

The influence of the main tillage and fertilization on weediness of sunflower crops

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Abstract. On the international and domestic markets of agricultural products, there is an increase in demand for oilseed crops, in particular annual sunflower and its processing products. Sunflower seeds are in permanent demand, which proves their high relevance. Cultivation of this crop is quite profitable for agricultural producers and does not require significant additional costs. That is why the scientifically based observance of crop rotation in the process of growing sunflowers is gaining more and more importance. Soil pollution affects the productivity of cultivated crops. The order of fertilization and cultivation of the sown area is important in improving its microbiological condition. The search for a method of rational and effective application of fertilizers is an urgent task for workers in the agricultural sector. The purpose of the work was to determine the number of weeds and weeds in a field of stationary grain-row crop rotation, to compare the type of weediness between the unfertilized and control variant of the soil, and to choose a more effective method of soil cultivation. In the course of the work, the laboratory method, as well as methods of observation and generalization, were applied. The article examines

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the influence of the main tillage and fertilization system on the weediness of sunflower crops in a stationary crop rotation during 2016-2018 in the conditions of the eastern part of the Forest Steppe of Ukraine. The largest number of types of weeds and weeds in crops was found on the background without fertilizers (plowing) and on the organic-mineral intensive background (manure residue, 30 t/ha + $N_{30}P_{30}K_{30}$, chiseling). The type and level of weediness of sunflower crops depends significantly on the studied factors. The scientific novelty consists in establishing a method of soil fertilization that ensures maximum crop productivity

Keywords: crop rotation, fertilizers, weeds, herbicides, eastern Forest-Steppe of Ukraine, crop protection, plowing

INTRODUCTION

On the global and domestic markets of agricultural products, there is an increase in demand for oil crops, especially annual sunflower (*Helianthus annuus* L.) and its processing products. Sunflower seeds are in constant demand, which proves their high liquidity. Cultivation of this crop is quite profitable for agricultural producers and does not require significant additional costs. That is why the scientifically based observance of crop rotation in the process of sunflower cultivation is becoming more and more important [1].

The obtained scientific data indicate that sunflower should occupy no more than 20% of the crop rotation structure. An important factor in increasing the productivity of this oilseed crop in crop rotation is the main tillage, which ensures the preservation of productive moisture reserves, the improvement of the microbiological condition of the soil, and the control of weeds. The last factor is of great importance in modern sunflower cultivation technologies [2].

In the conditions of the left-bank Steppe of Ukraine, it was established that, regardless of the weather and agrotechnical conditions of sunflower cultivation, weed seedlings appear in the period from the beginning of field work to the closing of the rows of dominant agrophytocenoses. Typical for sunflower crops are such weeds as *Amaranthus retroflexus* L., *Sinapis arvensis* L., *Xanthium strumarium* L., *Chenopodium album* L., *Setaria viridis* (L.) Beauv., *Cirsium arvense* (L.) Scop., *Lactuca tatarica* (L.) C.A. Mey., *Lappula squarrosa* (Retz.) Dumort. The results of model experiments showed that the yield of sunflower is affected by both species and quantity of weeds. Under the short-term type of weeding, the yield of sunflower decreases by 1.42 t/ha, under the mixed type – by 1.56 t/ha, and by the predominance of perennials – by 1.69 t/ha, compared to areas without weeds. On average, the presence of one Tatar lettuce plant per 1 m² reduces the yield of sunflower by 0.035 t/ha, white quinoa – by 0.016 t/ha, common sedge – by 0.024 t/ha, and bent scotch – by 0.012 t/ha [3].

