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The Weeds in Sunflower Crops when Grown in Arid Conditions of The Steppe of Ukraine

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ABSTRACT

In the arid conditions of the Steppe of Ukraine, the species composition of weeds characteristic of this soil-climatic zone develops. The correctly chosen method of basic soil tillage determines the effectiveness of weed suppression while simultaneously improving the growing conditions for sunflower varieties and hybrids. The purpose of the study was to identify the species composition of weeds in the steppe zone and establish the effectiveness the methods of basic tillage of soil in the technology of growing sunflower hybrids aimed at suppressing weeds and reducing the quantity of weeds in agrocenoses. Research has established that weeds of sunflower agrophytocenoses are represented by 78 species that belong to 2 classes, 18 orders, 27 families, 62 genera. In the agrophytocenosis of sunflower, the largest number of 93.5-96.3% is represented by dicotyledonous weeds (Magnoliopsida). The species composition is dominated by weeds of the Compositae family (Asteraceae) of the dicotyledonous class (Magnoliopsida), which leads to a significant decrease in the yield level. According to the species composition, 3 groups of weeds of the Asteraceae family (Asteraceae) were identified, of which 1 group of weeds is the most harmful and leads to the formation of a minimum yield of sunflower hybrids Yason and Daryi of 1.77-1.79 t/ha. The use of non-moldboard tillage leads to a percentage increase in the share of air dry mass of weeds of the *Asteraceae* family by 11.1-13.1%, while reducing the yield of sunflower hybrids by 0.13-0.21 t/ha. Thus, with the established species composition of weeds and the quantity of weeds, the use of plowing in sunflower cultivation technology makes it possible to form a maximum yield of 2.07-2.24 t/ha, providing more effective weed suppression in sunflower agrophytocenoses with a minimum percentage of air-dry mass of weeds of the Asteraceae family to the total number of weeds of 21.1-24.1%.

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Introduction

Of all oilseeds grown in Ukraine, sunflower is the most common crop. Over 90.0% of oils in Ukraine are made from sunflower seeds. Sown areas of sunflower in Ukraine are about 6.0 million hectares, which is approximately equal to 23.0% of the total sunflower area in the world. The soil and climatic conditions of the Steppe, southern and central parts of the Forest-Steppe are quite consistent with the biological properties of sunflower. A decrease in the assortment of crops grown in crop rotation has led in these parts of Ukraine to the greatest saturation of sunflower crop rotation (Adamenko, 2005; Aksyonov, 2003; Pakhnits & Dranishchev, 2001).

Sunflower cultivation provides the greatest economic efficiency of the functioning of agricultural enterprises in Ukraine, due to its high profitability, demand for marketable seeds and sunflower oil both in the country and outside the country.

With an average world sunflower yield of 1.75 t ha^{-1}, the average yield of this crop in Ukraine in recent years has reached 2.0 t ha^{-1}. The increase in yield is due to the cultivation of new sunflower hybrids with a higher level of genetic productivity potential (Gavrilyuk and Aksyonov, 2013).

However, a further increase in yield, a wider disclosure by the hybrids of their genetic potential for productivity is hindered by a low level of agricultural production technologies, a high level of weediness in crops (Bazdyrev et. al., 2004; Zakharenko, 1996).

High level weediness of crops and a high number of weed seeds in the arable soil layer create high competition in sunflower plants in agrocenoses, lead to significant unproductive losses of soil moisture and nutrients, shading and oppression of sunflower. These factors are one of the main reasons for the decline in yields of varieties and hybrids (Kott, 1964; Tatariko et.al., 2001).

It is known that sunflower, especially at the beginning of growth, is weakly resistant to weeds due to its biological characteristics. Even a small number of weeds in the rows reduces the yield. Agricultural techniques (pre-emergence and post-emergence harrowing, inter-row tillage) do not always ensure complete weed control (Zakharenko, 1996).

This is especially noticeable in our time, when there is an increase in crop litter and there is a species reorganization of the agrocenoses by weeding. Especially significant decrease in sunflower yield is observed with an increase in weediness of crops in fields with a low level of crop cultivation (Grigora, 2000; Kosolap, 2004).

As a result of the complex negative effect of weeds on plants, the level of productivity decline can reach from 40.0 to 80.0% (Pakhnits & Dranishchev, 2014).

The development and introduction into production of agricultural methods for weed control in Ukraine does not yet provide sufficiently effective methods for weed control in sunflower agrocenoses.

Insufficient knowledge of the species spectrum of weeds in agrophytocenoses significantly reduces the effectiveness of weed control during the growing season of sunflower.

The effectiveness of the developed methods is limited by the absence and discrepancy in the interpretation of the obtained data regarding biology and the growth of the most common and harmful weeds in agrocenoses in the south-eastern part of the northern Steppe of Ukraine.

Therefore, it becomes relevant to study and establish the species composition of weeds in sunflower crops, which will increase the efficiency of the development and use of agricultural methods aimed at the maximum weed control, increase the competition of sunflower with respect to weeds.

