilisation of the phytosanitary condition of agrocenoses of crops and their compliance with environmental requirements.

In this process there are violation of the ecological balance in agrocenoses, reduction of species biodiversity, contamination of soil and plants with chemicals, reducing product quality, the emergence of new species and resistant forms of

pathogens and so on. Adherence to agrotechnologies, constant phytosanitary monitoring, effective diagnosis and prognosis of the development and spread of pests in chickpea crops are significant in ensuring plant health and maintaining proper phytosanitary conditions.

Nowadays, in agriculture there is a different view of the role of weeds in agrophytocenoses. Earlier there was a concept of complete weeds destruction, but now new aspects are becoming widespread – the regulation of their amount [12-14]. The growing threat of pesticide pollution is the main reason for this. It is more economically feasible to prevent their mass distribution to an environmentally safe level, as weeds are dangerous due to their high amount rather than botanical diversity [11].

Controlling the amount of weeds in the crops provides an opportunity to respond in a timely manner and eliminate possible problems, and to control the amount of weeds successfully, we need complete information about their quantitative and species composition. One of the tools of control is the constant monitoring the weeds' spread in crops. The degree of weediness of crops is primarily characterised by the phytocenotic ability of cultivated plants to suppress weeds, the peculiarity of soil and climatic conditions, technologies of growing crops and the degree of potential soil contamination [5, 7].

Aim of the research is to identify the features of the formation of grain productivity of chickpeas in grey forest soils depending on soil herbicides and biological preparations for high quality seeds and to determine the effect of herbicides and their compositions on the weed component in chickpea agrocenoses.

Material and research methods. The research has been conducted in the research field of Vinnytsia National Agrarian University. The soil at the experimental site is grey forest soils with medium loam. According to the agrochemical survey, the humus content in the arable layer is low – 3%. The content of light hydrolysed nitrogen (according to Cornfield) is low – 7,0-8,0; mobile phosphorus (according to Chirikov) high – 16,0-19,4; exchangeable potassium (according to Chirikov) increased – 9,5 mg / 100 g of soil. Hydrolytic acidity is high and stands at 4,32 mg-eq./100 g of soil. In terms of metabolic acidity, pH 5,0-5,4 is a medium-acid soil. The soil of the experimental plot and its agrochemical parameters are typical for this area and suitable for growing beans.

The research objects are the Triumph chickpea variety, biological products and soil herbicides. Chickpeas were sown in the usual row way with a CH-16A seeder in the first decade of April to a depth of 4-5 cm. The sowing rate was 500 thousand pcs. / ha of similar seeds. Pre-sowing treatment of chickpea seeds was performed with a biofungicide and inoculant. The predecessor is winter wheat.

The cultivation technology generally corresponded to the recommended one for the Forest-Steppe zone. Herbicides were applied with a knapsack sprayer with a working fluid consumption rate of 250 l / ha. Repetition of the experiment – four times, the area of the accounting area was - 25 m^2. Location of plots – systematic.

Reports of crop weeds were taken according to the guidelines [10]. The species composition of weeds was determined using reference books. Yield accounting was done by the method of continuous harvesting [1].

Presentation of the main research material. The species composition of weeds in the soil is dominated by seeds of annual cereals and dicotyledons. The actual species composition of weeds in crops of different crops is formed depending on the biological characteristics of a particular crop, soil and climatic conditions of the zone and cultivation technologies. The distribution of weeds and their species composition in crops is determined by the ecological characteristics of individual species, their relationship to the main environmental factors – heat, moisture, light, etc.

Not only biological groups but also individual weed species react differently to weather conditions. Thus, in conditions with high soil moisture, field axes, white saltbush, smartweed, teff, plantain grow better. Under conditions with moderate humidity starweed, common spurry, self-seeding poppy, bitter mustard, common pigweed and others are distinguished. Lady's bedstraw, common oats, thistles, pennycress are typical for arid conditions.

