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CONTROL OF CORN POLLUTION IN THE CONDITIONS OF THE RIGHT-BANK FOREST STEPPE

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This article presents the results of studies of the main elements and methods of controlling the development of weeds in corn crops and the identified changes in water and nutrient properties of the soil. The optimal tank mixtures and technological combinations of new soil and insurance herbicides have been determined, which provide a high level of technical efficiency on a wide species spectrum of weeds that clog corn crops. In particular, for farm conditions, the complex nature of the formation of the type of weediness, which changes during the growing season of the crop, was noted. The results of assessments of the dynamics of weed vegetation indicate a gradual increase in cenotic tension due to the gradual transition of dominant species of weeds, such as Chenopodium album L., Amaranthus retroflexus L., Echinochloa crus-galli L., Elytrigia repens (L.) Gould , Sonchus arvensis L, Cirsium arvense L., Convolvulus arvensis L. in the middle tier of sowing with a simultaneous increase in the frequency of their determination by 1.1-1.3 times. It was established that the best growth and development of the total leaf surface of corn plants (2.15-2.26 pcs./m2) was noted on the herbicide agro background and complete removal of weeds, and with natural weediness of the crops - a negative effect on growth processes, size and duration of functioning of leaves (1.14 pcs./m2).

According to the research results, the technical efficiency against weeds of the first wave reached 100% when combining soil and insurance herbicides - Dual Gold - 1.5 l/ha (before sowing) + Stellar - 1.25 l/ha + Surfactant Metolate - 1.25 l/ha (by stairs); during the second and subsequent waves of weeds, protection systems that combine vegetative and soil deterrent effects are best controlled (Stellar - 0.8 l/ha + Akris - 1.5 l/ha + Surfactant Metolate - 0.8 l/ha and Kelvin Plus - 0.3 kg/ha + Akris - 1.5 l/ha + PA Hasten - 1 l/ha). The highest yield of corn grain (6.98 t ha^{-1} and 6.81 t ha^{-1}) was obtained from the combination of soil and insurance preparations Akris (before sowing) + Kelvin Plus and PAR Hasten (after the steps) and Dual Gold (before sowing) + Stellar and surfactant Metolat (by stairs); Akris + Stellar + metolat surfactant (yield - 6.68 t ha^{-1}) was singled out among post-emergence herbicide mixtures; with autonomous use of the preparations Stellar and Kelvin Plus, the yield was 6.35 t ha^{-1} and 6.22 t ha^{-1}, respectively.

The identical economic expediency of using such variants of herbicide application on corn Akris, 1.5 l/ha + Stellar, 0.8 l/ha + Metolat surfactant, 0.8 l/ha and Stellar, 1.25 l/ha + Metolat surfactant, has been confirmed ,1.25 l/ha, which was 43% higher than in the control with natural weeding and 33.2-33.4% higher than in the option of inter-row cultivation with manual weeding.

Key words: *corn, weeds, herbicide, productivity, economic efficiency.*
Table 5. Lit. 18.

Introduction. Recently, there has been a significant search for optimization of ways and means, methods, ways, forms of a rational integrated system of weed control in agricultural crops. At present, the positive and negative sides of technological schemes based on a powerful soil herbicide with the subsequent introduction of insurance, with the introduction of highly effective post-emergence herbicides or tank mixtures, are known. The need to conduct zonal studies to study the effectiveness of new synthesized drugs is also explained by the fact that their

phytotoxic effect on weeds depends not only on the physical and chemical properties of the herbicides themselves, but also on a number of exclusively regional soil and climate factors: potential soil contamination, content in its humus, productive moisture, temperature regime, its pH, etc. For the conditions of the forest-steppe zone of Ukraine, it is important to establish the assortment of herbicides and determine the scope of their use in the most vulnerable to weeding links of the crop rotation.

The purpose of the article is to determine the optimal tank mixtures and technological schemes of new insurance herbicides for corn crops to provide high technical efficiency for a significant number of weed species.

Analysis of recent research and publications. When growing agricultural crops, the producer must create the best conditions for their growth and development, in particular, eliminate other types of plants that compete with cultivated plants for the use of water, soil nutrients, and reduce the yield of the crop [1-2].

Considering the fact that corn is one of the weakest competitors of weeds in agrophytocenoses, it is necessary to approach the application of measures aimed at providing favorable conditions for its growth and development responsibly. One of the factors that ensures a sustainable harvest is the care of corn crops, namely, the creation of optimal conditions for the germination of seeds and the production of friendly seedlings, their protection from weeds, diseases and pests, as well as the provision of moisture and nutrients at all stages organogenesis [3].

The strategy for the protection of agricultural crops, including corn, should provide for early planning of measures. A reasonable approach to the protection of corn from a complex of weeds is needed both at the beginning of the growing season and during all periods of growth and development of the culture.

Limiting the number of monocotyledonous (cereal), dicotyledonous (dicotyledonous) and specialized weed species is an acute problem, especially in the case of growing corn in a short-rotation crop rotation. It is extremely important to control the level of weediness of crops, especially during the emergence of corn seedlings [4].

