KnE Life Sciences

DonAgro
International research conference on Challenges and Advances in Farming, Food Manufacturing, Agricultural Research and Education
Volume 2021

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Conference Paper

Results of Studying the Efficiency of Chemical Measures Against Weed Vegetation in Sunflower Crops

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Abstract

This study identified the most effective methods for protecting sunflowers from weeds through the treatment of crops with the herbicides Euro Lightning, Euro Lightning Plus and Express. These options provided substantial protection of sunflowers from weeds such as the cursed thistle, field bindweed, yellow bristle grass, field mustard, frost blite and redroot pigweed. In the fight against ragweed, the herbicides Euro Lightning and Euro Lightning Plus provided excellent action and the herbicide Express provided good results. Variants with the use of the soil herbicides Gezagard and Gardo Gold suppressed yellow bristle grass, field mustard and frost blite, and satisfactorily protected against redroot pigweed. However, they were ineffective against perennial species of weeds (cursed thistle and field bindweed) and ragweed growing in the experimental area. The application of soil herbicides did not influence the growth of sunflower broomrape and plots. The use of the herbicides Euro Lightning and Express helped to reduce the contamination of crops with this type of weed. When processing crops with the herbicide Euro-Lightning Plus, this type of weed was completely absent. Statistical processing of crop data showed a difference in yield in the studied variants. Carrying out weed control measures significantly increased the yield of sunflowers in comparison to control options (without treatment). There was a significant difference in the yield of oilseeds when herbicides intended for application on vegetating plants (Euro Lightning and Express) were used, compared to when the variants of soil herbicides Gezagard and Gardo Gold were used.

Keywords: sunflower, weed plants, herbicides, oilseed productivity

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Published: 5 April 2021

Publishing services provided by Knowledge E

Selection and Peer-review under the responsibility of the DonAgro Conference Committee.

1. Introduction

Sunflower is a leading technical crop in the southern regions of the Russian Federation. Sustainable demand and relatively high purchase prices will further stimulate its cultivation. Therefore, increasing the production of oilseeds of this crop by increasing

productivity is the most important task of any production [1]. At the same time, the average yield of sunflower oilseeds in farms of all categories still remains at a relatively low level, on average, not exceeding 10-14 kg/ha, and it is planned to increase it to 18 kg/ha only by 2020 [2]. Experts explain the low yield of sunflower by the violation of the technology of cultivation of sunflower, in particular by the wrong choice of variety or hybrid and the lack of effective control of weeds [3–5]. In this regard, the main objective of the research was to evaluate the effectiveness of various herbicides in weed control in the cultivation of sunflower.

2. Methods and Equipment

Studies on the effectiveness of chemical measures to control weeds in sunflower crops were carried out in 2017-2018 in the APC "50 Let Oktyabrya". Land use of the cooperative is located in the Neklinovsky district of the Rostov region.

The soils of the research site are represented by southern chernozems of various mechanical composition and varying degrees of erosion. The thickness of horizons A + B1 + B2 is an average of 62 cm. The average humus content in the arable layer of the soil is 3.79%, with a sharp decrease in depth. The reaction of the soil solution in the upper horizons is pH 7.4-7.7. The availability of soils with mobile forms of phosphorus is low and medium, with increased potassium exchange [6].

The Neklinovsky district is characterized by an arid insufficiently hot climate. During the period of active vegetation of agricultural crops, accumulates 3000-3200 °C; the frost-free period lasts 165-175 days. The average annual air temperature is +9.2 °C, the absolute maximum temperature is + 37 °C, the absolute minimum is –32 °C. The average annual rainfall is 487 mm, the average daily maximum is 144 mm [7].

Weather conditions during the years of research differed sharply from mean annual values. Thus, the temperature regime was significantly exceeded in comparison with long-term average values, but conditions were especially unfavorable from this point of view during the period of sunflower vegetation. Simultaneously with elevated temperatures, a significant shortage of precipitation was observed, leading to soil and air droughts. These weather conditions sharply negatively affected the productivity of all crops, including sunflower hybrids, grown in the experiment and led to low yields significantly inferior to the crop potential.