Due to the excessive moisture supply of the soil in the spring of 2020, soil herbicides were not able to provide total effective protection against weeds. Seeds of white saltbush, pennycress, camomile ox-eye daisy, bristle grass germinated simultaneously with chickpea plants. We would like also to note the presence of soil crust, the rupture of the so-called soil shield, which could lead to a decrease in efficiency, so the seedlings of weed plants are slightly ahead of chickpea plants. This was especially noticeable in the control areas.

Weak competition of chickpea plants with weeds is primarily explained by the peculiarity of the development of this crop in the early stages, when there are intensive development of the root system and slow development of the aboveground part. In these early stages of development, chickpea plants are not yet able to compete fully with weeds. The latter, on the other hand, are serious competitors, as they actively use nutrients, moisture and shade plants.

Systematic accounting measurements of the intensity of weed emergence in chickpea crops revealed some peculiarities of such processes. The first to appear in chickpea crops are weed seedlings from the biological group of early spring – field mustard, lady's bedstraw. 8-10 days passed, species of bitter gourd, white quince, and common knotweed appeared. Over the next 10 days of the growing season, the intensity of the emergence of seedlings of segetal flora reached the maximum level, as environmental conditions were favourable, and crop plants have not yet created sufficient projective coverage of the soil surface. At this time, seedlings of such late spring plants as common pigweed, cockspur and bristle grass were found.

There are some plants which do not require special temperature conditions for seed germination, among them are cockspur, bristle grass and sow-thistle, the optimum temperature for which is + 20-25^{o} C. Our research has shown that chickpea crops have formed a mixed type of weed, where cereals predominate. Cereal crops

were represented by bristle grass and cockspur. They differ significantly in biological and morphological peculiarities and belong to different botanical families. Dicotyledonous weeds were represented by the following species: white saltbush, pigweed, field pennycress, knotgrass, wild radish, field thistle.

Thus, in the structure of weeding of chickpea agrocenosis on the control plots there were 158 pcs. / m^2 of weeds, among them cereals – 97 and dicotyledonous 61 pieces / m^2, which were in the phase of 2-5 leaves.

The ecological and economic threshold of weed infestation is determined by the species composition and their amount or weight per m^2, or the degree of weed coverage, at which yield losses in monetary terms correspond to the possible costs of preventing these losses. In our research, the amount of weeds in chickpea crops is very strong, so herbicides should be used to reduce their amount.

In their scientific works many authors mention that chickpea crops have a low competitiveness against weeds, particularly in the first half of the growing season. The presence of weeds in chickpea crops significantly affects both productivity and crop quality. Therefore, careful weed eradication in chickpea crops is one of the significant conditions for obtaining high yields, and in most cases the use of herbicides has been justified in the technology of growing chickpeas [9].

Chickpeas in the initial period of growth and development improve a very strong root system and, at the same time, a slow vegetative mass, so it needs protection fro weeds that precede it in growth and development. The results of research show that in the segetal grouping of chickpea crops, the dominant place in terms of amounts is occupied by cereal annual (translucent) weeds, first of all, cockspur and yellow bristle-grass. Much less in chickpea crops dicotyledonous and perennial weeds [3].

The significance of herbicides in agriculture has enlarged due to both inmproving the technical efficiency of chemicals and increasing the volume of their use. The level of phytotoxic effects of combined preparations, mixtures and technological combinations caused a significant weakening of weed resistance, which ensured the destruction or deep suppression of weeds in the case of spraying crops. The group of priority and most common soil herbicides should include: Harnes and Frontier Optima, which, along with purely phytotoxic properties provide significant technological progress, easy to use formulations, high solubility, low dependence on external factors, increased environmental safety.

While growing chickpeas, it is necessary, first of all, to create all the conditions for the effective absorption of nitrogen from the air. In the initial phases (stages I-II of organogenesis) chickpeas need a small amount of nitrogen, and later the need of plants for it is provided by fixing this element by nodule bacteria. Nitrogen fixation in nature is realised due to a complex process of interaction between bacteria and plants.

