BIOLOGICAL EFFECTIVENESS OF HERBICIDES WITH ACTIVE INGREDIENT GLYPHOSATE APPLIED IN THE FIELD AFTER CROP HARVESTING

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Abstract

The paper presents a study on the biological effectiveness of two herbicides, having as active ingredient the glyphosate, against annual and perennial weeds in the field after winter wheat harvest. The experimental variants against the annual weeds were the following: the Control (1) – no herbicides, the herbicide Glyphogan 480 SL in a dose of 2.0 l/ha, and the herbicide Superklin 480 SL in the dose of 2.0 and 4.0 l/ha, respectively. The experimental variants against annual and perennial weeds were the following: the Control (2) – no herbicides, the herbicide Glyphogan 480 SL in a dose of 8.0 l/ha, and the herbicide Superklin 480 SL in the doses of 5.0 and 6.0 l/ha. There were determined 15 weed species on the experimental plots including two species of annual monocotyledonous weeds, 10 species of dicotyledonous weeds and 3 species of perennial dicotyledonous weeds. The degree of weed control based on the amount of weeds ranged from 92.2 to 100% compared with the control variant. The degree of weed control based on the green biomass of weeds ranged from 75.2 to 100% in all variants. The degree of weed control based on the dry biomass of weeds ranged from 79.0 to 100% in all variants. The studied herbicides showed a high biological effectiveness against annual weeds ranging from 87 to 100% and against perennial weeds ranging from 84 to 100%.

Key words: Annual weeds, Biological effectiveness, Glyphosate, Perennial weeds.

Annually, in The Republic of Moldova, half a million hectares of cereal crops is sown. Traditionally, after crop harvesting, the soil is tilled using the early tillage system or late tillage system. One of the main objectives of these systems was weed control and, especially, the control of perennial weeds. Due to the discovery of the active ingredient glyphosate, in 1970, global agriculture had the opportunity to control weeds by cheaper and more convenient means. Glyphosate and its salts have been described for the first time as herbicides in 1971 (Baird, D.D. and others, 1971). Also, in 1971, the glyphosate (Roundup) was registered for use on several crops and non-agricultural land in the United States, Canada and many other countries (Mullison, W.R. and others, 1979). In 2000, "Monsanto" company's patent to produce the active ingredient glyphosate expired and many companies in the world started to produce glyphosate. Currently, according to the "State Register of plant protection products and fertilizers allowed for use in the Republic of Moldova", 2012 edition, 30 commercial products with active ingredient glyphosate are permitted for use in the country. The purpose of researches carried out in 2011 was the study the biological effectiveness of the herbicide Superklin 480 SL (a. i. glyphosate, isopropylamine salt, 480 g/l) to control the monocotyledonous and dicotyledonous annual and perennial weeds on the fields after crop harvesting in the central part of the Republic of Moldova.

MATERIAL AND METHOD

Field researches, destined to assess the biological effectiveness of Superklin 480 SL herbicide, were carried out in the field of the Didactic Experimental Station "Chetrosu" of SAUM (State Agrarian University of Moldova), Anenii Noi district, located in the center of the country. The experimental plots are situated on a land with poor northwest exhibition. The soil consists of a strongly developed sandy-loam calcareous chernozem on a layer of loess. Weather conditions in the year of study were at the level of the average annual distribution of precipitations and air temperature. It should be noted that, for the conditions of experience, i.e. determining the biological effectiveness of the herbicide Superklin 480 SL with active ingredient glyphosate, the ideal conditions are established when the sufficient rainfall is provided. The experiments were accomplished on three repetitions in a crop rotation