For the entire north-central moderately arid subzone of the Steppe northern zone of Ukraine, the main agrophytocenoses with the participation of sunflower are the following weed species: wild radish (*Raphanus raphanistrum* L.); the bent sphincter; *Echinochloa crus-galli* (L.) Roem. et Schult.; field mustard; *Xanthium albinum* (Widder) H. Scholz; *Ambrosia artemisiifolia* L.;

white quinoa; *Setaria glauca* (L.) Beauv. As single plants in the crops, there are *Persicaria Maculosa* S.F. Gray, *Lycopsis arvensis* L., mousey green, black solanum (*Solanum nigrum* L.), one-year primrose (*Stachys annua* L.), etc. It was established that the highest crop losses are observed during the simultaneous vegetation of the crop with young species from the beginning of development to harvesting. In particular, the presence of 10 pcs./m² of these weeds with a raw above-ground weight of 170 g/m² leads to crop yield losses of 8.6%, compared to the control. Such indicators as the diameter of the basket (by 3.4 cm), the number of seeds from one basket (by 6 pcs.), the weight of 1,000 seeds (by 5.6 g) are reduced. In the case of an abundance of young species of 20 pieces/m² with a biomass of 197.5 g/m², sunflower seed yield losses reach 14.1%; 30 pcs./m² (241.3 g/m²) – 19.6%; 40 pcs./m² (300.5 g/m²) – 23.9%; 50 pcs./m² (327.5 g/m²) – 28.2%. Natural weeding by young species (293 pieces/m² with a weight of 455 g/m²) leads to a decrease in the yield of sunflower seeds by 44.2%, with a significant decrease in all indicators of the yield structure: the diameter of the basket – by 8.3 cm, the number of seeds from one basket – for 91 pieces, weight of 1,000 seeds – for 19.1 g [4].

According to the results of A.I. Babenko's research, the main polluters of sunflower crops in the right-bank Forest-Steppe of Ukraine are young monocotyledonous and dicotyledonous weeds (94%). Root weeds, represented by pink thistle (*Cirsium arvense* (L.) Scop.) and field birch (*Convolvulus arvensis* L.), occupy 6%. Among the young weeds, the main specific weight is the early spring ones – common plantain and common bitersweet (*Amaranthus retroflexus* L.). Among the early spring varieties, white quinoa is preferred. It was established that the critical period of competition between sunflower and weeds depends on the level of weediness, the duration of competitive relations, and the length of the growing season. In particular, the lowest yield of sunflower seeds was obtained in the variant where cultivated plants competed with weeds for life factors throughout the growing season. On these plots, 97 weeds/m² were counted, the raw above-ground mass of which was 2,131 g/m², and the seed yield was 1.4 t/ha, which is 2.9 t/ha or 67% less than in the version without competition from weeds. In the variants where sunflower plants competed with weeds for a certain growing

season, the number and mass of weeds depended on the duration of the competition. The fewest weeds were in the option where they were removed within 60 days after the emergence of seedlings (25 pcs./m², based on the raw above-ground mass of 307 g/m²). Yield reduction occurred by 0.4 t/ha or 9%. It was also established that weeds have the most significant effect on sunflower productivity when they are present in the first 60 days after the emergence of crop seedlings. For example, with the presence of weeds in the crops within 20 days after sunflower germination, the yield reduction was 11%, and 60 days after germination – 41% [5].

The sunflower crop is significantly reduced by a weed parasite, the sunflower wolfberry (*Orobancha cumana* Wallr.), the seeds of which can be stored in the soil for many years. Thus, according to the long-term data of the Mykolaiv State Agricultural Research Station, when sunflower is returned to its previous place in the crop rotation after 10, 6 and 4 years, the number of sunflower beetles in crops is 2, 12 and 38 pcs./m², respectively. The yield of sunflower when returning it to its previous place in crop rotation after 10, 6 and 4 years was 2.01, respectively; 1.33 and 1.11 t/ha [6].

In the last decade, there has been a massive spread of the virulent spring annual weed (*Cyclachaena xanthifolia* (Nutt.) Fresen.) in sunflower crops. It leads to huge losses of the harvest and deterioration of its quality, causes mass diseases of people due to polynomia. The dynamics of the emergence of black-leaved black-leaved weevil in sunflower crops is unfriendly and depends on weather and geographical conditions. In the Steppe zone, most of the seedlings of this weed in crops appear in the first decade of May, and in the Forest-Steppe zone - in the second decade of May. The total number of black-leaved aphids in sunflower crops in the Forest Steppe, southern Steppe, northern Steppe, and Dry Steppe zone is 40, 44, 43, and 47 pcs./m², respectively [7].