The plant accumulates solar energy through photosynthesis and supplies it in the form of chemically bound energy of carbohydrates to bacteria, which, in turn, satisfy 50-90% of the plant’s need for nitrogen. The ability to bind molecular nitrogen in easily digestible forms is inherent in some soil microorganisms, primarily nodule

bacteria that settle on the roots of legumes and initiate the formation of root nodules. After that between a plant and bacteria a symbiosis occurs: bacteria connect molecular nitrogen and transfer it to a plant which in turn provides them with other nutrients.

Chickpea is a plant of high farming standards, the presence of weeds in crops leads to severe depression, especially in the early stages of the growing season. The presence of large amounts of vegetative weeds during harvesting can also lead to deterioration in the quality of chickpea seeds. The analysis of the obtained data has revealed that chickpea crops have low competitive activity against weeds. A significant decrease in productivity (9,9%) was observed in the existence of 10 weed plants per square metre. With an increase in weed density up to 25 pcs. / m^2, a decrease in crop yield by 23,7% was observed. The existence of 50 pcs. / m^2 of weeds in chickpea crops with a raw weight of 812 g / m^2 caused a decrease in crop yield by 38,2%. In variants with natural weeds, which amounted to 93,5 pcs. / m^2, crop losses reached 58,7% relative to control. It has been determined that measures to protect chickpea crops from weeds should be carried out in the existence of 10 pcs. / m^2 of annual weeds and completed within 20 days from the emergence of seedlings [4].

However, when treated with herbicides, chickpea plants are exposed to stress, which can result in disruption of both photosynthetic and nitrogen-fixing processes. Therefore, to remove the negative impact of toxic drugs on chickpea plants, it is advisable to use in the technology of growing biological preparations.

As practice has shown, it is practically impossible to reduce the weediness of chickpea crops considering an economically harmless level only by agrotechnical measures. Weed control in chickpea crops should combine a set of agronomic and chemical measures. Agrotechnical measures include growing crops in the crop rotation system, timely and high-quality basic and pre-sowing tillage, sowing in optimal time to a given depth. Herbicides are applied taking into account the type, degree of weeding, and the economic threshold of harmfulness.

The use of soil (pre-emergence) herbicides is an effective method of controlling unwanted vegetation in different crops. A wide range of products containing different active substances, which belong to different groups of chemical compounds, provides excellent weed control before sowing seeds. And cultivated plants grow in clear fields, avoiding competition with weeds.

At present no herbicide authorized for the use while cultivating chickpea crops has been officially registered in Ukraine. Weed control measures are mainly used. However, profound experience in the use of herbicides has been accumulated in our country and abroad. In this regard, the efficiency and selectivity of soil preparations such as Harnes, 90% e. c., and Frontier Optima, 72% e. c. have been studied in chickpea crops.

These herbicides were applied after sowing chickpeas until seedling emergence. Application of Harnes herbicide, 90% e. c., at a rate of 3.0 l / ha in the soil before chickpea seedling emergence leads to a decrease in weed vegetation a month later after application of the herbicide to 88% compared to control areas where measures

to protect against storms vegetation were not carried out. This preparation effectively destroyed annual cereal and partially dicotyledonous weeds, up to 56-95% compared to control plots. At the time of chickpea harvest, the amount of weeds per 1 m^2 was 21 pcs. / m^2, while in the control areas this figure was within 145 pcs. / m^2. The protective effect of this herbicide, first of all, was expressed in the reduction of the amount and ability to accumulate raw mass of weeds. This preparation was less effective against annual dicotyledonous weeds, up to 73% compared to controls.

From the result recording of the month application it was noted that the amount of cereal weeds was 5 pcs. / m^2, and dicotyledonous weeds were at the level of 14 pcs. / m^2. At the same time, the herbicide did not show a noticeable toxic effect on the plants of perennial weeds (thistle species) that grew in chickpea crops, so they were able to grow, develop and accumulate their weight without hindrance.

Before harvesting chickpea seeds in areas where the herbicide Frontier Optima was applied, 72% e. c. at a rate of 1,2 l / ha, the amount of weeds was 14 pcs. / m^2, and the level of weeds compared to control areas without weed protection decreased by 90% (Table 1).