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system with eight fields after winter wheat harvesting. The variants of the experience designed to determine the biological effectiveness of the herbicide Superklin 480 SL against monocotyledonous and dicotyledonous weeds were the following: Control (1) - (no herbicides), herbicide Glyphogan 480 SL (standard) - 2.0 l/ha, herbicide Superklin 480 SL - 2 l/ha, herbicide Superklin 480 SL - 4,0 l/ha. The variants of the experience designed to determine the biological effectiveness of the herbicide Superklin 480 SL against annual and perennial monocotyledonous and dicotyledonous weeds were as follows: Control (2) - (no herbicide), herbicide Glyphogan 480 SL (standard) - 8.0 l/ha, herbicide Superklin 480 SL – 5 l/ha, herbicide Superklin 480 SL- 6,0 l/ha. The dosage of the herbicide is shown on the commercial product. Plot size was of 37.5 m^2. Herbicides were applied by spraying the weeds with herbicide solution using a manual sprinkler in the intensive period of weed growth - on August 19, 2011. The amount of solution per plot was calculated according to the ratio of 253 liters of solution per hectare. Weed species were determined using the indicator from "The Arable Weeds of Europe with Their Seedlings and Seeds" author Martin Hanf, edition of 1983. Determination of the biological effectiveness of the herbicide was performed according to the State Center Methodology described in the «The methodical guidelines for testing chemical and biological products to protect plants from pests, diseases and weeds in the Republic of Moldova», edition of 2002.

RESULTS AND DISCUSSIONS

In order to determine the biological effectiveness of the herbicides, there were carried out three records of weed control in the experiments. First record - before applying the herbicides, was marked on August 19, 2011. The second - 25 days after the application of herbicides. The third - 40 days after the application of herbicides. During the period of intensive growth of weeds there were determined 15 species of weeds, which cover four biological groups: annual monocotyledonous, annual dicotyledonous, biennial dicotyledonous and perennial dicotyledonous weeds. The biological group of annual monocotyledonous weeds included the yellow foxtail (*Setaria glauca* (L.) Beauv) and witchgrass (*Panicum capillare L.*). The biological group of annual dicotyledonous weeds included the lambsquarters (*Chenopodium album* L.), redroot pigweed (*Amaranthus retroflexus* L.), common ragweed (*Ambrosia artemisiifolia* L.), cannabis *(Cannabis ruderalis* Janisch.*),* flower-of-an-hour (*Hibiscus trionum* L.*),* chickweed (*Stellaria media* (L.) Vill.*),* common knotgrass (*Polygonum aviculare* L.*),* black nightshade (*Solanum nigrum* L.) and red chickweed (*Anagalis arvensis* L.). The biological group of biennial dicotyledonous included only one species - yellow sweet clove (*Melilotus officinalis* (L.) Pall.). The biological group of perennial dicotyledonous weeds included the birthwort *(Aristolochia clematitis* L.), Canada thistle *(Cirsium arvense* L.) and field bindweed *(Convolvulus arvensis* L.). The results of the first record showed that total amount of weeds in the variants studying the biological effectiveness against annual weeds was at the level of 344.1 - 396.6 weeds/m^2. In the variants studying the biological effectiveness against perennial weeds this indicator was at the level of 250.7- 297.8 weeds/m^2. The degree of weed control based on the amount of weeds in the variants with herbicides compared to the Control variant ranged from 92.2 to 100% (Table 1). The degree of weed control based on the green biomass of weeds in the variants with herbicides compared to the Control variant ranged from 75.2 to 100%. The degree of weed control based on the dry biomass of weeds in the variants with herbicides compared to the Control variant ranged from 79.0 to 100%. The degree of weed control based on the amount of weeds, green biomass and dry biomass of weeds on the surface of one square meter was more pronounced in the variants studying the biological effectiveness of herbicides against monocotyledonous and dicotyledonous perennial weeds because herbicide doses were double compared with the variants studying the biological effectiveness of herbicides with the active ingredient glyphosate against annual weeds. Table 2 presents data on the degree of control of the most widespread weeds in the experiment. Out of 15 weed species found in the field, only seven species were found in all variants of the experiment, therefore, the conclusions about the degree of weed species control is based on data obtained from these species. During the first record and before applying the herbicides, the degree of weed infestation in the experiment varied depending on the species and variants of experiment. In the variants studying herbicides effect against annual weeds, the degree of infestation with yellow foxtail ranged between 258 and 287 weeds/m^2, with lambsquarters ranged between 70 and 87 weeds/m^2, with redroot pigweed between 1 and 15 weeds/m^2, with common ragweed ranged between 3 and 6 weeds/m^2 and with cannabis ranged between 1 and 4 weeds/m^2. In the variants studying herbicides effect against annual and perennial weeds before applying herbicides, during the first record, the degree of infestation with yellow foxtail ranged between 105 and 137 weeds/m^2,