According to V.S. Zuza's long-term research, cereal annual weeds and millet weeds (*Panicum miliaceum* L.) are very common in sunflower crops in the conditions of northeastern Ukraine. The second place by mass and the third in number among weeds belongs to dicotyledonous perennial species. Dicotyledonous weeds stand out due to the variety of their species composition, among which the most harmful are vigorous species. At the same time, overwintering species are not inferior to warm weeds in terms of number, but they take second place in terms of mass. In total, about 50 types of weeds were found in the sunflower crops, of which the most numerous are common flat grass, gray mouse and common schirytzia. Also, the definition of the types of weediness shows that in the conditions of ordinary farms, in almost half of the fields under sunflower, the dominant position among the weeds is occupied by rhizome species. In the fields of experimental farms and experimental plots, under the conditions of observing the crop rotation system and carrying out the main

cultivation of the soil under the culture by the method of improved sedge, rhizome species prevail in only 20% of sunflower crops [8].

According to A.M. Kovalenko, sunflower crops were the least weedy in crop rotation with black steam, while in crops of other crop rotations, the number of weeds increased by 12.6-30.2%, and their mass increased by 1.4-2.0 times. The most widespread were early spring weeds, the share of which in crop rotation with peas was 52.2%, and in other crop rotations – 63.2-67.8%. In crop rotation with peas, the share of early spring weeds increased slightly - up to 28.9% and perennial weeds – up to 19.2%, compared to other crop rotations – 15.0-24.2% and 13.0-19.2%, respectively [9].

As evidenced by the results of M.V. Shevchenko's research, the use of various methods of tillage for sunflower, compared to plowing, led to an increase in the number of weeds in crops by 12-29% [10]. I.D. Tkalic and co-authors point out the increase in weediness of cultivated areas and the decrease in sunflower yield in the direction from plowing to zero tillage. In their opinion, this is caused by the deterioration of the physical condition of the soil and its moisture regime [2].

The conducted studies show that in the sowing of agricultural crops, including sunflower, against the background without herbicides in variants of the use of tillage, the number of short-term and perennial weeds, compared to plowing, increases by 10-20% and by 1.5-2%, respectively, 0 times. Accordingly, the mass of weeds also increases – by 20-30%. The use of herbicides before sowing sugar beets and sunflowers, as well as during the growing season for crops of continuous sowing, reduced the number of weeds by 4-4.5 times, compared to the herbicide-free background. That is, the introduction of herbicides against the background of tillage significantly reduces the difference in weediness, compared to systematic plowing [11; 12]. It is also possible to replace plowing with chisel tillage when growing sunflowers without herbicides, or diagonal loosening with a combination of mechanical and chemical methods of weed control [10].

Research by S.P. Tanchyk and A.I. Babenko indicate that the number of weed seedlings in the agocenosis depends on the sunflower cultivation technology, the biological characteristics of the culture and weeds, as well as weather conditions. Thus, in the phase of 6-7 leaves in sunflower, there were the fewest weed seedlings after plowing. In the variant without herbicides and mechanical weeding during the growing season, 83 pieces/m² of wild plants were counted. Against the background of chisel cultivation, the number of weeds increased by 2.3 times and amounted to 195 pcs./m². Carrying out shallow and surface cultivation with disk tools contributed to the increase of vegetative weeds by 2.6 and 3.0 times, respectively. Protection of sunflower crops from weeds significantly reduced their number. Thus, when applying herbicides against the