The aim of the research:

- to establish the weediness of crop rotation fields against the background of plowing and non-moldboard tillage of the soil when growing sunflower hybrids in the Steppe of Ukraine;
- to determine the effect of the method of base soil tillage on changing the type and level of weediness of fields;
- to establish the effect of the methods of base soil tillage and the level of weediness on the yield of sunflower hybrids formation;
- to determine the reaction of sunflower hybrids to the use of methods of base soil tillage and changes in the type and level of weediness.

Materials and Methods

The research was carried out in the farm "Adonis" of the Belovodsky district of the Luhansk region of Ukraine during 2014-2021.

The soil of the experimental site is represented by typical chernozem on loess-like loams with a humus layer thickness of 50 cm. The humus content in the arable soil layer according to Tyurin is 3.0-3.5%. The smallest moisture content of a meter layer of soil is 22-25%.

The experiments were carried out in a five-field crop rotation: fallow - winter wheat - corn grown for grain - spring barley - sunflower.

In the experiment to study the influence of the main tillage methods on the yield of sunflower hybrids and the number of weeds in the agrocenosis, the depth of the main tillage was 20–22 cm. Plowing was carried out with a PN-4-35 plow. Non-moldboard tillage was carried out with an anti-erosion agricultural cultivator KPG-250. The basic tillage practices (ploughing and moldboard-free ttillage of soil) were carried out in the first decade of October. The technology for growing hybrids of sunflower was generally accepted for the conditions of the Steppe of Ukraine. In spring, pre-sowing tillage consisted of early spring harrowing and one pre-sowing cultivation with simultaneous application of soil herbicide Harnes at a dose of 2.0 litres/ha. The depth of pre-sowing cultivation is 6-8 cm. The sowing depth of sunflower hybrids seeds is 6-8 cm. The term of sowing of sunflower hybrids is third decade of April.

The sunflower hybrids were sown at row spacing width of 70 cm. Plant stand density before harvesting is 50 thousand plants per hectare.

The care of sunflower crops included:

- harrowing after the emergence of sunflower sprouts;
- two inter-row cultivations of sunflower crops.

The species composition of weeds was established in a crop rotation with sunflower cultivation and in experiments to study the weediness of sunflower crops.

Inspection of the species composition of segetal weeds and pathways of weediness of sunflower crops was carried out using the route-expeditionary method. The abundance of weeds in agrocenoses was determined by a quantitative method.

The quantitative method for determining the weediness of crops was based on counting the number of weeds on the counting plots. When calculating, special frames with a size of 50 cm × 50 cm were used. The frames were superimposed in such a way that one of the crop sowing rows was its diagonal. After calculating the number of weeds within the framework, their average number was determined per one frame and with subsequent recalculation per 1 square meter. The degree of weediness of crops was determined on a scale (Table. 1).

Table 1. Scale for determining the degree of weed infestation

Weed quantity per 1 m^2	Weediness point	Weediness degree
1-5	1	very slight
6-15	2	slight
16-50	3	average
51-100	4	severe
more 100	5	very severe

Inspection of sunflower agrophytocenoses and counting the quantity of weeds was carried out at the beginning of the growing season (in spring), in summer in July; and at the end of the growing season (autumn).

The area of the sowing plot is 240 m^2, the registration area is 210 m^2. Experimental plots were placed in a randomized fashion in 4-fold repetition.

The experiment was set up with four replications according to the Randomized Blocks Trial Design, the statistical analysis of the obtained data was made in the according to the methods and statistical program (Aksyonov et. al., 2023; Dospekhov, 1985) and the Least Significant Difference (LSD) values.

Results

Observations to determine the composition of weeds in crop rotation fields showed that the species composition of weeds in agrophytocenoses was determined not only by natural conditions and the nature of anthropogenic impact, but also by the biological properties of crops used in crop rotation technologies.

During the research period, 78 types of weeds were found in crop rotations of the farm, which were assigned to 2 classes, 18 orders, 27 families, 62 genera (Table 2).

The class of Dicotyledonous (*Magnoliopsida*) weeds predominated in sunflower crops from growing weeds. The proportion of dicotyledonous weeds was 93.5-96.3%. The class of Monocotyledonous (*Liliopsida*) weeds accounted for 6.5-3.7%.

The weeds class of Dicotyledonous (*Magnoliopsida*), which grew in sunflower agrophytocenoses, included 26 botanical families of segetal species. Only one family belonged to the Monocotyledonous (*Liliopsida*) weed class.

The most quantity weed families by species composition included: Astereae (*Asteraceae*), Cabbage (*Brassicaceae*) (Table 3).

The families of weeds Astereae (*Asteraceae*) and Cabbage (*Brassicaceae*) in sunflower crops were represented by 18 and 9 species, respectively.

The families Labiate (*Lamiaceae*), Borage (Boraginaceae), Legume (*Fabaceae*) accounted for significantly fewer weed kinds. The family Labiate (*Lamiaceae*) had 6 species of weeds in sunflower crops, the family Borage (*Boraginaceae*), Legume (*Fabaceae*) – 4 species.

