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CONTROL OF WEEDS IN AGROPHYTOCENOSES OF SOWING PEAS

Summary.
The article contains the results of research of the impact of measures to regulate the number and weight of weeds in agrophytocenoses of sowing peas. It was determined that the quality control of weeds in pea crops was ensured by consistent treatment with the soil preparation Dual Gold (0.8 l / ha) and the insurance one MaxiMox (0.5 l/ha). The destruction of weeds was 91.6% of the natural weed background and reduced the above-ground air-dry mass by 88.9%. In the paper it is scientifically substantiated and proved, that such protection of crops from the harmful effects of weeds provides the level of pea yield for an average of three years at the level of 3.3 t/ha.

Keywords. *Pea, weeds, harrowing, herbicides, crop capacity.*

Formulation of the problem. In 2020, 582.6 thousand tons of peas were harvested in Ukraine from an area of 251.5 thousand hectares, with an average yield of 2.32 t/ha. And in 2019, 573 thousand tons of peas were harvested, from an area of 254.3 thousand hectares with a yield of 2.26 t /ha. It has great prospects in Ukraine for strengthening the economic indicators of the agricultural sector. For agriculture it is important the solving the issue of increasing the growth rate of pea yields and reducing the impact of unfavorable growing conditions, due to which it is possible to achieve a significant increase in the level of stability of grain production over the years.

In Vinnytsia region, 14.09 thousand tons of peas were threshed in 2020 with a yield of 29.97 quintal per hectare.

Sowing peas are sensitive to weediness of crops. Due to the harmful effect of weeds, its productivity can be reduced by 30% or more. Because in weedy fields yields are significantly reduced due to shading, reduction of soil moisture available to cultivated plants, difficulty of tillage and harvesting, deterioration of fertilizer efficiency, etc. One of the reserves of increasing the pea grain yield is to reduce the weediness of its crops.

As the weediness of the agrophytocenosis increases, the negative effects of weeds increase, causing large crop losses. Considering the high level of weed infestation, the use of herbicides remains an important element of integrated weed control. But for their highly effective use, it is necessary to know the actual species composition of weeds in each field, which makes it necessary to survey the territories.

As weeds compete with crops for moisture, photosynthetic radiation, and nutrients, limiting their harmful effects has been and remains one of the main problems in the crop industry. Timely intervention in the phytocenosis and measures, taken by man, will result in a good harvest.

Analysis of recent research and publications. Peas are an important legume. One of the reserves of increasing the yield of pea grain is to reduce the weediness of its crops. The level of presence of annual weeds in agrophytocenoses is determined by growing conditions and biological characteristics of cultivated plants. And the presence of perennial weeds is determined by the content of their vegetative reproductive organs in the soil. The level of weed component in agrophytocenoses by species, number and weight is a dynamic phenomenon during the growing season.

High weed infestation is a risk factor in agriculture. In Ukraine, this problem has become more acute in recent years for a number of reasons, which makes it important to find measures to improve weed control in agrocenoses. Monitoring of weed seed stocks in the arable soil layer (0-30 cm) in different soil and climatic zones of Ukraine shows, that in the zone of sufficient moisture there are 1.47 billion pcs/ha, in the zone of excessive moisture 1.71 billion pcs/ha, in the zone of insufficient moisture 1.14 billion pcs/ha [5].

The demanding nature of peas to the temperature regime limits the area of its cultivation in the Southern Forest-Steppe and Steppe Zones of Ukraine. In Polissya and in the Forest-Steppe the yield of peas is 1-5 dt/ha higher than when growing it in the conditions of the Steppe and the Southern Forest-Steppe Zones [3, 9].

The practice of many countries shows, that overcoming the existing shortage of high-quality protein for food and feed needs is possible only by increasing their production. The positive qualities of these crops contribute to the constant growth of sown areas and gross fees, second only to these indicators of grain crops [10].