background of plowing, their number decreased by 87-92%. At the same time, against the background of tillage, the effectiveness of herbicides was lower, compared to plowing. This is explained by the fact that the post-harvest residues and applied organic fertilizers are contained in the upper layer and adsorb part of the chemicals, which reduces their phytotoxicity, especially in dry years. The survival rate of weed seedlings in the phase of 6-7 leaves of the crop ranged from 38 to 14%. Carrying out one pre-emergent and post-emergent harrowing against the background of plowing, as well as one inter-row loosening in the phase of 5-6 leaves of the culture contributed to the reduction of weediness by 86%, and against the background of no-shelf cultivation – by 75-80%. With the use of mechanical measures, the weeds grew mainly in the row, especially under shelf-less tillage, and in the inter-rows they were destroyed by the working bodies of the tooth harrow and the cultivator [13]. In other studies, no regular influence of the main tillage on the effectiveness of herbicides was found. In addition, the introduction of soil herbicides against the background of direct sowing is ineffective, because the drug, remaining on the surface of the soil, evaporates under the influence of wind and solar energy. At the same time, it was shown that the species composition of weeds is formed under the influence of different methods of soil cultivation and herbicides [14].

The results of research by O.I. Polyakov and his co-authors show that the number of weeds in sunflower crops changes under the influence of the method of main soil cultivation and is almost independent of the fertilizer option. So, after caring for the crops (two inter-row cultivations) at the end of the growing season, the following was calculated: 7.2-7.6 pcs./m² – for the classical system of the main soil cultivation (discussion in two tracks, plowing); 9.1-9.3 pcs./m² – for bladeless (disking in two tracks, bladeless processing); 15.0-16.1 pcs./m² – for the minimum (disking in two tracks, cultivation). At the same time, the air-dry mass of weeds changed under the influence of the main tillage system and the background of mineral nutrition. Under the classical system of basic tillage, it was equal to 22.1-33.1 g/m². In sunflower crops under the no-till system, the air-dry mass of weeds increased by 11.5-13.5 g/m² in relation to the classic one, and by 16.1-18.3 g/m² under the minimum tillage system. In variants with mineral fertilizers, it increased by 5.7-11.0 g/m², 4.3-10.7 g/m², 4.9-12.4 g/m², respectively. Sunflower plants were the most competitive in the fight against weeds in the classic tillage system. The highest yield of sunflower was obtained when growing under the classical system of basic tillage and applying fertilizers in the dose of N₆₀P₉₀K₆₀ for pre-sowing cultivation [15].

The purpose of the research is to establish the influence of the methods of basic tillage, fertilization and protection systems on the weediness of sunflower

crops placed in the semi-grain-row crop rotation of the eastern part of the Forest Steppe of Ukraine.

MATERIALS AND METHODS

The research was carried out during 2016-2018 in a stationary 9-type steam-grain-row crop rotation of the Department of Plant Breeding and Varietal Research of the Institute of Plant Breeding named after V.Ya. Yuryev National Academy of Agrarian Sciences (black steam – winter wheat – sugar beets – spring grain ears – peas for grain – winter wheat – corn for grain ½ + soybean ½ – spring grain ears – sunflower), where the plots of the first order were the backgrounds of nutrition, and the second order – methods of basic soil cultivation in crop rotation. The scheme of the experiment included options: 1 – without fertilizers (control) – the agro background formed due to the alternation of crop rotation; 2 – organic background (application of 30 t/ha of manure under corn and in the field of black steam, which amounted to 6.6 t of manure per 1 ha of crop rotation area); 3 – organic-mineral background (a trace of manure + N₁₅P₁₅K₁₅); 4, 5 – organic-mineral intensive background (a trace of manure + N₃₀P₃₀K₃₀). In options 1-4, fertilizers were applied under plowing, and in option 5 – under tillage (chiseling).