The less quantity of weed species – two each, accounted for the families Chenopodiaceae (*Chenopodiaceae*) and Euphorbiaceae (*Euphorbiaceae*).

The weeds of the Astereae family, having the highest percentage in the infestation of sunflower agrophytocenoses, were subdivided into three groups according to their species composition. Groups of weeds according to the species composition of weeds of this family were determined by the type of weediness in the crop rotation fields.

The first group of weeds growing in sunflower agrophytocenoses included: small-flowered quick weed (*Galinsoga parviflora Cav.),* common groundsel *(Senecio vulgaris L.)*, acantholeaf thistle (*Carduus acanthoides L.*), common thistle (*Cirsium vulgare (Savi) Ten*), bristly thistle (*Cirsium setosum (Willd) Bess),* creeping thistle (*Cirsium arvense (L) Scop.*).

The second group of weeds included: common chicory (*Cichorium intybus L.*), medicinal dandelion (*Taraxacum officinale Webb. Ex Wigg.*), yellow thistle (*Sonchus arvensis L.*).

The third group of weeds of the Astereae (*Asteraceae)* family, having a different species composition in sunflower agrophytocenoses, included: tartar lettuce *(Lactuca tatarica (L) C.A. Mey*), yellow thistle (*Sonchus arvensis L.*), ragweed (*Ambrosia artemisifolia L.*).

The first group of weeds of the family of Astereae (*Asteraceae)* had the most harmful effect on the yield of sunflower. With the same level of weed quantity of 1.7 pieces per 1 square meter, sunflower hybrids Dariy and Yason formed a minimum yield level of 1.77-1.79 t/ha in agrophytocenoses with the species composition of weeds of the first group (Figure 1).

In agrophytocenoses with the species composition of weeds of the second and third groups, a higher competitiveness of sunflower in relation to weeds was observed. In these agrophytocenoses, the hybrids formed the yield at the level of 1.87-1.90 t/ha.

In the agrophytocenoses of sunflower grown for plowing, the percentage of weeds of the Astereae (*Asteraceae)* family was 18.5-20.0% in relation to the total number of weeds of other families. Sunflower hybrids with such a number of weeds of this family for plowing formed a yield within 2.07-2.24 t/ha.

The use of moldboard-free tillage in the technology of sunflower cultivation led to an increase in the number of weeds of the family of Astereae (*Asteraceae)* by 10.0-12.0%, while reducing the yield of sunflower by 0.21-0.23 t/ha compared to the cultivation of sunflower by plowing (Table 4).

Table 2. Taxonomic composition of weeds in sunflower agrophytocenoses, (2014-2021)

Class	Family		Genus		Species	
	quantity, per 1 m^2	%	quantity, per 1 m^2	%	quantity, per 1 m^2	%
Dicotyledonous (*Magnoliopsida*)	26	96.3	53	93.5	73	95.0
Monocotyledonous (Liliopsida)	1	3.7	4	6.5	5	5.0
Total	27	100	62	100	78	100

* - difference is statistically significance from check at $P_{0.05}$

Table 3. Spectrum of weeds in sunflower agrophytocenoses by families, (2014-2021).

Botanical family	Quantity of species
Astereae (*Asteraceae)*	18
Cabbage *(Brassicaceae)*	9
Labiate (*Lamiaceae)*	6
Borage (*Boraginaceae)*	4
Legume (*Fabaceae)*	4
Ranunculaceae *(Ranunculaceae)*	3
Amaranthaceae (*Amaranthaceae)*	3
Chenopodiaceae *(Chenopodiaceae)*	2
Euphorbiaceae *(Euphorbiaceae)*	2

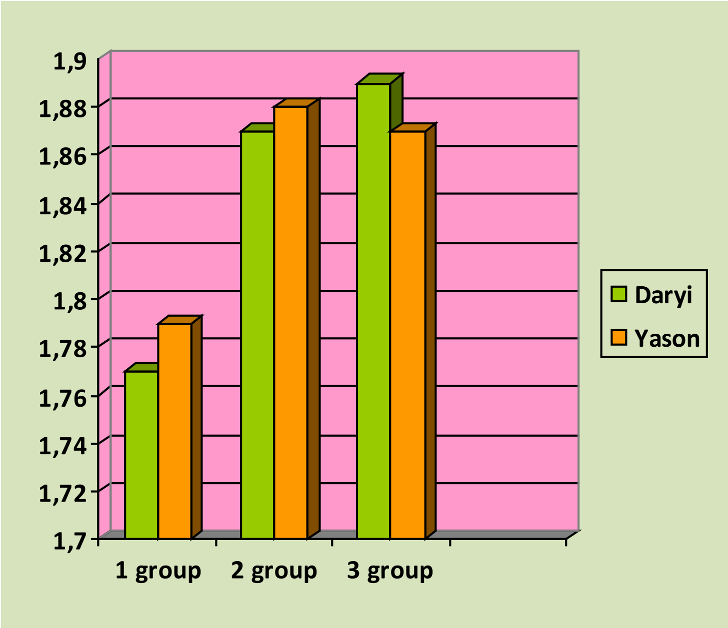

Figure 1. The yield of sunflower hybrids in agrophytocenoses with different species composition of weeds of the Astereae (*Asteraceae)* family (2014-2021).