Today, high weediness of corn crops is one of the main problems of its low productivity. In recent years, due to the presence of objective (lack of funds for the purchase of fuel and plant protection products), as well as non-objective (ignoring the use of scientifically based crop rotations in production, simplification of the soil cultivation system, etc.) reasons, in all zones of Ukraine it is noted the growth of the seed bank in the soil of various biological groups of weeds [3].

According to different estimates of scientists, corn crops are weedy in almost all areas of its cultivation from 90 to 98 percent. Depending on the soil and climate zone in which the crop is grown, the species composition of weeds in the fields differs. The number of weed species in crops can vary from 10 to 15 species. This amount is enough to significantly reduce the productivity of the culture [5].

The following types of segetal vegetation are noted as harmful weeds and most economically significant for crop productivity, depending on the soil and climate zone. Chicken millet (*Echinochloa crus-galli* L.), wild radish (*Raphanus*

raphanistrum L.), field mustard (*Sinapis arvensis* L.), field cabbage (*Brassica campestris* L.), white quinoa (*Chenopodium album*) prevail in the Poliska soil and climate zone L.), and from perennials - creeping heather (*Elymus repens* (L.) Gould), horsetail (*Equisetum arvense* L.) and others.

In the forest-steppe zone, pink thistle (*Cirsium arvense* L.), yellow thistle (*Sonchus asper* L.), field birch (*Convolvulus arvensis* L.), *euphorbia stricta* L., and *Descurainia sophia* (L.) Webb are dominant. ex Prantl), gray mouse (*Setaria glauca* L.) and green (*Setaria viridis* L.), chicken millet, white quinoa, field mustard, wild radish, white horseradish (*Amaranthus albus* L.), common (*Amaranthus retroflexus* L.) and *Amarantchus blitum* L., *Ambrosia artemisiifolia* L., *Gailinsoga parviflora* L., *Thlaspi arvense* L., *Polygonum lapathifolium* L., *Capsella bursa- pastoris* L.), Canadian sedge (*Erigeron canadensis* L.), field violet (*Viola arvensis* Murr.), odorless chamomile (*Matricaria perforata* merat.) and others [6, 17].

In the Steppe region and on irrigated lands, the most harmful are thistles - pink and yellow thistles, birch bitter gourd (*Polygonum convolvulus* L.), sedge (*Cardaria draba* (L.) Desv.), Tatar buckwheat (*Polygonum tataricum* L.), chicken millet, white quinoa, common and white sorrel, black nightshade (*Solanum nigrum* L.), datuta stramonium L., ragweed and others [5].

During the cultivation of agricultural crops, the main goal of the producer is to obtain their high and high-quality harvest. However, today it is impossible to achieve this goal without proper protection of crops from weeds.

Weeds are better adapted to survive in competitive conditions for living space and energy sources than cultivated plants, for the cultivation of which the producer must provide careful care. During the cultivation of agricultural crops, maintaining the fields in a weed-free state is the most important prerequisite for their high productivity [11].

When growing agricultural crops, the producer must create the best conditions for their growth and development, in particular, eliminate other types of plants that compete with cultivated plants for the use of water, soil nutrients, and reduce the yield of the crop. Considering the fact that corn is one of the weakest competitors of weeds in agrophytocenoses, it is necessary to approach the application of measures aimed at providing favorable conditions for its growth and development responsibly. One of the factors that ensures a sustainable harvest is the care of corn crops, namely, the creation of optimal conditions for the germination of seeds and the production of friendly seedlings, their protection from weeds, diseases and pests, as well as the provision of moisture and nutrients at all stages organogenesis [2, 3, 8].

Periodic fluctuations in population density and size depend both on environmental factors and on the characteristics of the population itself. In some species of organisms, there is a natural periodicity of population fluctuations, when a significant increase in the number of individuals alternates with a decline in their reproduction [5]. It is believed that with an optimally acceptable balance between cultivated plants and weeds, the benefits of weeds significantly exceed their harm. They protect the seedlings of cultivated plants from a number of adverse

effects, contribute to the processes of soil formation, protect the soil from erosion, many of them are honey-bearing and fodder plants [6]. In corn crops, the uncontrolled number of weeds not only reduces the productivity of the main and additional products, but also requires additional costs, makes it difficult to perform some field work. Losses from crop weeding can reach 10-70% of the harvest [7].

Materials and methods of research. The research was conducted in the conditions of the Ukragrotech corporation, Khrystynivka, Khrystynivka district, Cherkasy region, during 2021-2022. Dark gray forest soil with a humus content of 2.5%, with a high availability of mobile phosphorus compounds and elevated potassium, environmental reaction close to neutral. The weather conditions of 2021-2022 had a certain contrast and differed from the average multi-year data. Thus, for the conditions of the corn growing season in 2021, intense temperature fluctuations were noted in the April-May period, which affected both the formation of crop seedlings and the initial level of weediness of the crop.

In the following months of the growing season, there was an intense increase in temperatures against the background of intense and even excessive moisture, which contributed both to the growth of the vegetative mass of the corn plants themselves and to the intensive growth of the number of weeds in the coenosis. For the conditions of 2022, a less dynamic amplitude of moisture fluctuations was noted in the spring-summer period and even some abnormally cold and hot periods with moisture deficiency in the period from 3 to 5-7 leaves of corn and intensive moisture in the period after the formation of the cob. In general, the weather conditions were acceptable-satisfactory for the growth and development of corn with the possibility of obtaining an above-average grain yield. In terms of agro-soil zoning, the territory of the land-use economy is located in the zone of the southern border of the Forest-Steppe zone, where chernozem soils dominate. The main features of this zone are the potential moisture deficit and the potential danger of wind erosion of the soil if it is not used properly. The soil and climatic conditions of the society are suitable for the cultivation of various agricultural crops.