The system of protection of sunflower crops from weeds based on herbicides during the years of research was as follows: 2016 – Trophy 90 EC (active substance and its content – acetochlor, 900 g/l; preparation form – emulsion concentrate; applicant (registrant), manufacturer – “Dow Agro Sciences WmbH”, Australia), 2.5 l/ha before seedlings + Fusilade Forte 150 EC (active substance and its content – fluazifop-P-butyl, 150 g/l; preparation form – emulsion concentrate; applicant (registrant), manufacturer – Syngenta, Switzerland), 2.0 l/ha during the growing season of the crop; 2017 – Hortus (active ingredient and its content – acetochlor, 900 g/l; preparation form – emulsifiable concentrate; applicant (registrant), manufacturer – Company Ukravit LLC, Ukraine, Agrochemical Factory LLC, Ukraine), 2.5 l/ha to seedlings + Queen Star Max (active substance and its content – hizalofop-P-ethyl, 125 g/l; preparation form – emulsifiable concentrate; applicant (registrant), manufacturer – Ukravit Company LLC, Ukraine, LLC “Factory of Agrochemicals”, Ukraine), 1.2 l/ha during the growing season of the crop; 2018 – Teaser (active substance and its content – propisochlor, 720 g/l; preparation form – emulsifiable concentrate; applicant (registrant), manufacturer – Ukravit Company LLC, Ukraine, Agrochemical Factory LLC, Ukraine), 3.0 l/ha to seedlings.

The years of research were different in terms of meteorological conditions. Thus, in April and May 2016, the amount of precipitation exceeded the long-term norm by 29.2 and 43.9 mm, respectively, and the average daily air temperature exceeded the long-term norm by 4.6 and 1.5°C, respectively. In June, the average daily air temperature was higher than the norm by 1.9°C, and the amount of precipitation was lower than the norm

by 21.7 mm. The average daily air temperature in July, August and September was higher than normal by 1.9; 2.7 and 0.6°C, respectively. However, the amount of precipitation in July exceeded the norm by 40.0 mm, and in August and September they fell below the norm by 8.8 and 24.4 mm, respectively.

The average daily air temperature in April 2017 was 1.2°C more than the optimal level, and in May it was almost at the level of the long-term norm. The amount of precipitation in April exceeded the norm by 5.7 mm, and in May it was less than the norm by 12.2 mm. In June, July, August and September, the average daily air temperature was 1.0; 0.3; 4.6 and 3.5°C higher than the climatic norm. The amount of precipitation in June, July, August and September was less than the norm by 46.6%; 34.8; 43.5 and 13.4 mm, respectively.

The average daily air temperature in April 2018 was 4.1°C more than the optimal level, and in May – by 4.4°C. The amount of precipitation in April was less than the climatic norm by 22.4 mm, and in May by 31.9 mm. In June, July, August and September, the average daily air temperature was higher than the climatic norm by 2.2; 1.6; 4.5 and 4.6°C, respectively. The amount of precipitation in June, July and September was less than the norm by 21.5%; 37.7 and 3.6 mm, respectively. There was no precipitation in August. In general, according to the indicator of the amount of precipitation, 2016 can be characterized as sufficiently moistened, and 2017-2018 – insufficiently moistened. An excess of average daily air temperatures for the spring-summer period was also noted, compared to the average long-term indicators.

Inspection of sunflower crops for weediness was carried out in September according to the method of V.S. Zuzy, R.A. Gutyanskyi [16]. For each option, a separate form was allocated, in which after the survey, the identified types of weeds or litterers (including carrion from the seeds of field crops) were entered. At the same time, both dominant and subdominant species of weed plants were counted. The dominant role of each species was assessed quantitatively, based on its share in the formation of the total mass of the segetal grouping on the variant. Those species whose weight exceeded 10% of the total weight of all weeds were considered dominant, and subdominant – 3-10%, respectively.

When determining the type of weediness in its name, the group that was most represented in the total mass of weeds was put on the first place, and on the second or third – groups of weeds in accordance with their participation in the segetal grouping. The level of weediness in each option was determined by the specific share of weeds in the total mass of agrophytocenosis: up to 1% – very weak; 1-5% – weak; 6-15% – average; 16-45% – strong; more than 45% is very strong.

RESULTS

In the Table 1 summarizes the results of our three-year research, which shows ten main types of weeds, which

according to the occurrence rate are classified from very widely (76-100%) to widely (51-75%) common species in sunflower crops. Among them, gray mouse, common flat and white quinoa were present in all variants every year. In addition, the following were found annually: in option 1 – common sedum, bitter gorse (*Polygonum lapathifolium* L.), pink thistle and field birch; in option 2 – nightshade black and bitter gorse; option 3 – common sedum, black nightshade and bitter gorse; option 4 – common scotch, nightshade, bitter gorse and field birch; option 5 – common sedum, nightshade, garden purslane (*Portulaca oleracea* L.), ragweed and malva neglecta Wallr.