As an object of research we used sunflower hybrids of leading manufacturers on the Russian market and occupying large areas in the zone - Kondi (designed for cultivation using classical technology), Neoma (designed for the Clearfield production system),

Paraizo 1000 (designed for the Clearfield Plus system), P64LE25 (adapted to ExpressSun system). The experimental design included nine options (Table 1).

Table 1: Scheme of experience

Pos.	Variant / Hybrid	Consumption rate [l/ha,kg/ha]	Application Dates
1	Untreated / Kondi (c)	-	-
2	Gezagard / Kondi	3.5	spraying the soil without introducing the herbicide before germination of sunflower
3	Gardo Gold / Kondi	4.0	spraying the soil without introducing the herbicide before germination of sunflower
4	Without treatment / Neoma (v)	-	-
5	Euro Lightning / Neoma	1.2	spraying in the phase of 4-6 sunflower leaves
6	Untreated / Paraizo 1000 (c)	-	-
7	Euro-Lightning Plus / Paraizo 1000	2.5	spraying in the phase of 4-6 sunflower leaves
8	Without treatment / P64LE25 (v)	-	-
9	Express / P64LE25	0.03	spraying in the phase of 4-6 sunflower leaves

As control options no processing was used. The experience was organized with 4-fold repetition. Allocation of plots was consistent. The accounting area of the experimental plot was 196 m^2.

Soil herbicides Gezagard at a dose of 3.5 l/ha and Gardo Gold at a dose of 4 l/ha and herbicides intended for introduction on vegetative plants on hybrids resistant to these herbicides were used as chemicals for weed control in sunflower crops: Lightning at a dose of 1.2 l/ha, Euro-Lightning Plus at a dose of 2.5 l/ha and Express at a dose of 0.03 kg/ha.

The predecessor in the experiment was winter wheat. The main elements of the technology for growing sunflower corresponded to the zonal recommendations for the Azov zone of the Rostov region.

All necessary counts and observations were carried out according to the Methodology of state variety testing of agricultural crops [8].

Accounting for sunflower yield was carried out by the method of continuous harvesting.

The data on the yield of oilseeds of sunflower in the experiment were processed by the method of variance analysis according to B.A. Dospekhov. [9].

3. Results

For the development and implementation of the most optimal system of measures for weed control, as well as for monitoring the effectiveness of the various methods used, it is necessary to have information on the composition of the weed component of agrophytocenoses in each field of crop rotation according to the types of weed-field vegetation, bio-groups and the degree of weediness. Analysis of the data obtained over the years and comparing them with agricultural technology allows the best methods for the elimination of weeds in local conditions to be established [10].

Over 100 species of harmful organisms can cause direct damage to the formation of elements of the structure of the sunflower crop to one degree or another during the entire growing season [11]. A thorough study of the morphological and biological characteristics of weeds allows justifying the most effective strategy for controlling them. As S.I. Luchinsky notes [12], the coefficient of harmfulness of weeds growing in sunflower crops is not constant and depends on the degree of weediness (number of weeds per m^2), the type of weeds clogging the crops and the botanical and biological characteristics of the crop (height of sunflower plants, leafiness of the stem, growth rate stems in the early phases of the growing season, the duration of the growing season). In his opinion, the economic threshold for severity when sunflower is clogged with dicotyledonous weeds, when the ratio of prices for sunflower oil seeds, fuels and lubricants and the main herbicides used in this crop is 21.4-23.8 pcs/m^2, depending on the botanical and biological characteristics of the variety (hybrid). For ragweed, one of the most harmful weeds in sunflower crops, the economic threshold for severity is 5.5–8.4 pcs/m^2. With weediness of crops by cereal weeds, the economic threshold for harmfulness in sunflower is in the range of 16.0-17.3 pcs/m^2. At the same time, he clarifies that if hybrids are grown, then the maximum weediness limit will be 17.3 pcs/m^2, and if varieties are cultivated, the economic threshold of harmfulness rises to 22.9 pcs/m^2 and associates this with the ability of varieties to better resist the negative impact of this component of agrophytocenosis [13].

According to P.A. Saskevich et al. [11] the economic thresholds for harmfulness are lower and correspond to 18 pcs/m^2 in total, for non-perennial weeds, and 2-5 pcs/m^2 for perennial ones.