Object of research: processes of changes in quantity and weight dynamics and species composition of weed groups in corn agrocenoses and the formation of crop productivity under different plant protection systems.

Subject of research: Mid-early hybrid corn for grain Amelior. Herbicides (pre-emergence, post-emergence application): Akris, Dual Gold, Kelvin Plus, Stellar. Prylypach: South African Hasten, South African Metolat. Annual, two-year and perennial weeds: fennel, white quinoa, common sorrel, mouse green, chicken millet, ragweed, field birch, pink thistle. Each variant of the experiment occupied an area of 20 m^2. Repeatability in experiments is 4 times. Placement of options is randomized. The scheme of the experiment is presented in table 1.

Pre-emergence herbicides were applied the day after sowing, pre-sowing, post-emergence - in the phase of 3-5 leaves of the crop. According to the method and technology of application, the degree of environmental safety, the selection of pre-emergence and post-emergence preparations was carried out taking into account the

Table 1

Scheme of the experiment

№ p/p	Plant protection system	
	Pre-yield herbicides	Post-emergence herbicides
1	Dual Gold, 1.5 l/ha	Stellar, 1.25 l/ha + Surfactant Metolate, 1.25 l/ha
2	Akris, 3 l/ha	Kelvin Plus, 0.35 kg/ha + Hasten surfactant, 1.0 l/ha
3	-	Stellar, 1.25 l/ha + Surfactant Metolate, 1.25 l/ha
4	-	Kelvin Plus, 0.35 kg/ha + Hasten surfactant, 1.0 l/ha
5	-	Stellar, 0.8 l/ha + Akris, 1.5 l/ha + Surfactant Metolate, 0.8 l/ha
6	-	Kelvin Plus, 0.3 kg/ha + Akris. 1.5 l/ha + PA Hasten, 1.0 l/ha
7	Natural weediness of crops without removing weeds - control 1	
8	Inter-row cultivation + manual weeding - control 2	

the source is formed on the basis of own research results

mechanism of impact on weeds (table 2). The research program provided for the following observations and records: Phenological observations. In addition to the sowing date - April 25, the following phases are noted: sprouting, 3-5 and 8-10 leaves, flowering of panicles, appearance of

Table 2

Characteristics and regulations for the use of herbicides

Herbicides	Characteristics of drugs			
	active substance	chemical group	preparatory form	distribution in the plant
Akris	dimethenamid-P (280 g/l) + terbuthylazine (250 g/l)	chloracetamides, triazines	co-emulsion (SC)	system selective
Dual Gold	C-metolachlor (960 g/l)	chloracetamides	emulsion concentrate (CE)	system selective
Kelvin Plus	dicamba (424 g/kg) + diflufenzopyr (170 g/kg) + nicosulfuron (106 g/kg)	benzoin derivatives acids + semicarbazones + sulfonylureas	water dispersible granules (WG)	system selective
Stellar	topramesone (50 g/l) + dicamba (160 g/l)	pyrazolones + benzoic acid derivatives	soluble concentrate (SL)	system selective

Regulations for the use of herbicides

Herbicides	consumption norms of the drug	terms of application	spectrum of action	multiplicity of treatments, toxicity, price
Akris	1,5-3 л/га	pre-emergent or post-emergent	annual grasses and dicotyledonous weeds	One III class 492 hryvnias/l
Dual Gold	1,2-2 л/га	pre-emergent	annual grasses and dicotyledonous weeds	One III class 300 hryvnias/l
Kelvin Plus	Kelvin Plus, 0.35 kg/ha + Hasten surfactant, 1.0 l/ha	processing in the phase of 3-5 leaves of the culture	annual and perennial grass and dicotyledonous weeds	One III class 2500 hryvnias/kg
Stellar	Stellar, 1.25 l/ha + Surfactant Metolate, 1.25 l/ha	processing in the phase of 3-8 leaves of the culture	annual and perennial dicots, annual cereals	One III class 700 hryvnias/l

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female inflorescences (filaments), milky state of grain, waxy and full ripeness of grain. The beginning of the phase - entry of 10% of plants, onset - 75% of plants [10]. Determination of the above-ground weediness of corn crops was carried out by counting the number and species composition of weeds according to the experiment options on the accounting sites with an area of 0.25-0.50 m^2 in five repetitions along the diagonal of the plot before the introduction of insurance herbicides, 20 days after the introduction preparations, as well as before harvesting with simultaneous uprooting of plants to determine their weight [10].

Research results. According to different estimates of scientists, corn crops are weedy in almost all areas of its cultivation from 90 to 98 %. Depending on the soil and climate zone in which the crop is grown, the species composition of weeds in the fields differs. The number of weed species in crops can vary from 10 to 15 species. This amount is enough to significantly reduce the productivity of the culture.