Table 4. The quantity of weeds in sunflower crops by different methods of basic tillage (average for 2014-2021)

Method of basic tillage	Before harvesting sunflower		
	quantity of weeds per 1 m^2	air-dry weight of weeds, g/m^2	Yield, t/ha
agrocenosis of the hybrid Yason			
plowing (control)	2.1	4.9	2.24
non-moldboard tillage	5.4	14.2	2.11
agrocenosis of the hybrid Daryi			
plowing	2.3	4.8	2.07
non-moldboard tillage	5.5	14.1	1.86

Least Average Difference $(LMD)_{0.05}$ t/ha tillage of soil 0.07 hybrid 0.08

Discussion

Weed control in the agrophytocenoses of sunflower is one of the most important elements of growing technology, which makes it possible to obtain high yields of hybrids and varieties of this crop (Pannacci et al., 2007; Smatana et al., 2014).

Materials from scientific articles by researchers on this problem show that important weeds of the sunflower agrophytocenoses are as follows: Cirsium arvense (L.) SCOP, Elytrigia repens (L.) DESV, Chenopodium album L., Amaranthus retroflexus L., Chenopodium hybridum L., Sinapis arvensis L., Datura stramonium L., Echinochloa crus-galli (L.) P. BEAUV, Persicaria lapathifolia RAF. S. F. GRAY, Persicaria maculata RAF. S. F. GRAY, Fallopia convolvulus L. A. LOVE, Avena fatua L., Convolvulus arvensis L., Tripleurospermum perforatum (L.) SCHULTZ-BIP., Iva xanthiifolia (L.) NUTT., Galinsoga parfiflora CAV. (Kohout, 1993; Rapparini, 2006; Smatana et al., 2008).

Analysis of our results obtained during the examination of sunflower agrocenoses in the fields of field crop rotations showed that in the conditions of the Steppe of Ukraine, and other growing species of weeds were also identified in sunflower agrophytocenoses.

During the research, we observed a weed community in sunflower agrophytocenoses, composed of different species, density and abundance, which was typical of weed flora in the crop rotation fields of the Steppe zone of this region.

The most common were weeds that belonged to different families: bristle-grass green (*Setaria viridis (L.) Beauv*), bristle-grass gray (*Setaria Glauca (L.) Beauv*) – family of Gramineous (*Poaceae*); field pennycress (*Thlaspi arvense L.*), field mustard (*Sinapis arvensis L.*), wild radish (*Raphanus raphanistrum L.*), shepherd's purse (*Capsela bursa pastoris (L.)*), flixweed (*Descurainia sophia L.*) – family of Cabbage (*Brassicaceae*); white goosefoot (*Chenopodium album L.*). redroot (*Amaranthus retroflexus*), prostrate amaranth (*Amaranthus blitoides Wats.)* – family of Amaranth (*Amaranthaceae*) and different types of weeds of the *Asteraceae* family.

Weeds of the families Gramineous (Poaceae), Cabbage (Brassicaceae), of Amaranth (Amaranthaceae) had a less harmful effect on the formation of sunflower yields compared to weeds of the Astereae (Asteraceae) family. The introduction of soil herbicide harness (active ingradient – acetochlor) 2.5 l/ha for pre-sowing cultivation, carrying out pre- and post-emergence harrows, inter-row cultivation of sunflower crops ensured the suppression of weeds of families of Gramineous (Poaceae), Cabbage (Brassicaceae), of Amaranth (Amaranthaceae) by 80.0-90.0% for plowing and non-moldboard processing.

The introduction of soil herbicides did not ensure the suppression of weeds of the Asteraceae family in sunflower agrocenoses, which cause the greatest damage to crops and lead to a significant decrease in yield.

The suppression of weeds of the *Asteraceae* family during the preparation of the soil for sowing and during the growing season was possible only through the correct use of mechanical agricultural methods: pre-sowing cultivation, inter-row cultivation of sunflower crops.

In suppressing weeds in sunflower crops, the application of selective herbicides against weeds is an important agrotechnical technique for growing sunflower from an economic and environmental point of view (Elezovic et al., 1994; Kavdir, 2004).

When the our data obtained at the end of the research are evaluated, the effectiveness suppression of weeds in agrophytocenoses was predetermined by a set of agrotechnical techniques in the technology of growing of the sunflower hybrids.

The use of mechanical agricultural methods in the pre-sowing period and during the growing season ensures the suppression of weeds of the *Asteraceae* family only within 50.0-60.0%.

A higher efficiency of the use of agricultural practices was achieved with a late sowing period and the second inter-row tillage to a depth of 8.0-10.0 cm with hilling plants of sunflower in rows. The use of such a complex of agricultural methods in fields that are clogged forming suckers weeds of the Asteraceae family provides a yield increase of 24.7% compared to the use of agrotechnical methods: sowing sunflower at the recommended time and carrying out the second inter-row cultivation without hilling plants in rows.