In Ukraine, there is a similar trend to increase the use of herbicides, and reduce agrotechnical methods of weed control [11].

Due to the significant level of littering of most agricultural lands, agrotechnical measures cannot always achieve the desired result of weed control, which necessitates the use of highly effective herbicides [4, 13].

In pea crops, weeds, with insufficient protective measures, can be the main reason for reduced crop yields, they strongly shade and suppress pea crops, dry and deplete the soil, complicate crop care and harvesting, promote the reproduction and spread of pests and pathogens, etc. [2, 15].

Extermination measures should be carried out in the presence of 10 pcs/m^2 of weeds. Decreased pea yields are observed, when weeds have been in pea crops for 20 days after emergence of pea seedlings. Later, weed control measures no longer compensate for the losses, that were inflicted on peas during this period [14].

Obtaining high and stable yields of pea varieties significantly depends on the timely passage of stages of growth and development, which are determined by both varietal characteristics of the culture, weather and climatic conditions of the years. Growth and development is one of the most important agrobiological features of peas, which reflect a certain interaction of the plant genotype with a set of technological techniques and agroclimatic resources of the growing region [6, 7].

The development of the most effective control system of the weed component cenosis with the use of chemical plant protection products in the cultivation of peas is an extremely important element of technology [8].

The purpose of the study is to determine the effect of harrowing and herbicides on the weed component in the agrocenosis and to identify the peculiarities of the formation of grain productivity of peas, depending the options of controlling its weediness.

Presenting main material. During 2018-2020, the experiments were based on the experimental field, where the soil has the following parameters: gray forest soil of medium-loamy mechanical composition; humus content - 3.0%; pH of the salt is 5.4. The weather characteristics of the three years of the study were typical for the Forest-Steppe zone and suitable for growing peas.

The technology of growing peas of the Magnat variety was generally accepted for the Forest-Steppe zone. The sown area of the plot was 22.5 m^2; the accounting area was 20 m^2. The experiment was repeated four times with a randomized placement of variants. The working solution was applied with a knapsack sprayer with a liquid consumption rate of 250 l/ha. Weed counts were performed according to generally accepted methods. The first record was performed quantitatively, using a framework in 30 days after sowing, and the second - quantitative weight method-before harvesting. Recording for pea yield was performed in sections. Statistical processing of the obtained data was performed by analysis of variance.

The scheme of the experiment

Options
1. Natural background of weediness (control)
2. Pre-emergence and post-emergence harrowing
3. Before the emergence of pea seedlings - Dual Gold emulsion ratio, 1.6 l/ha
4. In the phase of 2-3 true leaves of MaxiMox crop, soluble ratio, 1.0 l/ha
5. Before the appearance of pea seedlings - Dual Gold emulsion ratio, 0.8 l/ha + in the phase of 2–3 true leaves of MaxiMox crop soluble ratio, 0.5 l/ha

Peas are less demanding of temperature than other legumes. The minimum germination temperature of its seeds is 2-3°C. But under such conditions, early spring and winter weeds can also grow in agrophytocenoses. Our research has shown, that in agrophytocenoses of peas a mixed type of weeding was formed, where monocotyledonous species had the largest share: *Echinochloa cruss-galli L.*Pal. Beauv., *Setaria glauca L.* Pal. Beauv.), *Agropyrum repens L.* Dicotyledonous perennial weeds are present in the experimental plots: *Chenopodium album L., Thlaspi arvensis L., Stellaria media L., Sinapis arvensis L.*, and perennial - *Sonchus arvensis L.* [1, 12].

Unlike early cereals, peas have certain weed species. In particular, its agrophytocenosis is dominated by annual cereals and spring dicotyledonous weeds. Due to the symbiosis with nodule bacteria, in the rhizospheric zone peas have excretions,that are enriched with nitrogen and other elements. And this creates favorable conditions for the germination and vegetation of weeds in its crops.