On the plots where, in addition to the application of the soil herbicide Harnes, chickpea seeds before sowing were tilled with microbiological inoculant Rhizobophyte and biofungicide Biopolicide in the norm of application of 100 ml / t of seeds, a positive role of preparations was noted. First of all, chickpea plants developed better and looked good compared to control areas and competed slightly with weeds. It was noted that the amount of weeds on these plots decreased, compared to areas where only the soil herbicide Harnes was applied. Thus, the amount of weeds a month later after application of herbicides on the plots where seeds were treated with biological products was 16 pcs./ m2, on the plots where seeds were not treated, but soil herbicide Harnes was applied, the amount of weeds was within 19 pcs. / m^2. During the chickpea harvest period, the amount of weeds on the plots with the treatment of chickpea seeds using biological preparations and the application of herbicide Harness was reduced by 90% compared to the control plots.

Analysing the efficiency of the chemical protection system for chickpea plants, we would like to note that the best effect of the preparation was on annual cereals and weeds. On these plots, bristle grass and cockspur were detected before the chickpea harvest. Among the dicotyledons there are pigweed, field pennycress, persicaria. The best options to apply the preparations with their complex effect on chickpea plants, particularly the action of inoculant, biofungicide and herbicides Harnes and Frontier Optima.

Thus, for the mixed nature of weeds, which have recently dominated in forest-steppe crops, in chickpea fields some herbicides are not able to control the full range of weeds, it is also necessary to use biological preparations which stimulate plant chickpeas to build a strong root system for further better growth and development of chickpea plants.

Table 1

Impact of herbicides on weed infestation in agrocenoses of Chickpea Triumph (average for 2019-2020)

Research options	Amount of weeds, pcs. / m^2						
	One month later after putting herbicides into the soil			Reduction of weeds before the control, %			Before harvesting chickpeas
	Total	Cereal	Dicots	Total	Cereal	Dicots	Total
Control 1 (without preparations)	158	97	61	-	-	-	145
Frontier Optima, 72% e. c.	12	4	8	92	96	87	14 (90)*
Harnes, 90% e. c.	19	5	14	88	95	56	21 (86)
Frontier Optima, 72% e. c. + Rhizobophyte + Biopolycid	9	3	6	94	97	90	13 (91)
Harnes, 90% e. c. + Rhizobophyte + Biopolycid	16	5	10	90	95	84	15 (90)

Source: obtained on the basis of own research results

Vegetation conditions of chickpea plants have shown their impact on the productivity of crops. The absence or reduction of competition from weeds has contributed to fuller realization of the productive potential of the crop, particularly on those plots where the seeds were treated with inoculant Rhizobophyte and biofungicide Biopolycid before sowing.

Yield is an integral indicator of the efficiency of all measures in the cultivation of crops, including a set of microbiological, physiological and biochemical processes in plants and the soil, using preparations of different physiological and chemical action are reflected in the amount of chickpea seed yield. The main measure to increase the yield of chickpea seeds is to inoculate the seeds with biological products and control weeds with herbicides before sowing.

In terms of research years the highest level of chickpea seed yield was observed in 2019 in the variant where chickpea seeds were treated with biological products before sowing and before sowing chickpeas applied soil herbicide Frontier Optima, 72% e. c., normal 1,2 l / ha, the level seed yield was in the range of 2,15 t / ha.

On average in the framework of the research years low yields of chickpea seeds were under the weed control, on average for two research years – 0,47 t / ha. Chickpea seeds treatment with inoculant Rhizobophyte and Biopolicide and application of soil herbicide Frontier Optima, 72% e. c., at a rate of 1,2 l / ha contributed to the yield of chickpea seeds within 2,12 t / ha, that was 1,65 t / ha higher compared to the level of productivity on weed control (Table 2).