Sunflower hybrids of early-ripening and mid-ripening groups turned out to be less competitive in relation to weeds of the first group of the Asteraceae family, which are represented by forming suckers species.

Compared with the weeds of the Asteraceae family of the second and third groups, the weeds of the first group of the same family had a more depressing effect on the growth and development of sunflower plants.

As reported by Smatana (2003), sunflower as a row crop, even at optimal density of plants, does not can compete with the weeds and suppress weeds.

Research conducted in 2014-2021 showed that in the conditions of the Steppe of Ukraine, the competitiveness of sunflower hybrids increased in relation to weeds and was determined by the ability of the each genotype to compete with weeds in the agrophytocenoses, the method the basic tilling, the number of weeds in the agrophytocenoses, the type of weeds.

Field inspection and yield records in the arid conditions of the eastern Steppe of Ukraine show that in the technology of growing sunflower hybrids in crop rotation fields, the early-ripening hybrid Yason, in comparison with the early-medium hybrid Daryi, has a greater competitive ability in relation to weeds of the *Asteraceae* family of the first and second groups.

With the same number of weeds, the first species group of the *Asteraceae* family formed a large vegetative mass in sunflower crops and, before harvesting hybrids, had a greater air-dry mass by 11.1 g/m compared to the weeds of the second and third groups of this family. An increase in the air-dry mass of weeds of the first group by 11.1 g/m^2 led to a decrease in yield in the early ripe hybrid Yason by 0.08-0.10 t/ha, in the early ripe hybrid Daryi by 0.10-0.13 t/ha.

In agrophytocenoses with the species composition of weeds of the second and third groups, a higher competitiveness of sunflower in relation to weeds was observed. In these agrophytocenoses, the hybrids formed the yield at the level of 1.87-1.90 t/ha.

Our research results are consistent with those reported by Papamichali et. al (2002). The decrease in competition with respect to weeds and the yield of sunflower hybrids depended on the species composition of weeds, the density population of the weed, the relative time of their appearance in agrophytocenoses.

If, according to the experiments of Pacanoski, Z. & Mehmeti (2021), Knezevic et. al. (2013), Stefanic et. al. (2023), the large broadleaf weeds Ambrosia artemisiifolia, Chenopodium album and Polygonum lapathifolium, that dominated throughout the experiment, had the greatest negative effect on sunflower yield, significantly suppressing the yield.

In the arid conditions of the Ukrainian Steppe, the first group of weeds small-flowered quick weed (*Galinsoga parviflora Cav.),* common groundsel *(Senecio vulgaris L.)*, acantholeaf thistle (*Carduus acanthoides L.*), common thistle (*Cirsium vulgare (Savi) Ten*), bristly thistle (*Cirsium setosum (Willd) Bess),* creeping thistle (*Cirsium arvense (L) Scop.*) contributed to the greatest reduction in the yield of sunflower hybrids.

Consequently, a multispecies community of weed has different effects on sunflower yield depending on the environmental factors.

Our research in a broader aspect confirms that the yield of sunflower hybrids depended on the species composition of weeds, conditions of environmental, the use the methods of basic tillage, crop care, the reaction of hybrids to growing conditions.

Weeds quickly inhabited sparse crops, plant-free parts of fields in the agrocenoses and formed optically dense sinuses together with agricultural plants. With a decrease in the density of standing sunflower plants to 35-30 thousand/ha in agrocenoses not only increased the clogging of crops by 7.0-11.0% compared to the optimal density of standing plants 40 thousand/ha, but new species of weeds appeared, belonging to the class Dicotyledonous (*Magnoliopsida*) - ragweed.

The basic element of sunflower cultivation technology is the method of basic tillage. Therefore, when developing agricultural method for growing sunflower, it is necessary to take into account the weediness of crops according to different methods of basic cultivation, and in particular, non-moldboard tillage.

A higher level of weediness of sunflower crops, with a predominance of weeds of the family of *Astereae* (*Asteraceae)*, was noted for non-moldboard tillage.

Compared to plowing, non-moldboard tillage did not provide a decrease in weediness of sunflower crops. The use of moldboard-free tillage led to an increase in the quantity of weeds in sunflower agrophytocenoses: by 157.1% in the crops of the early-ripening hybrid Yason and by 139.1% in the crops of the early-medium hybrid Daryi. The air-dry mass of weeds on nonmoldboard tillage increased in the crops of the Yason hybrid by 189.8%, in the crops of the Daryi s hybrid by 193.8%.