The structure of sown peas agrocenosis weediness was determined: in total during the 3 years of research there were in average 93 weeds/ m2, among them monocotyledons - 70% and dicotyledons - 30% (Table 1).

Table 1

Weediness structure of pea agrocenosis (average 2018-2020), pcs/m^2

Name of weeds	Number of weeds
Total	93
Echinochloa cruss-galli L.	37
Setaria glauca L.	19
Poa annua L.	3
Agropyrum repens L.	6
Total monocotyledons	**65**
Chenopodium album L.	6
Stellaria media L.	5
Thlaspi arvensis L.	3
Sinapis arvensis L.	2
Matricaria perforate Merat L.	2
Polygonum convolvulus L.	1
Sonchus arvensis L.	3
Other species	6
Total dicotyledons	**28**

Control of segetal vegetation and its harmful effects in agrophytocenosis of peas to economically insignificant level is a very important condition in the technology of its cultivation.

In peas' agrocenosis, the issue of weed protection is given a special place. Practical experience shows, that it is almost impossible to reduce the weediness of pea crops to an economically insignificant level only with the help of agronomic measures. The system of peas protection from weeds should combine a set of agrotechnical and chemical measures, that are carried out consistently and are mutually agreed.

Peas had a mixed type of weediness, where annual cereal species predominated - about 65 pc /m^2 according to research years. The most common weed species were *Echinochloa cruss-galli L., Setaria glauca L., Agropyrum repens L., Chenopodium album L., Stellaria media L., Sonchus arvensis L., Thlaspi arvensis L., Sinapis arvensis L., Perforated matrix Merat.*

When caring for crops, measures to limit the number and harmful effects of weeds are important to obtain the planned harvest. During the pea growing season in the control variant, the number of weeds decreased by an average of 10 pcs/m^2 over three years of research. This is the result of suppression of weeds, which were in the lower tier of the coenosis, by cultivated plants (Table 2).

Table 2

Influence of harrowing and herbicides on weediness of peas agrocenosis (average for 2018-2020)

Experiment options	Record	Number of weeds, pcs/m^2			Weed destruction,%		
		Total	Mono cotyledons	Dico tyledons	Total	Mono cotyledons	Dico tyledons
Natural background of weediness (control)	1	93	65	28	-	-	-
	2	83	64	19	-	-	-
Pre-emergence and post-emergence harrowing	1	16	7	9	82,8	89,2	67,9
	2	19	7	12	77,1	89,1	36,8
Dual Gold e.c, 1.6 l/ha	1	11	5	6	88,2	92,3	78,6
	2	12	4	8	85,5	94,2	57,9
MaxiMox, s.l.,1.0 l / ha	1	8	4	4	91,4	93,8	85,7
	2	7	3	4	91,6	94,2	78,9
Dual Gold e.c.,0.8 l/ha + MaxiMox s.l., 0.5 l/ha	1	7	3	3	93,5	95,3	89,3
	2	7	3	4	91,6	95,3	78,9

During the experiment an agrotechnical method of weed control in agrophytocenoses of peas – pre-emergence and post-emergence harrowing was used. Before harvesting, 19 pcs/m2 of weeds were counted on this variant. Harrowing in agrophytocenoses of peas reduced the level of their numbers by 77.1% and their air-dry mass-by 49.5%.

In our studies, the degree of weediness in agrophytocenoses was on a high scale, so herbicides had to be used to reduce their presence.

The application of the dual Gold herbicide at the rate of 1.6 l/ha before pea emergence ensured the reduction of weeds in one month after application by 88.2%, compared to control areas, where weed protection measures were not carried out. The active substance S-metolachlor has a negative effect on cell division, which slows down the growth process and subsequently causes death of weeds.