Table 2

Chickpea seeds Yield of depending from exposure to herbicides and biologicals, t / ha

Application options	Seed yield, t / ha			Increase before the control	
	2019	2020	середнє	t / ha	%
Control 1 (without preparations)	0,51	0,43	0,47	-	-
Frontier Optima, 72% e. c.	1,87	1,74	1,81	+ 1,34	285
Harnes, 90% e. c.	1,66	1,62	1,64	+ 1,17	249
Frontier Optima, 72% e. c. + Rhizobophyte + Biopolycid	2,15	2,08	2,12	+ 1,65	351
Harnes, 90% e. c. + Rhizobophyte + Biopolycid	2,08	2,02	2,05	+ 1,58	336
HIP_{05}	0,17	0,18			

Source: obtained on the basis of own research results

Thus, one of the main measures to obtain high yields of chickpea seeds is inoculation and treatment of chickpea seeds with biofungicide before sowing and reliable protection of its crops from weeds.

Conclusions and further research prospects. Research results have proved that the chickpea yield is determined by the weediness level of its crops, as with a relatively short growing season chickpea plants are the most sensitive, because on the whole before the period of active growth they have a low potential for competitiveness. The use of soil herbicides and biologicals takes a significant place in the technology of growing chickpeas. Inoculation of chickpea seeds with Rhizobophyte at a rate of 1 l / t and biofungicide Biopolicide at a rate of 100 ml / t and application of soil herbicides Harnes 90% e. c., at a rate of 3.0 l / ha and Frontier Optima, 72% e. c., at a rate of 1,2 l / ha contribute to the weeds reductions to 90-91%, and the ability to obtain a yield of chickpea seeds at the level of 2,05-2,12 t / ha.

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АНОТАЦІЯ

ВПЛИВ ГЕРБІЦИДІВ НА ФОРМУВАННЯ УРОЖАЙНОСТІ НУТУ

Нут – рослина високої культури землеробства, а наявність в посівах бур'янів приводить до сильного пригнічення рослин нуту, особливо на початкових етапах вегетації. Для підвищення рівня реалізації біологічного потенціалу культури важливе значення має впровадження у виробництво сучасних конкурентоспроможних технологій вирощування, які повинні базуватися на доборі адаптованих до грунтово-кліматичних високопродуктивних сортів, застосування гербіцидів та біопрепаратів.

Внесення гербіцидів є одним із ефективних заходів контролю бур'янів у посівах нуту. Широкий спектр продуктів, що містять різні діючі речовини, які належать до різних груп хімічних сполук, забезпечує відмінний контроль бур'янів ще до висівання насіння і культурні рослини проростають на чистих полях, уникаючи конкуренції з бур'янами.

В статті наведені результати по вивченню впливу ґрунтових гербіцидів Харнес та Фронтьєр Оптіма, інокулянта Ризобофіт та біофунгіцидного протруйника Біополіцид на зменшення забур'яненості посівів сорту нуту Тріумф і його урожайності. На дослідних ділянках нуту, де вносився грунтовий гербіцид Фронтьєр Оптіма, 72% к.е. в нормі витрати 1,2 л/га чисельність бур'янів перед збиранням зерна нуту становила 14 шт./м^2, а рівень забур'яненості в порівнянні з контрольними ділянками без захисту від бур'янів зменшився на 90%. На ділянках, де крім внесення грунтового гербіциду Фронтьєр Оптіма насіння нуту перед посівом оброблялось мікробіологічним інокулянтом Ризобофіт та біофунгіцидним протруйником Біополіцид відмічено позитивну роль препаратів. Рослини нуту краще росли і розвивались, мали гарний вигляд в порівнянні з контрольними ділянками і в незначній мірі конкурували з бур'янами. Інокуляція насіння нуту Ризобофітом в нормі витрати 1 л/т і біофунгіцидним препаратом Біополіцид в нормі витрати 100 мл/т та внесенням ґрунтового гербіциду Фронтьєр Оптіма, 72% к.е., в нормі витрат 1,2 л/га сприяють зменшенню бур'янів до 91%, та можливість отримати врожайність насіння нуту на рівні 2,12 т/га.

Ключові слова: *нут, агроценоз, технологія, бур'яни, гербіциди, біопрепарати, урожайність.*

Табл. 2. Літ. 14.

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