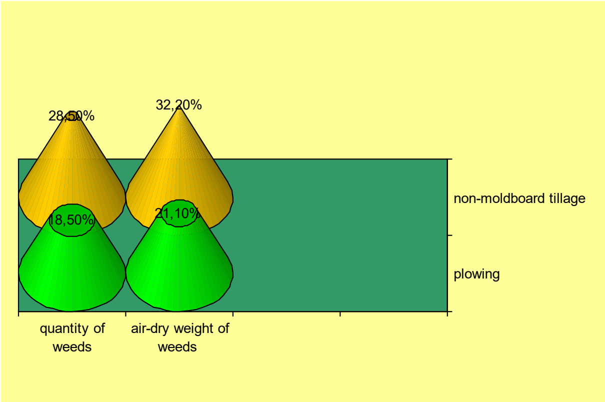

Figure 2. The percentage of weeds of the *Asteraceae* family to the total number of weeds in the agrophytocenosis of the sunflower hybrid Yason before harvesting, (average for 2014-2021).

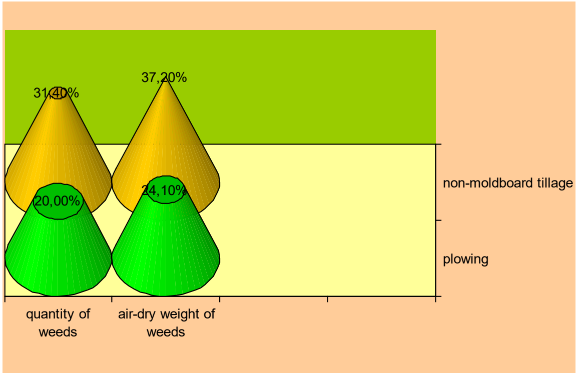

Figure 3. The percentage of weeds of the Asteraceae family to the total number of weeds in the agrophytocenosis of the sunflower hybrid Daryi before harvesting, (average for 2014-2021).

The proportion of weeds of the *Asteracea*e family to the total quantity of weeds in sunflower agrophytocenoses was 18.5 % (agrophytocenose of hybrid Yason) and 20.0% (agrophytocenose of hybrid Daryi) for plowing (Figure 2).

The use of non-moldboard tillage led to an increase in the quantity of weeds of the *Asteraceae* family in agrophytocenoses of hybrids. The proportion of weeds of the Asteraceae family to the total quantity of weeds in sunflower agrophytocenoses was 28.5 % (agrophytocenose of hybrid Yason) and 31.4% (agrophytocenose of hybrid Daryi) for non-moldboard tillage.

An increase in the number of weeds of the *Asteraceae* family led to an increase in the proportion of their air-dry to the total amount of air-dry mass of weeds in the agrophytocenosis before sunflower harvesting.

Before harvesting sunflower, the percentage of air-dry mass of weeds of the Asteraceae family in the agrophytocenosis of the Yason hybrid increased to 20.1% for plowing and up to 32.2% for non-moldboard tillage.

An increase in the number of weeds of the *Asteraceae* family by 10.0%, their share of air-dry mass to the total number of weeds in the agrophytocenoses of the Yason hybrid by 11.1% with non-moldboard tillage led to a decrease in the yield of the hybrid by 5.8%.

The percentage of air-dry mass of weeds of the Asteraceae family in the agrophytocenosis of the Daryi hybrid increased more significantly to 24.1% for plowing and up to 36.4% for non-moldboard tillage (Figure 3).

An increase in the number of weeds of the *Asteraceae* family by 11.4%, their share of air-dry mass to the total number of weeds in the agrophytocenoses of the Daryi hybrid by 13.1% with non-moldboard tillage led to a decrease in the yield of the hybrid by 10.1%.

This was one of the main factors in reducing the yield of sunflower hybrids with the use of non-moldboard tillage.

An increase in the number of weeds, including weeds of the *Asteraceae* family, led to a decrease in the yield of non-moldboard tillage in the Yason hybrid by 0.13 t/ha. In the Daryi hybrid, due to its low competitive ability in relation to weeds, the decrease in productivity for non-moldboard tillage was more significant - 0.21 t/ha.

At the same time, it should be noted that the hybrid Daryi refused to be less competitive in relation to the weeds of the *Asteraceae* family. In the agrophytocenoses of this hybrid, a large quantity of weeds of the *Asteraceae* family and a greater level of yield reduction were noted for both methods of basic tillage. The increase in the number of weeds of the *Asteraceae* family and their air-dry mass for non-moldboard tillage was the main factor in the decrease in yield by 0.21 t/ha.

With almost the same quantity of weeds in the agrofitocenoses of both hybrids for non-moldboard tillage, an increase in the percentage of air-dry mass of weeds of the *Asteraceae* family in the crops of the Daryi hybrid by 5.0%, compared with the crops of the Yason hybrid, led to the formation of the lowest level of productivity in this hybrid 1.86 t ha^{-1}. While at a percentage of the air-dry mass of weeds of the *Asteraceae* e family of 32.2% in the crops of the Jason hybrid, the hybrid formed a higher yield level for non-moldboard cultivation - 2.11 t/ha.

This shows that the Daryi hybrid in dry conditions has less competitive ability in relation to weeds than the Yason hybrid.