In all soil and climatic zones, such weeds as ragweed ragweed, pink and yellow thistle, field birch, field mustard, white quinoa, white and common wheatgrass, creeping wheatgrass have the greatest effect on corn productivity. Such annual grass weeds as chicken millet and mouse are common in all corn-growing regions and are dominant in corn crops. Violation of cultivation technology or delay in taking measures to protect the crop from the above-mentioned weeds leads to losses of its harvest at the level of 30 to 50 percent.

The characteristic physiological features of corn plants are that in the initial phases (up to 5 leaves) the culture grows and develops slowly. In this regard, there is no competition from her side, which creates favorable conditions for the growth and development of weeds both in rows and between rows.

The negative impact of weeds on corn varies depending on a certain stage of organogenesis of the crop. So, until the phase of 2-3 real leaves, it is not very sensitive to the negative impact of weeds. Clogging of crops during the phase from 4 to 8 leaves can already be the cause of a sharp decrease in the corn yield. Therefore, before this critical period, it is necessary to carry out weed control measures in corn crops. If these requirements are not met, that is, herbicides are not applied or agrotechnical measures are not carried out, weeds are able to absorb from the soil such an amount of water and nutrients that would be enough to form 4-6 tons of corn grain.

It should be noted that herbicides that are applied later (usually after the formation of the fifth leaf of the crop in the corn plant) may have low effectiveness against weeds, because in them biological protection is triggered as the corresponding coating in the form of wax, etc. is formed on the leaves. In addition, the growth of the leaf surface of the culture sharply reduces the probability of the working solution hitting the surface of the weeds [14].

According to the results of the assessments and records, the composition of weeds on the corn plantation differed significantly depending on the site and the year. As a result of determining the species composition of weeds in corn crops, it is possible to fight them correctly and effectively. The chosen chemical method with the

recommended mechanical method of plant care should be economically, and above all, ecologically justified [18]. Weeds are undesirable "neighbors" for cultivated plants. In the process of vegetation, they develop, accumulate above-ground mass and root system faster than cultivated plants, as a result - shading and suppression of cultivated plants. And the deeply penetrating roots of weeds take moisture and nutrients from it [3].

Over the years of research, the following weeds of various biological groups were found in the experimental plots.

In both years of research, the composition of weeds began to manifest itself quite early, because the field was an area plowed in the fall. The species composition of the weeds was presented (table 1): Galium aparine, Amrich patula, Chenopodium album, Sonchus oleraceus, Galeopsis tetrahit; late spring: chicken millet (*Echinochloa crusgalli*), wintering: common sorrel (*Sarsella bursa-pastoris*), field sedge (*Thlaspi arvense*) and chamomile (Matricaria); mycelium-rooted: creeping buttercup (*Ranuncuius repens*); taproots: lanceolate plantain (*Plantago lanceolata*), barberry (*Barbarea vulgaris*), dandelion (*Taraxacum officinale*); rhizomes: creeping heather (*Elytrigia repens*), common sedge (*Poa travalis*), horsetail (*Eguisetum arvense*); rhizomes: field thistle (Sonchus arvensis), field thistle (*Sónchus arvénsis*). There were also bitter wormwood (Artemisia absintium), fumária offícinális, as well as Stellaria graminta and small-flowered galinsoga (*Galinsoga quadriradiata*) isolated on the site.

Among the annual weeds, chicken millet (*Echinochloa crus-galli*), common buckwheat (*Capsella bursa-pastoris*), thlaspi arvense (Thlaspi arvense), common heather (*Persicária lapathifólia*), white quinoa (*Chenopodium album*) prevailed. There were also veronica officinalis, field violet (*Víola arvénsis*), tricolor violet (*Víola tricolor*), annual thistle (*Cirsium arvense*) and others.

Two stages can be distinguished according to the terms of application of herbicides in crops of most agricultural crops, including corn [17]:
before or after sowing agricultural crops, but before the appearance of sprouts of cultivated plants (pre-emergence period); after the appearance of seedlings of cultivated plants (post-emergence period).

To ensure the best conditions at the early and initial stages of the organogenesis of the crop, both soil and post-emergence preparations are used. But the use of herbicides in violation of regulations and recommendations leads to the poisoning of cultivated plants, and sometimes to significant crop losses. Therefore, it is necessary to take into account the phytotoxicity of drugs in relation to cultivated plants.

According to the term of application, the visualization of the symptoms of poisoning of cultivated plants is divided (if the disturbance of their growth and development is really caused only by the effect of the herbicide): immediately during the emergence of seedlings, or some time after the application of the drug during the growing season of the plants.

When implementing all of these strategies, it must be kept in mind that an average rate of herbicide application is always more effective than a lower rate.

Corn belongs to crops of the late sowing period, and accordingly has a long pre-sowing period (almost 30 days on average). This period is characterized by the active germination of weeds from seeds, the seedlings of which during the traditional system of tillage can be destroyed with the help of pre-sowing soil tillage measures, and if mechanical tillage is refused in the No-till farming system, with general-killing herbicides. But it is necessary to take into account the fact that the protection of culture should be based on the biology of the object, the level of prevalence of which must be controlled [10].