Table 1

Effectiveness of herbicides with glyphosate as active ingredient depending on the applied doses

Variants of experiments, records, dose of herbicide	Number of weeds/m^2	Degree of control, % (based on the number of weeds)	Green mass of weeds, g/m^2	Degree of control, % (based on the green mass of weeds)	Dry mass of weeds, g/m^2	Degree of control, % (based on the dry mass of weeds)
Control (1), no herbicide						
2nd Record	238,6	-	457,3	-	229,6	-
3rd Record	257,1	-	398,8	-	297,4	-
Glyphogan 480 SL 2,0 l/ha						
2nd Record	18,4	92,2	103,5	75,2	48,3	79,0
3rd Record	12,6	95,1	7,9	98,0	4,2	98,0
Superklin 480 SL 2,0 l/ha						
2nd Record	10,9	95,4	70,0	84,7	37,2	83,7
3rd Record	9,6	96,3	12,9	96,8	9,7	96,8
Superklin 480 SL 4,0l/ha						
2nd Record	1,7	99,2	11,3	97,5	5,9	97,4
3rd Record	0,9	99,6	3,2	99,2	2,0	99,0
Control(2) no herbicide						
2nd Record	260,2	-	392,8	-	184,4	-
3rd Record	257,4	-	385,4	-	202,0	-
Glyphogan 480 SL 8,0 l/ha						
2nd Record	8,9	96,6	10,0	97,4	3,3	98,2
3rd Record	0	100	0	100	0	100
Superklin 480 SL 5,0 l/ha						
2nd Record	6,6	97,5	17,8	95,5	7,0	96,2
3rd Record	8,0	96,9	6,6	98,3	3,9	98,1
Superklin 480 SL 6,0 l/ha						
2nd Record	3,4	98,7	2,8	99,3	1,2	99,3
3rd Record	3,2	98,8	2,8	99,3	1,3	99,4

Table 2

The weed control of the most frequently encountered weeds in the field after winter wheat harvesting

Records	The more widely available species of weeds													
	Setaria glauca L.		*Chenopodium album* L.		*Amaranthus retroflexus* L		*Ambrosia artemisiifolia* L		*Cannabis ruderalis* Janisch.		*Cirsium arvense* L.		*Convolvulus arvensis* L.	
	1*	2**	1*	2**	1*	2**	1*	2**	1*	2**	1*	2**	1*	2**
Control, no herbicides(1)											Control, no herbicides (2)			
2nd Record	146	-	66	-	3	-	15,3	-	3,6	-	48,0	-	8,0	-
3rd Record	184	-	58	-	1	-	12,5	-	1,7	-	38,0	-	16,0	-
Glyphogan 480 SL - 2,0 l/ha											Glyphogan 480 SL 8,l/ha			
2nd Record	1,7	98	11,0	83	0	100	5,3	65	0,4	89	0,9	98	7,1	11
3rd Record	1,3	99	2,3	96	0	100	0,9	93	0	100	0	100	0	100
Superklin 480 SL - 2,0 l/ha											Superklin 480 SL 5,0 l/ha			
2nd Record	4,4	97	1,3	98	0	100	4,4	71	0,4	89	2,0	96	2,0	75
3rd Record	0,4	99	7,6	87	0	100	0,4	97	0	100	6,0	84	2,0	87
Superklin 480 SL - 4,0 l/ha											Superklin 480 SL 6,0 l/ha			
2nd Record	0	100	0	100	0	100	1,7	89	0	100	0	100	3,4	57
3rd Record	0	100	0	100	0	100	0,9	93	0	100	2,6	93	0,6	96