Conclusion

The research carried out made it possible to establish the species composition of weeds in the agrophytocenoses of sunflower grown in the conditions of the northern steppe of Ukraine. Studies have established that in sunflower agrophytocenoses, the dominant class of weeds is Dicotyledonous (*Magnoliopsida*). The largest quantity of weeds of the Dicotyledonous (*Magnoliopsida*) class growing in sunflower crops belongs to the families Astereae (*Asteraceae*), *Cabbage* (*Brassicaceae*).

Research has allowed us to establish and identify three species groups of weeds of the Astereae family (*Asteraceae*). In agrophytocenoses, the first group of weeds, which included: small-flowered quick weed (*Galinsoga parviflora Cav.),* common groundsel *(Senecio vulgaris L.)*, acantholeaf thistle (*Carduus acanthoides L.*), common thistle (*Cirsium vulgare (Savi) Ten*), bristly thistle (*Cirsium setosum (Willd) Bess),* creeping thistle (*Cirsium arvense (L) Scop.*), had the most significant and negative impact on the decrease in sunflower yield to the level of 1.77-1.79 t/ha.

The growth of weeds of the first group of the *Asteraceae* family in sunflower agrophytocenoses leads to a decrease in the yield of the early-ripening hybrid Yason by 0.08-0.10 t/ha, by the early-ripening hybrid Daryi by 0.10-0.13 t/ha.

The species composition of weeds depended on the type of weed infestation of crop rotation fields.

The level of yield reduction determined by sunflower was determined by the species composition of weeds, the methods of basic tillage, the competitive ability of hybrids to weeds in agrophytocenoses.

The use of plowing in the technology of sunflower cultivation made it possible to form a maximum yield of 2.07 t/ha for the Daryi hybrid and 2.24 Yason hybrid t/ha, providing more effective weed suppression in sunflower agrophytocenoses with a minimum percentage of air-dry mass of weeds of the Compositae family to the total number of weeds 21.1-24.1%.

The use of non-moldboard tillage, compared with plowing leads to an increase in the air-dry mass of weeds during non-moldboard tillage of 189.8-193.8%.

The increase in the percentage ratio in sunflower agrophytocenoses of the share of weeds of the Asteraceae family by 11.1-13.1% on non-moldboard tillage contributes to a decrease in yield in the early-ripening hybrid Yason per 0.13 t/ha, in the mid-ripening hybrid Daryi per 0.21 t/ha.

The sunflower hybrid Jason has a higher competitive ability in relation to weeds than the hybrid Darius.

In comparison with the agrophytocenoses of the Yason hybrid, in the agrophytocenoses of the Daryi hybrid, a large percentage of the air-dry mass of weeds of the *Asteraceae* family was noted by 3.0% for plowing, by 5.0% for non-moldboard tillage. An increase in the percentage of weeds of the *Asteraceae* family leads to a decrease in the yield of the Daryi hybrid by 0.17 t/ha for plowing, by 0.25 t/ha for non-moldboard tillage.

The level of yield reduction on non-moldboard tillage with an increase in weed infestation of the Asteraceae family in the Yason hybrid was 5.8%, in the Daryi hybrid - 10.1%.

Establishment of weediness of sunflower crops on the background of different methods of basic tillage has also practical consequences. Application of non-moldboard tillage will lead to an increase in the number of weeds in sunflower cultivation on the fields of crop rotations and especially weeds of the first group of small-flowered quick weed (Galinsoga parviflora Cav.), common groundsel (Senecio vulgaris L.), acantholeaf thistle (Carduus acanthoides L.), common thistle (Cirsium vulgare (Savi) Ten), bristly thistle (Cirsium setosum (Willd) Bess), creeping thistle (Cirsium arvense (L) Scop.), which have a strong negative impact on the yield of sunflower hybrids. On fields with a large number of weeds and their air-dry mass it is recommended to grow sunflower hybrid Yason.

Declarations

The author declares no conflict of interest in the design, collection, writing of manuscript and decision to publish this work.

References

Adamenko, T. (2005). Prospects for sunflower production in Ukraine in the in conditions of climate change. *Agronomist*, 1, 12-14.

Aksyonov Igor. (2003). Yield of sunflower on black steppe soil of Ukraine. *Helia*, 26 (39), 161-166.

Aksyonov, I. V., Evtushenko, G., O., Matsai N. Yu., Korzhova, N. O. & Aksyonova I. I. (2023). *Methods for statistical analysis of the results of scientific research in in crop production (textbook)*. Poltava: Luhansk National University named after Taras Shevchenko, 178 p.

Dospekhov, B. A. (1985). *Methods of field experience*. Moscow: Kolos, 351 p.

Gavrilyuk, Yu. V. & Aksyonov, I. V. (2013). The level of harmfulness of weeds and the yield of sunflower cenoses in the conditions of the northern steppe of Ukraine. *Science-Technology Bulletin for the Institute of Olseed crops of the NAAS*, 19, 78-83.

Bazdyrev, G. I., Loshakov, V. G., Pupovin, A. I., Rassadin, A. Ya. (2004). *Zemledelie*. Moscow, Kolos.