The protective effect of soil herbicide was manifested in the reduction of the number and ability of weeds to accumulate vegetative mass. It was especially effective against monocotyledonous weeds. During the recording in a month after the application of the preparation, it was noted, that the number of monocotyledonous weeds was 5 pcs/m^2, and dicotyledonous - 6 pcs/m^2. The level of weediness by cereal weeds decreased by 92.3%, and dicotyledons - by 78.6%, compared to control. However, the herbicide did not show any toxic effect on perennial weeds in the pea crops, so they were able to grow freely, develop and accumulate their weight. The number of weeds before harvesting peas in the areas, where the soil herbicide Dual Gold was applied at a rate of 1.6 l/ha was 12 pcs/m^2, the level of weeds decreased by 85.5%, compared to control areas.

Pea plants are highly sensitive to the action of herbicides in the periods before the phase of 2 leaves and after 5 leaves. And when its plants have from 2 to 5 leaves, the wax layer best protects against negative chemical influence. So, the insurance herbicides to protect peas from weeds are recommended to be applied at this stage of crop development. Spraying crops at an earlier or later date can negatively affect cultivated plants: their development is delayed, leaves are deformed, stems are distorted.

Analysis of the insurance herbicide MaxiMox action at the rate of 1.0 l/ha showed, that it effectively destroyed perennial weeds. Its active substance imazamox inhibits protein synthesis in weeds, which leads to chlorosis of young leaves, the death of growth points, the suspension of growth processes and the weeds death. After chemical treatment with MaxiMox, weed growth stops within a few hours, although visible signs of toxicity of the herbicide may not appear for several days after application. Complete weeds death occurs after 3-6 weeks after application.

During the second weed record, it was found that the herbicide MaxiMox had the effectiveness of 91.6%. The number of perennial monocotyledonous species decreased compared to the control by 94.2%. The reduction in the number of dicotyledonous weeds on the options for its application was 78.9%. MaxiMox herbicide destroyed perennial weeds, so the total weediness of crops decreased by 91.6% compared to control plots.

It was recorded, that negative effects of herbicides on cultivated plants were not detected during studies. Dual Gold and MaxiMox herbicides decompose quickly in the soil and in the recommended application rates do not have a negative effect on those crops that will be sown after peas.

In the experimental variants, in the second half of the pea growing season, due to the detoxification of herbicides and precipitation, we observed a weakening of their effect on weeds. This has led to an increase in the number of certain species. There was an increase in the level of pea weediness in the variants, where the Dual Gold herbicide was applied. A new wave of dicotyledonous weeds appeared in the areas after precipitation: *Chenopodium album L.*, *Stellaria media L.* and from monocotyledons – *Echinochloa cruss-galli L.*

Consecutive application of herbicides: Dual Gold at the rate of 0.8 l/ha and Maxi Moks at the rate of 0.5 l/ha allowed to regulate qualitatively the presence of weeds in agrophytocenoses during the growing season of sowing peas. At the time of crop harvesting, weed death in this variant averaged 91.6% over three years of research, and the above-ground air-dry mass was 105 g/m^2.

Table 3

Influence of harrowing and herbicides on weeds in the pea agrocenosis (average for 2018-2020)

Experiment options	Number of weeds, pcs/m^2	Aboveground mass of weeds (air-dry)	
	total	g/m^2	reduction to control,%
Natural background of weediness (control)	84	948	-
Pre-emergence and post-emergence harrowing	20	479	49,5
Dual Gold e.c., 1.6 l/ha	12	211	77,7
MaxiMox s.l., 1.0 l ha	8	136	85,7
Dual Gold e.c., 0.8 l/ha + MaxiMox s.l., 0.5 l/ha	7	105	88,9

The process of growing stable yields of peas is highly dependent on the ability of the agronomic service to provide favorable conditions for cultivated plants for their formation. The decrease in the number and weight of weeds in agrophytocenoses contributed the increasing in the density of standing pea plants, their better growth and development, and increasing crop yields.