The category of moderately common (26-50%) weed plants in terms of the species occurrence rate in sunflower crops includes: birch fallopium (*Fallopia convolvulus* (L.) A. Love), waste millet (*Panicum miliaceum* var. *ruderales* Kitag.), netreba common, black-leaved black-leaved, the curls are neglected, triticale (*Triticosecale* Witt.), field plantain (*Thlaspi arvense* L.), hairy pea (*Vicia villosa* Roth.).

The category of rare (1-25%) species in crops includes: green mouse, common sedge (*Avena fatua* L.), annual sedge, common bitter gourd, bird's sedge (*Polygonum aviculare* L.), sunflower sedge, spring barley (*Hordeum vulgare* L.), spring wheat (*Triticum* L.), buckwheat (*Capsella bursa-pastoris* (L.) Medik.), spring sedge (*Senecio vernalis* Waldst. et Kit.), Canadian sedge (*Erigeron canadensis* L.), *Sisymbrium Loeselii* L., field violet (*Viola arvensis* Murr.), medium star (*Stellaria media* (L.) Vill.), white milkweed (*Melandrium album* (Mill.) Garcke), spotted hemlock (*Conium maculatum* L.), yellow field thistle (*Sonchus arvensis* L.), common wormwood (*Artemisia vulgaris* L.), wild chicory (*Cichorium intybus* L.), large burdock (*Lappa major* Gaertn.), dandelion (*Taraxacum officinale* Web. et Wigg), meadow clover (*Trifolium pratense* L.), common flax (*Linaria vulgaris* Mill.), curly sorrel (*Rumex crispus* L.), mo Tatar locan (*Lactuca tatarica* (L.) S.A. Mey).

In total, 42 species of weeds and weeds (including carrion from the seeds of field crops) were detected in sunflower crops after spring grain ear crops. Bright species predominated among them. Thus, 21 species were included in the group of early and late spring weed plants: gray mouse, green mouse, common plantain, common millet, white quinoa, common sorrel, black solanum, garden purslane, ragweed, broad-leaved mustard, Birch-like fallopium, common netreba, black-leaved black-leaved, neglected curlews, common spore, common sedge, sunflower wolfberry, spring barley, spring wheat, spring triticale. The group of overwintering, winter and two-year weeds was represented by 10 species: common buckwheat, spring sedge, Lozel's dry rib, field sedge, field violet, Canadian sedge, medium star, white hemlock, spotted hemlock, and hairy pea. The group of perennial weeds included 11 species: pink thistle, yellow field thistle, field birch, common wormwood, wild chicory, large burdock, medicinal dandelion, meadow clover, common flax, curly sorrel, Tatar molokan.

The highest number of the weed component was recorded in the control (option and on the organic-mineral intensive background, where fertilizers were applied under no-till tillage (option 5). Thus, in options 1, 2, 3, 4 and 5, respectively, 29, 23, 21, 23 and 27 types

of weeds and clogs. The share of spring early and late types of weed plants in variants 1, 2, 3, 4 and 5 was 62, 65, 62, 56 and 63%, respectively, wintering, winter and two-year – 24, 22, 9, 22 and 11%, perennial - 14, 13, 29, 22 and 26%.