He basis for making a decision on weed control in corn crops is the species composition and the dynamics of the appearance of weed seedlings in the pre-sowing and post-sowing periods. Also, for effective weed control, it is important to carry out processing in optimal terms, which are more limited for post-emergence weed control than for pre-emergence. However, unlike preemergence, during postemergence spraying, control of the number of not only annual, but also perennial weeds is ensured. And the efficiency of processing depends to a lesser extent on the quality of soil processing. At the same time, as already noted, regardless of the possibility of purposeful destruction of harmful objects, one post-emergence spraying of crops is not enough [7, 9].

The rather high effectiveness of soil herbicides should be considered a characteristic feature at the beginning of the corn growing season. Low (4.0-5.6 pcs./m^2) level of weediness of crops on the 30th day after wrapping the preparations (24.05 - phase 4-6 leaves). when swelling and germination of weed seeds took place. Thus, this phenomenon is due to the peculiarities of the hydrothermal conditions of April and May during the period when the swelling and germination of weed seeds took place.

In the pre-sowing period (April 15-20) in the years of research, the amount of precipitation (17-24 mm) was recorded, which made it possible to get the preparations into the moist soil during the pre-sowing cultivation of the field. As you know, moderately warm weather with an air temperature of 15-20 0C and a soil moisture level of more than 20% is favorable for the action of soil herbicides. Moist soil is a necessary factor for the manifestation of phytotoxicity of chloracetamides (Acris, Dual Gold), since their active substances are active only in the soil solution. Sufficient moisture of the upper (0-10 cm) layer of arable land (20-21%), as well as periodic rains of varying intensity from 1-2 mm to 20-25 mm against the background of the optimal temperature regime ensured proper control of the first "wave of weeds".

Among the investigated pre-emergence herbicides, the best results in controlling wild species, in particular annual grasses (mouse green, chicken millet), were obtained from the use of Akris (3 l/ha), which includes the active substance dimethenamid-P. Its solubility is 3-5 times higher than that of C-metolachlor (Dual Gold), which makes dimethenamid-P more mobile and available to weed seedlings. Before the introduction of post-emergence herbicides, a fairly varied background weediness of corn crops was recorded. It was high and varied from 102 units/m^2 to 155 units/m2 depending on the experiment.

The agrocenosis was dominated by: common sedge - 58%, sedges (mouse green, chicken millet) - 23.2%, ragweed - 9%, white quinoa - 7%. Dicot perennials were represented by pink thistle – 1.2%, yellow thistle – 0.4%, field birch – 1.2%. The records conducted 21 days after spraying with insurance drugs showed that the greatest number of weeds of the first wave (in relative terms) were neutralized by protection systems that combined soil and insurance herbicides in the following sequence: 1. Dual Gold - 1.5 l/ha (before sowing) + Stellar - 1.25 l/ha + PARA Metolate - 1.25 l/ha (after planting); 2. Akris - 3 l/ha (before sowing) + Kelvin Plus - 0.35 kg/ha + PAR Hasten - 1 l/ha (after planting). Their technical efficiency against all biogroups of wild flora reached 97.5- 100% (table 3).

Table 3

The contamination of corn crops and the effectiveness of herbicides in the agrocenosis of the Amelior hybrid (average for 2021-2022)

Variant	Terms of registration of weeds				Technical efficiency herbicides (first wave of weeds), %
	before entering post-emergence herbicides, (pieces/m^2)	for 21 days after making post-of herbicides, (pieces/m^2)	phase of full grain maturity		
			pieces/ m^2	g/m^2	
Soil and post-emergence herbicides					
Dual Gold - 1.5 l/ha + Stellar - 1.25 l/ha + Surfactant Metolate - 1.25 l/ha	5,6	-	7,2	50,7	100
Akris - 3 l/ha + Kelvin Plus - 0.35 kg/ha + PAR Hasten - 1 l/ha	4,0	0,1	4,0	34,7	97,5
Post-emergence herbicides					
Stellar - 1.25 l/ha + Surfactant Metolate - 1.25 l/ha	155,2	14,9	19,9	88,4	90,4
Kelvin Plus - 0.35 kg/ha + Hasten surfactant - 1 l/ha	153,6	18,4	23,2	95,3	88,0
Mixtures of post-emergence herbicides					
Stellar - 0.8 l/ha + Akris - 1.5 l/ha + Surfactant Metolate - 0.8 l/ha	146,4	8,6	12,9	60,4	94,1
Kelvin Plus - 0.3 kg/ha + Akris - 1.5 l/ha + SAL Hasten - 1 l/ha	132,0	13,2	15,2	71,0	90,0
Control					
Natural weediness of crops (without removing weeds)	102,4	180,0	186,4	988,5	-
Inter-row cultivation + manual weeding	-	-	-	-	-

the source is formed on the basis of own research results

It should be noted that in the conditions of the experimental period, the weeds of the second wave appeared quite late, cultivated plants at that time were well developed and strongly suppressed wild species. As a result, their share in the total biomass of the weed community was minimal.

The highest clogging of the agrocenosis was registered in control 1 (without removing weeds). Their number at the time of full ripeness of the corn grain was equal to 186.4 pcs./m2, mass - 988.5 g/m2, which is 7-31 times more compared to other variants of the experiment with herbicides.