In any case, all measures for the destruction of weeds in sunflower crops should be carried out no later than 4 weeks after seedlings. The longer presence of weeds in sunflower crops leads to daily seed yield losses of up to 31.4 kg/ha [12].

During the years of research, the composition of weeds in the experimental plot was represented by both perennial (cursed thistle, field bindweed) and annual (yellow bristle grass, field mustard, frost blite, redroot pigweed, ragweed) varieties.

According to the results of the survey, it was found that the total number of weeds per unit area was 20.1 pcs/m2, of which perennial species are 0.9 pcs/m^2, including the cursed thistle (0.1 pcs/m^2), field bindweed (0.8 pcs/m^2); annual species are 19.2 pcs/m^2, including yellow bristle grass (5.1 pcs/m^2), field mustard (6.4 pcs/m^2), frost blite (3.3 pcs/m^2), redroot pigweed (1.2 pcs/m^2), ragweed (3.2 pcs/m^2).

Targeted weed control over the past few years under farm conditions has significantly improved the phytosanitary situation on the fields of the enterprise, but nevertheless, the economic threshold of harmfulness still exceeds the regulatory requirements for growing sunflower and requires measures to destroy the weed component in the crops of this crop.

When carrying out plant protection measures, it is necessary to calculate the effectiveness of this or that technique. Efficiency was determined by determining the reduction in the number of harmful objects as a result of the measures taken in percentage terms.

The test results made it possible to identify the following most effective variants for protecting sunflower from weeds: treating crops with Euro-Lightning, Euro-Lightning Plus and Express herbicides on hybrids resistant to these drugs.

These variants provided almost complete protection of sunflower from such weeds as cursed thistle, field bindweed, yellow bristle grass, field mustard, frost blite and redroot pigweed—the action is excellent (death of more than 80%) (Table 2). Against ragweed, the preparations Euro-Lightning and Euro-Lightning Plus demonstrated excellent protection, the preparation Express demonstrated good results (60-80% of death).

Variants with the use of soil herbicides Gezagard and Gardo Gold suppressed well the yellow bristle grass, field mustard and frost blite (good effect (60-80% death)) and suppressed satisfactorily redroot pigweed (40-59% death), but were ineffective against perennial weed species (cursed thistle and field bindweed) and ragweed growing in the experimental plot—the effect was weak or absent (death less than 40%).

Among the weeds found in sunflower crops, a special place is occupied by sunflower broomrape. This widespread and extremely harmful on sunflower parasite constantly mutates; new, previously unknown races appear, as a result, even resistant hybrids and varieties are affected, especially where crop rotation is disturbed. Due to the high degree of harmfulness, the yield of sunflower infected with broomrape decreases from 14 to 75%, or complete death of cultivated plants occurs [14]. It is noted that preventive and agrotechnical measures alone are not enough, and today one of the most effective

Table 2: Effectiveness of weed control measures

Weed plants	Variant				
	Gezagard (3.5 l/g)	Gardo Gold (4 l/ha)	Euro-Lightning (1.2 l/ha)	Euro-Lightning Plus (2.5 l/ha)	Express (0.03 kg/ha)
Cursed thistle	-	-	xxx	xxx	xxx
Field bindweed	-	-	xxx	xxx	xxx
Yellow bristle grass	xx	xx	xxx	xxx	xxx
Field mustard	xx	xx	xxx	xxx	xxx
Frost blite	xx	xx	xxx	xxx	xxx
Redroot pigweed	x	x	xxx	xxx	xxx
Ragweed	-	-	xxx	xxx	xx

Legend of the actions: xxx - excellent (fatality is more than 80%); xx - good (fatality is 60-80%); x - satisfactory (fatality is 40-59%); - - weak or absent (fatality is less than 40%)

ways to combat broomrape species is the chemical control method, the essence of which is the use of herbicides [15].

Studies have shown that the use of the herbicide Euro-Lightning Plus can be considered as the most effective method in the fight against broomrape (Table 3). When processing crops with this herbicide, this type of weed plant was completely absent in this variant.