Table 1. Species composition, dominant role and share of the occurrence of main weeds in sunflower crops depending on the methods of the main tillage and fertilization system (2016–2018)

Types of weeds	Option															Meeting share, %
	1			2			3			4			5			
	d	s	p	d	s	p	d	s	p	d	s	p	d	s	p	
Yellow bristle grass	33		33	11	11	33	22	33		22	33	11	11	33	100	
Echinochloa crus-galli	11	11	33		11	33	11	33		11	33	11	11	33	100	
Common lambsquarters			33	22		33	22		33	2		33	22		33	100
Livid amaranth			33	11		22	11		33	22		33	11		33	93
Solanum nigrum			22			33			33	11		33			33	93
Purslane			22			11			22			22			33	67
Common ragweed		11	22		11	11	11	1	22	11		22	11		33	67
Pale smartweed		11	33			33			33			33			33	93
Pink sow thistle	11	22	33		12	22	12	22		11	22	22			22	73
Field bindweed			33			11			22			33			22	73

Note: Dominance (d), subdominance (s) and presence (p) of weed plants in sunflower crops during: 1 – one year; 2 – two years; 3 – three years of research

The system of protection of sunflower crops from weeds was different in the years of research, but each year soil herbicides from the chloracetomidine group were used in crops: Trofi 90 ES, Hortus and Tizer. This affected the indicators of dominance and subdominance of certain weed species in the years of research. Thus, in 2016, after the composition of Trofi 90 EC and Fusilade Forte 150 EC, sunflower crops were significantly dominated by white quinoa, primarily in the variants with fertilizer application. In addition, the dominant and subdominant positions in individual variants were occupied by the pink thistle, the gray mouse and the flat common thistle. This is explained as follows: white quinoa is moderately sensitive to Trofi 90 EC, pink thistle is resistant to these drugs, and overgrown plants of annual cereals did not completely die under the action of the graminicide Fusilade Forte 150 EC.

In 2017, sunflower crops were dominated by pink thistle, gray mouse thistle, and common flatleaf thistle. The presence of pink thistle in crops is due to the lack of influence on it by the soil herbicide Hortus and the graminicide Queen Star Max. The incomplete effectiveness of the anti-grass herbicide Queen Star Max against

gray mouse and common flat mouse is associated with adverse weather conditions during the treatment period.

Sunflower crops in 2018 were dominated and sub-dominated by white quinoa, common sedum, and ragweed in most variants. The insufficient effectiveness of the Tizer soil herbicide in relation to white quinoa and ragweed is associated with their moderate sensitivity to this drug, and in the case of common vetch – with a lack of precipitation during its application. In addition, according to our observations, the process of forming resistance to chloracetomidine herbicides, especially to the active substance propisochlor (in our case, to the Tizer drug), is currently taking place in common sedum.

It was found that 6 types of weediness were formed in sunflower crops depending on fertilizer, tillage and weed protection system over the course of three years of research (Table 2):

- 1) dicotyledonous-cereal annual-rhizome;
- 2) dicotyledonous-rhizophylic-cereal annual;
- 3) dicotyledonous-cereal annual;
- 4) annual cereal-rhizome-perennial dicotyledonous;
- 5) cereal annual-dicot nomaloric-rhizome;
- 6) rhizome-cereal annual-dicotyledonous annual.

Table 2. Type of weediness of sunflower crops depending on the methods of the main tillage and fertilization system

Option	A year of research		
	2016	2017	2018
1	dicotyledonous-cereal annual-rhizome	cereal annual-rhizome-dicotyledonous annual	dicotyledonous-cereal annual
2	dicotyledonous-cereal annual-rhizome	cereal annual-rhizome-dicotyledonous annual	dicotyledonous-cereal annual
3	dicotyledonous-cereal annual-rhizome	cereal annual-rhizome-dicotyledonous annual	dicotyledonous-cereal annual
4	dicotyledonous-cereal annual-rhizome	cereal annual-rhizome-dicotyledonous annual	dicotyledonous-cereal annual
5	dicotyledonous-cereal annual-rhizome	cereal annual-rhizome-dicotyledonous annual	dicotyledonous-cereal annual

It was established that in 2016, in all variants, dicotyledonous species predominated in the total mass of weeds.

In 2017, cereal annual weeds prevailed in the fertilized variants, and rhizomes prevailed in the control. At the same time, in 2018, dicotyledonous annual species prevailed in the fertilized variants, and cereal annual species prevailed in the control.