The optimal phase of development of corn plants for application of post-emergence herbicides is the phase of 3-5 leaves. It is before the appearance of the 3rd leaf that nodes, internodes, and tiers of the nodal root system are formed, and the formation of the vegetative parts of the stem is completed. At the moment of the formation of the fifth leaf in corn, the laying of future cobs begins, therefore, violation of the regulations for the use of herbicides leads to a slowdown in the development of the secondary root system, the absence of cobs, or the growth of additional shoots from the roots. In addition, when applying insurance herbicides, we must take into account the phases of weed development, because the highest efficiency from the use of insurance herbicides can be achieved when dicotyledonous weeds have formed 1-3 pairs of true leaves, and grasses - 3-4 leaves [3-5, 14]. It is noted [15] that mechanical and chemical weed control measures have a positive effect on the formation of biometric parameters of the culture. Thus, when closing the rows at the end of the critical period of competitive relations with weeds, even with one inter-row tillage, the height of the plants increased significantly to 147 cm compared to 132 cm without crop care. This indicator was the best in the variant using the technological combination of the soil herbicide harness (2.5 l/ha) with the post-emergence herbicide dialen super (1.25 l/ha) and was practically not inferior to the control with manual weed removal. With the help of only one inter-row tillage, it is not possible to significantly improve the formation of the assimilation apparatus. Applying the soil herbicide harness (2.5 l/ha) followed by spraying with the post-emergence herbicide dialen super (1.25 l/ha) made it possible to practically eliminate the negative impact of weeds on the formation of the leaf area, which in the phase of panicle ejection reached 0.49 m^2 per plant and was close to control with manual weeding - 0.51 m^2.

The size of the leaf surface reached the same value when the post-emergence herbicide Myster (150 g/ha) was applied, which also demonstrates its better ecological and economic attractiveness. Important for the final yield of corn is the optimization of not only the individual, but also the total area of leaves per unit of sowing area, which is defined as the leaf index. The use of the best combinations of mechanical and chemical means of plant protection against weeds, depending on the level of their technical efficiency, made it possible to reach an almost maximum value of the leaf index of 2.2 (at 2.3 - without weeds), which is 44-50% higher than the control .

Similar results were obtained in our research. Thus, according to the obtained data, the height of corn during the flowering of panicles in the areas with chemical plant protection varied between 204.8-209.0 cm. With NIR_{05} 10.2 cm, the differences in the indicators according to the experimental variants can be considered insignificant. Approximately the same mark (205.4 cm) was reached by plants grown with row weeding. A significant decrease in the intensity of growth processes (121.8 cm) was observed against the background of natural weediness of crops as a result of a significant deterioration of the properties and regimes of chernozem under the influence of a large number of wild flora (table 4).

Table 4

Biometric indicators of corn plants of the Amelior hybrid in the panicle flowering phase depending on the options for the use of herbicides in the agrocenosis (average for 2021-2022)

Variant	Plant height, cm	Leaf area of 1 plant, dm^2	Leaf surface index, m2/m2
Akris - 3 l/ha (before seedlings) + Kelvin Plus - 0.35 kg/ha + PAS Hasten - 1 l/ha (phase of 3-5 leaves of culture)	205,7	49,1	2,21
Dual Gold 1.5 l/ha (before seedlings) + Stellar - 1.25 l/ha - + Surfactant Metolate - 1.25 l/ha (phase 3-5 leaves of culture)	207,6	47,7	2,15
Stellar - 0.8 l/ha + Akris - 1.5 l/ha + Surfactant Metolate - 0.8 l/ha (phase 3-5 leaves of culture)	209,0	48,4	2,18
Kelvin Plus - 0.3 kg/ha + Akris - 1.5 l/ha + Hasten surfactant - 1 l/ha (phase 3-5 leaves of culture)	204,8	48,6	2,19
Stellar - 1.25 l/ha + Surfactant Metolate - 1.25 l/ha (phase 3-5 leaves of culture)	207,0	47,4	2,16
Kelvin Plus - 0.35 kg/ha + Hasten surfactant - 1 l/ha (phase 3-5 leaves of culture)	204,9	48,2	2,17
Natural weediness of crops (without removing weeds)	121,8	25,4	1,14
Inter-row cultivation + manual weeding	205,4	50,3	2,26
$HIP_{0,5}$	10,2	2,5	0,19

the source is formed on the basis of own research results

Today, it is usually impossible to grow corn without using herbicides. In Ukraine, 99% of production areas under corn are treated with herbicides. At the same time, a high biological efficiency of their action is required in order not only to exclude competition with corn during the growing season, but also to prevent the

accumulation of weed seed reserves in the soil. At the same time, it is indicated that corn needs reliable protection at the first stage of vegetation, namely within 40-50 days from the appearance of seedlings. Starting from the phase of 2–3 real leaves and until the appearance of the 10th and subsequent ones, weeds sharply reduce the yield of corn [8, 14].

At the beginning of the growing season, corn plants develop very slowly, they cannot compete with weed species that are adapted to cool spring days, form and develop a powerful, productive above-ground and underground part. The main competition between weeds and corn plants is for moisture and nutrients.

Corn consumes the least amount of moisture to form dry matter, unlike weeds. For example, the transpiration coefficient for corn is only 320, and for such weeds as common flat grass - 470, bent sedge - 560, field sedge - 665, white quinoa - 801, field mustard - 870, ragweed - 948, creeping wheatgrass - 1183.