*number of weeds per meter square

** degree of control,

with lambsquarters ranged between 56 and 66 weeds/m^2, with redroot pigweed ranged between 2 and 7 weeds/m^2, with common ragweed ranged between 1 and 4 weeds/m^2 and respectively the degree of infestation with cannabis ranged between 1 and 4 weeds/m^2. Prior to herbicide application the degree of infestation with perennial weeds was as follows: with Canada thistle from 58 to 79 weeds/m^2 and with bindweed from 4 to 30 weeds/m^2. The degree of weed control in the variants with herbicides against annual weeds depended more on the weed species than on the dose of studied herbicide. The use of the herbicide Superklin 480 SL in a dose of 2.0 l/ha and 4.0 l/ha controlled yellow foxtail at a level of 97 and 100% in the second record and at a level of 99 to 100% in the third record, while the use of herbicide Glyphogan 480 SL in a dose of 2.0 l/ha recorded a level of 98% in the second record and respectively 99% in the third record. The use of the herbicide Superklin 480 SL in a dose of 2.0 l/ha and 4.0 l/ha controlled lambsquarters at a level of 98 and 100% in the second record and 87 and 100% in the third record, while the use of herbicide Glyphogan 480 SL in a dose of 2.0 l/ha controlled lambsquarters at a level of 83% in the second record and respectively 96% in the third record. The degree of control of redroot pigweed was at the level of 100% in all variants with herbicides.

Also, the applied doses of herbicide effectively controlled other annual weeds such as common ragweed and cannabis. In the experimental variants studying the biological effectiveness of the herbicides against annual and perennial weeds, all encountered annual weeds species were controlled at a level of 100%, that's why data are not presented in Table 2. Table 2 presents only data concerning the degree of control of perennial weeds. The application of herbicide Superklin 480 SL in a dose of 5.0 l/ha and 6,0 l/ha controlled Canada thistle at a level of 96 and 100% in the second record and at a level of 84 and 93% in the third record. The application of herbicide Glyphogan 480 SL in a dose of 8.0 l/ha has controlled Canada thistle at a level of 98% in the second record and at level of 100% in the third record. The application of herbicide Glyphogan 480 SL in a dose of 8.0 l/ha has controlled Canada thistle at a level of 98% in the second record and at level of 100% in the third record. The application of herbicide Superklin 480 SL in a dose of 5.0 l/ha and 6,0 l/ha controlled field bindweed at a level of 75 and 57% in the second record and at a level of 87 and 96% in the third record.

The application of herbicide Glyphogan 480 SL in a dose of 8.0 l/ha controlled field bindweed at a level of 11% in the second record and at a level of 100% in the third record.

CONCLUSIONS

Weather conditions in the spring - summer of 2011 were favorable for the growth and development of weeds. The herbicide Superklin 480 SL in a dose of 2.0 l/ha and 4.0 l/ha effectively controlled monocotyledonous and dicotyledonous annual weeds, the degree of control of the weed species being the following: yellow foxtail - 99-100%, lambsquarters - 87 -100%, redroot pigweed - 100%, common ragweed - 93-96.8%, cannabis - 100%. The herbicide Superklin 480 SL in a dose of 5.0 l/ha and 6.0l/ha showed a high biological effectiveness against monocotyledonous and dicotyledonous annual and perennial weeds. The degree of control of yellow foxtail, lambsquarters, redroot pigweed, common ragweed and cannabis was 100%. The degree of control of Canada thistle was 84-93% and for bindweed 87-96%. The herbicide Superklin 480 SL in a dose of 5.0 l/ha and 6.0 l/ha showed a high biological effectiveness against monocotyledonous and dicotyledonous annual and perennial weeds. The degree of control of yellow foxtail, lambsquarters, redroot pigweed, common ragweed and cannabis was 100%. The degree of control of Canada thistle was 84-93% and for bindweed 87-96%. Biological efficiency of the herbicide Superklin 480 SL was at the same level as the approved product Glyphogan 480 SL. As a result of our investigations, it was proposed the registration of the herbicide Superklin 480 SL (a. i. glyphosate) for use in weed control on fields after crop harvesting, against monocotyledonous and dicotyledonous annual weeds in doses of 2,0-4,0 l/ha and against monocotyledonous and dicotyledonous perennial weeds in a dose from 5.0 to 6.0 l/ha by spraying weeds in the intensive phase of their growth.

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