One of the set of measures to obtain high yields of pea grain is high-quality protection of its coenoses from the negative effects of weeds. After all, the yield is an integral indicator of the productivity of cultivated plants, which determines the relationship of a set of quantitative signs with growing conditions.

Table 4

Pea yields depending on weed control (average for 2018-2020), t/ha

Experiment options	Seed yield, t/ha				Increase to control	
	2018	2019	2020	average	t/ha	%
Natural background of weediness (control)	1,6	1,4	1,4	1,5	-	-
Pre-emergence and post-emergence harrowing	2,1	1,9	1,8	1,9	+0,4	26,7
Dual Gold e.c.,1.6 l/ha	2,7	2,3	2,2	2,4	+ 0,9	60,0
MaxiMox s.l., 1.0 l/ha	3,2	2,7	2,6	2,8	+ 1,3	86,7
Dual Gold e.c., 0.8 l/ha + MaxiMox s.l.,0.5 l/ha	3,5	3,2	3,3	3,3	+ 1,8	120,0
LSD_{05}	0,17	0,16	0,16			

The protection of pea plants from the negative effects of weeds contributed to the quality realization of the productive potential of the crop. On average over three years of research, the yield of pea grain on the variants with the introduction of herbicides was 2.4-3.3 t/ha, which was higher, than in the control areas by 60-120%. The largest increase in pea seed yield was obtained in the variants with the application of Dual Gold (0.8 l/ha) and the subsequent use of MaxiMox (0.5 l/ha). On the average for three years of researches it was 1,8 t/ha.

Over three years of research high herbicidal activity was characteristic of the sequential variant of herbicides application: soil Dual Gold with consumption rate of 0.8 l/ha and insurance MaxiMox with a consumption rate of 0.5 l/ha. Qualitative control of crop weeding made it possible to obtain the yield of pea grain on average at the level of 3.3 t/ha.

Conclusions.

1. In agrophytocenoses of peas a mixed type of weediness was formed. The ratio of groups was dominated by monocotyledonous weed species - 72.0%.

2. During the first record, the presence of weeds in the control was 93 psc/m^2. And during the pea growing season, due to interspecific competition, their presence decreased by 10 pcs/m^2.

3. As a result of harrowing pea crops, the number of weeds decreased by 77.1% and by 49.5% aboveground air-dries mass.

4. Treatment with soil herbicide Dual Gold at a rate of 1.6 l/ha killed 85.5% of weeds and reduced their weight by 77.7%, compared to the control option.

5. Spraying of peas with the insurance herbicide MaxiMox at the rate of 1.0 l/ha ensured the death of 96.1% of weeds and reduction of their weight by 85.7% before control.

6. On options of consecutive application of Dual Gold (0.8 l/ha) and MaxiMox (0.5 l / ha) there was the best control of pea weediness: in relation to the control, the death of weeds was 91.6% and the reducing of their weight by 88.9%.

7. The largest increase in pea yield (1.8 t/ha on average over three years of research) was obtained in the variants with application of Dual Gold (0.8 l/ha) and subsequent use of MaxiMox (0.5 l/ha). Reducing the number and weight of weeds allowed to get a pea harvest at the level of 3.3 t/ha.

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ECOLOGICAL EFFICIENCY OF INCREASING YIELD OF AGRICULTURAL CROPS BY BEE POLLINATION

Abstract

The ecological efficiency of increasing the yield of agricultural crops due to bee pollination has been studied. It was found that in the period from 2000 to 2016, 175.6 mg of lead and 56.2 mg of cadmium per 1 hectare of agricultural land in the territory of Vinnytsia region; of them with nitrogen fertilizers – 47.4 % and 3.7 %; with phosphorus – 29.2 % and 16.5 %; with potassium – 23.3 % and 80 %. During the cultivation of winter rape and sunflower on the area of 405370 ha with mineral fertilization in order to increase their yield, 908.2 kg of lead and 214.5 kg of cadmium got into the soil. The increase in yields of these crops due to bee pollination against the