That is, in 2017-2018, the type of weediness of sunflower crops in the control variants differed from

the type of weediness in the fertilized variants. The level of weediness in 2016 and 2018 in option 1 was medium, and in options 3-4 and 5 – strong and very strong, respectively. In 2017, options 1 and 5 showed a high level of weediness, while the others showed a medium level.

That is, a higher level of weediness was observed annually in the option with no-shelf main tillage (chiseling) than in most options with plowing (Table 3).

Table 3. The level of weediness of sunflower crops depending on the methods of the main tillage and fertilization system

Option	A year of research		
	2016	2017	2018
1	average	strong	average
2	average	average	strong
3	strong	average	strong
4	strong	average	strong
5	very strong	strong	very strong

CONCLUSIONS

When sunflower was placed in the last field of a stationary 9-field steam-grain-row crop rotation after the predecessor of spring grain ear crops, 42 types of weeds and weeds were found in its crops. The main types of weeds in the crops were yellow bristle grass, *Echinochloa crus-galli*, common lambsquarters, livid amaranth, *solanum nigrum*, purslane, common ragweed, pale smartweed, pink sow thistle and field bindweed. The herbicide application system significantly influenced the indicators of dominance and subdominance of certain weed species in the years of research. The largest number of different types of weeds and pollutants was determined in the control (without fertilizers, plowing) and on the organic-mineral intensive background (manure residue,

030 t/ha + N₃₀ P₃₀ K₃₀, chiseling). For the most part, the type of weediness of sunflower crops in the control variants differed, compared to the non-fertilized variants. The level of weediness in the no-till option was strong and very strong, and in the other options – medium and strong.

So, on the basis of the obtained data, it can be stated that plowing, which has advantages in reducing the weediness of crops, is the best method of the main cultivation of the soil for sunflower in the conditions of the eastern part of the Forest Steppe of Ukraine, compared to plowing the soil without tilling (chiseling).

Further research should be directed to a detailed study of the impact of long-term fertilization systems on the weediness of sunflower crops under the conditions of a semi-grain-row crop rotation.

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Вплив основного обробітку ґрунту та удобрення на забур'яненість посівів соняшнику

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Анотація. На міжнародних та вітчизняних ринках продукції сільськогосподарської сфери спостерігається підвищення попиту на олійні культури, зокрема соняшник однорічний та продукти його переробки. Соняшникове насіння користується перманентним попитом, що доводить його високу релевантність. Вирощування цієї культури є досить рентабельним для сільськогосподарських товаровиробників і не вимагає суттєвих додаткових витрат. Саме тому все більшого значення отримує науково обґрунтоване дотримання сівозміни у процесі вирощування соняшнику. Забур'яненість ґрунту впливає на продуктивність вирощуваних сільськогосподарських культур. Порядок удобрення та обробітку посівної площі має важливе значення у поліпшенні її мікробіологічного стану. Пошук способу раціонального та ефективного застосування добрив є нагальним завданням працівників аграрної сфери. Метою роботи було визначення кількості бур'янів і засмічувачів у полі стаціонарної зерно-просапної сівозміни, порівняння типу забур'яненості між неудобреним та контрольним варіантом ґрунту, вибір ефективнішого способу обробітку ґрунту. У ході проведення роботи застосовано лабораторний метод, а також методи спостереження та узагальнення. У статті досліджено вплив основного обробітку ґрунту та системи удобрення на забур'яненість посівів соняшнику в стаціонарній сівозміні впродовж 2016-2018 рр. в умовах східної частини Лісостепу України. Найбільшу кількість різновидів бур'янів і засмічувачів у посівах виявлено на фоні без добрив (оранка) та на органічно-мінеральному інтенсивному фоні (післядія гною, 30 т/га + N₃₀, P₃₀, K₃₀, чизелювання). Тип і рівень забур'яненості посівів соняшнику суттєво залежить від досліджуваних факторів. Наукова новизна полягає у встановленні методу удобрення ґрунту, що забезпечує максимальну продуктивність культури

Ключові слова: сівозміна, добрива, бур'яни, гербіциди, східний Лісостеп України, захист посівів, оранка