Boyko, M. G. (2008). Protection of sunflower crops from weeds. *Corn*, 4, 44.

Elezovic, I., Datta. A., Vrbnicanin, S., Glamoclija, D., Simić, M., Malidza, G., Knezevic, S. Z. (2012) Yield and yield components of imidazolinone-resistant sunflower (Helianthus annuus L.) by pre-emergence herbicide and time of post-emergence weed removal. *Field Crops Research*, 128 (3), 137–146. DOI: http://dx.doi.org/10.1016/j.fcr.2011.12.020.

Grigora, I. M. & Solomakha, V. A. (2000). *Fundamentals of phytocenology*. Kiev, Phitosotsiotsentr.

Kavdir, I. (2004) Discrimination of sunfower, weed and soil by artificial neural networks. *In Computers and Electronics in Agriculture*, 153-160. DOI: http://dx.doi.org/10.1016/j.compag.2004.03.006.

Knezevic, S.Z., Elezovic, I., Datta, A.; Vrbnicanin, S., Glamoclija Dj Simic, M., Malidza, G. (2013). Delay in the critical time for weed removal in imidazolinone-resistant sunflower (*Helianthus annuus*) caused by application of pre-emergence herbicide. *Int. J. Pest Manag.*, 59, 229-235.

Kohout, V. (1993). *Weed Control of Field*. Praha: Ministry of Agriculture.

Kosolap, M. P. 2004. *Herbology.* Kiev, Aristey.

Kott, S. A. (1964). *Weed plants and the struggle against them*, Moscow, Rosselkhosizdat.

Lapenko, V. P., Luchinskyi, S. I. (2007). Harmfulness of cereal weeds in sunflower crops. *4th International Conference of Young Scientists and Specialists "Topical Issues of Breeding, Technology and Processing of Oilseeds", dedicated to the 95th anniversary of the founding of VNIIMK, March 27-29, 2007, Krasnodar.* Krasnodar, VNIIMK, 150-152.

Maysuryan, N. A. & Atabekov, A. I. (1973). *Qualifier to seeds and fetus of weeds*. Moscow, Kolos.

Pacanoski, Z. & Mehmeti, A. (2021). Weed control in sunflower (*Helianthus annuus* L.) with soil-applied herbicides affected by a prolonged and limited rainfall. *Poljoprivreda*, 27, 3-14.

Pakhnits, V. M. & Dranishchev, M. I. (2001). Productivity of sunflower biotypes maturing at different times, depending on plant density. *Miscellany of scientific papers of LSAU*, 11 (23), 81-83.

Pannaci, E., Graziani, F. & Covarelli, G. (2007). Use of herbicide mixtures for pre and postemergence weed control in sunflower (Helianthus annuus L.). Crop Protection, 26 (8), 1150-1157. DOI: http://dx.doi.org/10.1016/j.cropro.2006.10.008.

Papamichali, D., Eleftherohorinos, I., Froud-Willians, R. Gravanis, F. (2002). Critical periods of weed competition in cotton in Greece. *Phytoparasitica*, 30, 105–111.

Phisyunov, A. V. (1983). *Methodical recommendations for taking into account weediness of crops and soil in field experiments*. Kursk.

Rapparini, G. (2006) Preventive weed control in sunflower. L´Informatore Agrario, 62 (10), 44–49.

Smatana, J. (2003). Actual weed infestation of sunflower in Slovak Republic and their influence by forecrops. *Sustainable agriculture and rural development*. Nitra: SPU in Nitra, 276–278.

Smatana, J., Macak, M. & Vereš, T. (2008) Effect od forecrop on weed infestation of Helianthus annuus in the Slovak Republic. Lucrari Stiintifice, 40 (1), 489-492.

Smatana Jozef, Macák Milan & Ernst David. (2014). Weed control in sunflower (Helianthus annuus L.) on the interface of agro-climatic conditions of maize and sugar beet growing region. *Acta fytotechnica et zootechnica*. 17 (04), 115-121. DOI:10.15414/afz.2014.17.04.115-121.

Stefanic, E., Rasic, A., Lucic, P., Zimmer, D., Mojic, A., Antunovic, S., & Japundzic-Palenkic, B., Lukacevic, M., Zima, D. & Stefanic, I. (2023). The Critical Period of Weed Control Influences Sunflower (*Helianthus annuus* L.) Yield, Yield Components but Not Oil Content. Agronomy, 13 (8). Doi.org/10.3390/agronomy13082008.

Tatariko, Yu. O., Nesmashna, O. E. & Glushchenko L. D. (2001). *Energy Evaluation of systems of husbandry and crop growth technologies: methodical directions*. Kiev, Nora-Print.

Veselovskyi, I. V., Manko, Yu. P. & Kozubskyi, O. B. (1993). Directory on weeds. Kiev, Urozhayi.

Zakharenko, A. V. (1996). The relationship between the components of agrophytocenosis and weed control. *Zemledelie*, 6, 42-43.

Zakharenko, A. V. (1996). Energy evaluation of weed control methods. *Zemledelie*, 1, 41.