According to the conducted studies, the joint presence of corn from the seedling phase to the V5 phase (7-8 visible leaves of corn) with such weeds as white quinoa in the amount of 12 pcs./m^2, birch mustard - 2 pcs./m^2, chicken millet - 3 pcs. ./m^2, bitter gorse - 1 pc./m^2, locust beans - 5 pcs./m^2, three-ribbed sedum - 7 pcs./m^2 contributed to the loss of 656 m^3/ha of moisture from the soil, which is equal to the amount of moisture for the formation of 1 ton of corn grain.

In addition, these weeds competed for the consumption of nitrogen, phosphorus and potassium, which subsequently leads to an increase in the water consumption of corn. In clean crops, corn seedlings spread their leaves across the row, this allows them to occupy the maximum area, which leads to active growth and development. In clogged ones, the stairs seem to twist, adjust to the location of the weeds.

In order to avoid shading, the corn plant tries to stretch out as much as possible, which leads to inhomogeneity in crops in height, reducing their manufacturability. As a result, high weediness of corn sowing leads to a significant decrease in crop yield [2, 7]. For example, in experiments [13], a significant increase in the yield of corn grain was obtained when herbicides were applied, because the conditions for the growth and development of this crop improved significantly as a result of the destruction and suppression of weeds.

On the other hand, when choosing a protection strategy, you should rely on the use of an integrated system of weed protection, which includes the use of various agrotechnical measures in combination with chemical protection.

Mechanical processing separates the daughter plants from the mother plants and spreads them across the territory. At the same time, mechanical cultivation removes other competing annual species: as a result, well-nourished sprouts and rhizomes grow optimally in conditions of low competition. Therefore, most noxious weeds are perennials. But deep and frequent mechanical cultivation of the soil, as a rule, is harmful for perennials [9]. Adherence to crop rotation is also important [11]. We came to similar conclusions in our research (Table 5).

Thus, the highest yield of corn grain directly on the herbicide agrophone (6.81-6.98 t ha^{-1}) was obtained from a combination of soil and insurance preparations: Akris

- 3 l/ha (for pre-sowing cultivation) + Kelvin Plus - 0.35 kg/ ha + Hasten surfactant – 1.0 l/ha (phase 3-5 leaves of culture) and Dual Gold – 1.5 l/ha (before sowing) + Stellar – 1.25 l/ha + Metolate surfactant – 1.25 l /ha (by stairs).

During the research period, taking into account the cumulative effect of weather factors, the combined system of chemical plant protection best controlled the total number and mass of weeds. Among the mixtures of post-emergence herbicides, the following were singled out: Stellar (0.8 l/ha) + Akris (1.5 l/ha) + Surfactant Metolate (0.8 l/ha). Synergy of chemical products different in mechanism and duration of action, as well as in the level of phytotoxicity of chemical products ensured proper destruction of wild plant species and yield of grain crop -6.68 t ha^{-1}.

Table 5

Corn yield of the Amelior corn hybrid depending on herbicide application options (average for 2021-2022)

Plant protection system	Grain yield, t ha-1	Grain growth before control, t ha-1
Soil and post-emergence herbicides		
Dual Gold - 1.5 l/ha + Stellar - 1.25 l/ha + Surfactant Metolate - 1.25 l/ha	6,81	4,54
Akris - 3 l/ha + Kelvin Plus - 0.35 kg/ha + PAR Hasten - 1 l/ha	6,98	4,71
Post-emergence herbicides		
Stellar - 1.25 l/ha + Surfactant Metolate - 1.25 l/ha	6,35	4,08
Kelvin Plus - 0.35 kg/ha + Hasten surfactant - 1 l/ha	6,22	3,95
Mixtures of post-emergence herbicides		
Stellar - 0.8 l/ha + Akris - 1.5 l/ha + Surfactant Metolate - 0.8 l/ha	6,68	4,41
Kelvin Plus - 0.3 kg/ha + Akris - 1.5 l/ha + SAL Hasten - 1 l/ha	6,40	4,13
Control		
Natural weediness of crops (without removing weeds)	2,27	-
Inter-row cultivation + manual weeding	7,14	4,87
NIR05 (Appendix A)	0,27	-

the source is formed on the basis of own research results

In terms of impact on the soiling of crops and plant productivity, the autonomous application of such drugs as Stellar and Kelvin Plus was inferior to the combined use of synthetic compounds. They were not effective enough to control the first, second and subsequent waves of weeds, so the grain yield was formed at the level of 6.22-6.35 t ha^{-1}. The increase in corn grain with the use of chemical components of weed control compared to control 1 (natural weediness of crops - 2.27 t ha^{-1}) was statistically evident.

Conclusions and prospects for further research. Based on the results of the research, the main elements and methods of controlling the development of weeds in corn crops were developed and changes in the water and nutrient properties of the

soil were identified. The optimal tank mixtures and technological combinations of new soil and insurance herbicides have been determined, which provide a high level of technical efficiency on a wide species spectrum of weeds that clog corn crops.

1. The complex nature of the formation of the type of weediness, which changes during the growing season of the crop, is noted. The results of assessments of the dynamics of weed vegetation indicate a gradual increase in cenotic tension due to the gradual transition of dominant species of weeds, such as *Chenopodium album* L., *Amaranthus retroflexus* L., *Echinochloa crus-galli* L., *Elytrigia repens* (L.) Gould , *Sonchus arvensis* L, *Cirsium arvense* L., *Convolvulus arvensis* L. in the middle layer of sowing with a simultaneous increase in the frequency of their determination by 1.1-1.3 times.