Table 3: The weediness of sunflower crops by broomrape sunflower according to the options of experience

Variant / Hybrid	Number of broomrape plants [pcs]*	Mass of broomrape plants [g]*	Average weight of 1 broomrape plant [g]
Untreated / Kondi (C)	2.25	11.07	4.92
Gezagard (3.5 l/ha) / Kondi	2.50	12.14	4.86
Gardo Gold (4.0 l/ha) / Kondi	2.00	9.60	4.80
Without treatment / Neoma (c)	2.50	12.16	4.86
Euro-Lightning (1.2 l/ha) / Neoma	0.50	1.27	2.54
Untreated / Paraizo 1000 (c)	2.00	10.20	5.10
Euro-Lightning Plus (2.5 l/ha) / Paraizo 1000	0.00	0.00	0.00
Without treatment / P64LE25 (c)	2.25	11.77	5.23
Express (0.03 kg/ha) / P64LE25	0.75	2.26	3.01

* - accounting for the entire area of the experimental plot

On untreated variants (control), the number of broomrape plants in the plot varied, depending on the hybrid grown, from 2.00 to 2.50 pcs, and the average weight of 1 broomrape plant was the largest and amounted to 4.86-5.23 g.

The use of soil herbicides had practically no effect on the development of broomrape plants: the number of broomrape plants in these variants was 2.00-2.50 pcs/plot, the average weight of 1 plant was 4.80-4.86 g.

The use of Euro-Lightning and Express herbicides helped to reduce the clogging of crops with this type of weed plant. The number of broomrape plants in these experimental variants varied from 0.5 to 0.75 pcs/plot, the average weight of 1 broomrape plant varied from 2.54 to 3.01 g.

Productivity is one of the most important characteristics of the effectiveness of a particular technique or element of a technology.

The yield of oilseeds of sunflower according to the options of the experiment are presented in Table 4.

Table 4: Productivity of oilseeds of sunflower

Variant / Hybrid	Productivity [t/ha]	deviation vs. control	
		±t/ha	± %
Untreated / Kondi (C)	0.61	-	-
Gezagard (3.5 l/ha) / Kondi	1.71	+ 1.10	+ 280.3
Gardo Gold (4.0 l/ha) / Kondi	1.79	+ 1.18	+ 293.4
Without treatment / Neoma (c)	0.62	-	-
Euro-Lightning (1.2 l/ha) / Neoma	2.11	+ 1.49	+ 340.3
Untreated / Paraizo 1000 (c)	0.50	-	-
Euro-Lightning Plus (2.5 l/ha) / Paraizo 1000	1.82	+ 1.32	+ 364.0
Without treatment / P64LE25 (c)	0.74	-	-
Express (0.03 kg/ha) / P64LE25	2.27	+ 1.53	+306.7
LCD_{05}	0.10		

Statistical processing of yield data showed the presence of mathematically proven differences in yield on the studied options. Carrying out weed control measures significantly increases the yield of sunflower in comparison with the control options (without treatment).

A significant difference was found in the oilseed yield level when applying the herbicides intended for application to vegetating plants (Euro-Lightning and Express), in comparison with the variants with soil herbicides Gezagard and Gardo Gold.

The maximum oilseed yield was 2.27 t/ha, significantly exceeding the level of the rest of the studied hybrids was noted in the variants with the application of the Express herbicide at a dose of 0.03 kg/ha on the crops of the P64LE25 hybrid.

4. Discussion

The studies established the high efficiency of the application of herbicides intended for application to vegetative plants—Euro-Lightning, Euro-Lightning Plus and Express—in

the fight against weeds and broomrape in sunflower crops. The use of these drugs in the studied doses made it possible to obtain crops almost pure from weeds and contributed to a significant increase in the level of crop productivity.

5. Conclusion

In order to increase the efficiency of production of sunflower oilseeds, agricultural enterprises are recommended to carry out chemical protection of crops from clogging. It is preferable to use chemicals designed for application to vegetative plants on hybrids resistant to these drugs: Express (0.03 kg/ha) and Euro-Lightning (1.2 l/ha). Processing is carried out in the phase of four real leaves in sunflower.

Acknowledgement

The authors would like to thank their colleagues for their contribution and support to the research. They are also thankful to all the reviewers who gave their valuable inputs to the manuscript and helped in completing the paper.

Conflict of Interest

The authors have no conflict of interest to declare.

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