2. The best increase and development of the total leaf surface of corn plants (2.15-2.26 pcs./m^2) was noted in the herbicide agrofon and complete removal of weeds, and in the case of natural weediness of crops - a negative effect on growth processes, sizes and duration functioning of leaves (1.14 pcs./m^2).

3. The technical efficiency against weeds of the first wave reached 100% with a combination of soil and insurance herbicides - Dual Gold - 1.5 l/ha (before sowing) + Stellar - 1.25 l/ha + Surfactant Metolate - 1.25 l/ha (on the stairs); during the second and subsequent waves of weeds, protection systems that combine vegetative and soil deterrent effects are best controlled (Stellar - 0.8 l/ha + Akris - 1.5 l/ha + Surfactant Metolate - 0.8 l/ha and Kelvin Plus - 0.3 kg/ha + Akris - 1.5 l/ha + SAL Hasten - 1 l/ha).

4. The highest yield of corn grain (6.98 t ha^{-1} and 6.81 t ha^{-1}) was obtained from the combination of soil and insurance preparations Akris (before sowing) + Kelvin Plus and PAR Hasten (after the steps) and Dual Gold (before sowing) + Stellar and surfactant Metolat (by stairs); Akris + Stellar + Metolat surfactant (yield - 6.68 t ha^{-1}) was singled out among post-emergence herbicide mixtures; with autonomous use of the preparations Stellar and Kelvin Plus, the yield was 6.35 t ha^{-1} and 6.22 t ha^{-1}, respectively.

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АНОТАЦІЯ
КОНТРОЛЬ ЗАБУР'ЯНЕНОСТІ КУКУРУДЗИ В УМОВАХ ПРАВОБЕРЕЖНОГО ЛІСОСТЕПУ

У даній статті наведено результати досліджень основних елементів та методів контролю розвитку бур'янів в посівах кукурудзи та виявлених зміни водних і поживних властивостей ґрунту. Визначено оптимальні бакові сумішки та технологічні поєднання нових ґрунтових і страхових гербіцидів, які забезпечують високий рівень технічної ефективності на широкому видовому спектрі бур'янів, що засмічують посіви кукурудзи. Зокрема, для умов господарства відмічено складний характер формування типу забур'яненості, яка змінюється у ході вегетації культури. Результати оцінок динаміки бур'янистої рослинності вказує на поступове зростання ценотичної напруги за рахунок поступового переходу домінант-видових бур'янів, таких як Chenopodium album L., Amaranthus retroflexus L., Echinochloa crus-galli L., Elytrigia repens (L.) Gould, Sonchus arvensis L, Cirsium arvense L., Convolvulus arvensis L. в середній ярус посіву при одночасному зростанні частоти їх детермінації в 1,1-1.3 рази. Встановлено, що кращий приріст і розвиток сукупної листкової поверхні рослин кукурудзи (2,15-2,26 шт./м^2) відмічено на гербіцидному агрофоні та повному видаленні бур'янів, а за природної забур'яненості посівів – негативний вплив на ростові процеси, розміри і тривалість функціонування листя (1,14 шт./м^2).

Згідно результатів досліджень технічна ефективність проти бур'янів першої хвилі досягала 100 % при поєднані ґрунтового і страхового гербіцидів – Дуал Голд – 1,5 л/га (до сівби) + Стеллар – 1,25 л/га + ПАР Метолат – 1,25 л/га (по сходах); під час другої і наступних хвиль бур'янів найкраще контролюють системи захисту, які поєднують вегетативну та ґрунтову стримуючу дію (Стеллар - 0,8 л/га + Акріс - 1,5 л/га + ПАР Метолат - 0,8 л/га та Кельвін Плюс – 0,3 кг/га + Акріс - 1,5 л/га + ПАР Хастен – 1 л/га).

Найвищу врожайність зерна кукурудзи (6,98 т/га і 6,81 т/га) отримано від поєднання ґрунтових і страхових препаратів Акріс (до сівби) + Кельвін Плюс і ПАР Хастен (по сходах) та Дуал Голд (до сівби) + Стеллар і ПАР Метолат (по сходах); поміж сумішей післясходових гербіцидів виокремлено Акріс + Стеллар + ПАР Метолат (урожайність - 6,68 т/га); за автономного використання препаратів Стеллар і Кельвін Плюс, урожайність складала 6,35 т/га і 6,22 т/га відповідно. Підтверджена тотожна економічна доцільність застосування таких варіантів застосування гербіцидів на кукурудзі Акріс, 1,5 л/га + Стеллар, 0,8 л/га + ПАР Метолат, 0,8 л/га та Стеллар, 1,25 л/га + ПАР Метолат,1,25 л/га, що забезпечилу вищу на 43 %, ніж на контролі із природною забур'яненістю та на 33,2-33,4 % ніж у варіанті міжрядного обробітку із ручним прополюванням.

Ключові слова: *кукурудза, бур'яни, гербіцид, урожайність, економічна ефективність.*

Табл. 5. Літ. 18.

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