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AFTER EFFECT OF THE HERBICIDE ENVOKE ON THE ROOT WEIGHT AND THE SPROUT WEIGHT OF COTTON SEEDS (*Gossypium hirsutum* L.)

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Abstract

The after effect of the herbicide Envoke on the root weight and the sprout weight of cotton seeds was studied in two cultivars - Chirpan-539 and Helius (Gossypium hirsutum L.). The herbicide was applied during the crop's vegetation, once during the 4-5 leaf stage and twice during the 4-5 leaf and budding stages of the cotton. It was tested at the doses - 10 g.ha^{-1}, 15 g.ha^{-1} and 20 g.ha^{-1}. Seed germination samples taken from cotton plants treated with the herbicide Envoke during the growing season were placed. The root weight and the sprout weight were recorded on the 7th day after the samples were planted. The results obtained from each herbicide variant were compared with those of the two controls - the untreated control and the economic control. The herbicide Envoke, applied during the growing season of the two cotton cultivars - Chirpan-539 and Helius, did not have aftereffect the root weight of the cotton seeds. The herbicide had not negative affect on the sprout weight of the cultivar Helius, but did effect on this indicator of the cultivar Chirpan-539.

Key words*: cotton, herbicides, foliar treatment, cultivars, root weight, sprout weight.*

INTRODUCTION

The Cotton is a crop with a long growing season. Due to its weak competitive ability, it is sensitive to weeding in the early stages of its development (Berger et al., 2015). Then even a lower degree of weeding can affect the growth, the development, the yield, the seed germination properties and the fiber quality (Dogan et al., 2015; Charles & York, 2019). Weed control during the cotton growing season is an important part of cotton production technology (Jabran, 2016).

The problem of primary weed infestation with broadleaf and weeds of the *Poaceae* family, as well as weed infestation with weeds of the *Poaceae* family during the cotton growing season, has been largely solved (Chachalis & Galanis, 2007; Kahramanoglu & Uygur, 2010; Singh et al., 2016; Tariq et al., 2018a,b). Today, in the conventional crop cultivation technology, are a problem the broadleaf weeds during the growing season and the lack of the effective and the selective herbicides to control them. (Stoychev, 2013; Barakova, 2017). A large part of the research conducted with foliar herbicides shows that they exhibit phytotoxic effects on the crop (Montazeri, 2009; Barakova et al., 2018; 2021; Barakova, 2024; 2025). To date, there is little data on whether the herbicides applied during the growing season have an impact on the sowing properties of the cotton seeds. From what has been stated so far, it follows that it is necessary to search for not only efficacy, but also selective vegetation herbicides for the this crop.

The aim of the study is to investigate the aftereffect of the herbicide Envoke on the root weight and sprout weight of cotton seeds in the cultivars Chirpan-539 and Helius (*Gossypium hirsutum* L.).

MATERIALS AND METHODS

Research was conducted during the period 2022-2024. At the Field Crops Institute in Chirpan, under laboratory conditions, the aftereffect of the vegetation herbicide Envoke (trifloxysulforon-sodium) was studied in the cotton cultivars (*Gossypium hirsutum* L.) - Chirpan-539 and Helius.

The herbicide was applied once in the 4-5 leaf stage and twice during the 4-5 leaf and cotton budding stages. The doses in which the herbicide preparation was tested were 10 g.ha^{-1}, 15 g.ha^{-1} and 20 g.ha^{-1}. The variants of the study are listed in Table 1. The herbicide Envoke was applied with the adjuvant

Supersonic - 500 ml.ha^{-1}. All variants of the herbicide were applied with a backpack sprayer during the crop growth period – with working solution 300 l.ha^{-1}.

Table 1. Variants of the study

Cultivars				
Chirpan-539	Untreated control			
	Economic control			
	Herbicide	Phenological stages during treatment	Tested doses	
	Envoke	4-5 leaf	10 g.ha^{-1}	
			15 g.ha^{-1}	
			20 g.ha^{-1}	
		budding stage	10 g.ha^{-1}	
			15 g.ha^{-1}	
			20 g.ha^{-1}	
		4-5 leaf and budding stages	10 g.ha^{-1} + 10 g.ha^{-1}	
			15 g.ha^{-1} + 15 g.ha^{-1}	
			20 g.ha^{-1} + 20 g.ha^{-1}	
Helius	Untreated control			
	Economic control			
	Herbicide	Phenological stages during treatment	Tested doses	
	Envoke	4-5 leaf	10 g.ha^{-1}	
			15 g.ha^{-1}	
			20 g.ha^{-1}	
		budding stage	10 g.ha^{-1}	
			15 g.ha^{-1}	
			20 g.ha^{-1}	
		4-5 leaf and budding stages	10 g.ha^{-1} + 10 g.ha^{-1}	
			15 g.ha^{-1} + 15 g.ha^{-1}	
			20 g.ha^{-1} + 20 g.ha^{-1}	

The herbicide Envoke was applied against the background of the herbicide combination Dual Gold 960 EC (S-metolachlor) – 1.2 l.ha^{-1} + Smerch 24 EC (oxyfluorfen) – 1.0 l.ha^{-1}. It was applied before cotton emergence with a working solution of 400 l.ha^{-1}, in order to combat primary proliferation of weeds of the *Poaceae* family and broadleaf weeds.

The untreated control was left without hoeing and without herbicide treatment. The economic control was untreated and the weeds there were removed by three hoeings during the vegetation of the crop.

The root weight and the weight of the sprout of the cotton seeds were studied. The indicators were reported in grams (g). Germination samples of 100 pieces per variant (twenty five samples in one repetition) were set for both cotton cultivars. The seeds were from plants that were treated with the tested doses of the herbicide during the growing season.The root and sprout weights were recorded on the seventh day after the samples had been planted.

The values obtained from the herbicide variants were compared with those of the two controls.

A statistical assessment was made to characterize the representativeness and reliability of the influence of the studied indicators through variance analysis and Fisher's parametric F criterion (Shanin, 1977; Barov, 1982). The ANOVA123 program (Lidanski, 1988) was used when analyzing variance.

RESULTS AND DISCUSSIONS

In the cotton cultivar Chirpan-539, the average root weight for the study period varied from 2.1 g to 2.8 g (Table 2). The reported root weight value for both controls was 2.8 g. The values of the indicator for all variants of the Envoke herbicide are approximately equal to that of the commercial control, and the differences between them are mathematically unproven.

The root weight for the cultivar Helius varies within wider limits – from 2.1 g to 3.3 g. The

lowest value of the indicator was measured for the untreated control – 2.1 g. The root weight for the commercial control is 2.5 g. The values of the indicator for the herbicide variants are equal to or exceed the value of the commercial control.

On average, during the study period, the vegetation treatment of the two cotton cultivars with the herbicide Envoke, at the tested doses and different stages of the crop development, did not have aftereffect on the root weight of the cotton seeds.

Table 2. Aftereffect of the herbicide Envoke on the root weight of cotton seeds (2022-2024)

Factor A		Variants of the study			Root weight of cotton seeds, g			
					2022	2023	2024	Mean
Cultivars	Chirpan-539	Untreated control			2.3	3.2	3.0	2.8
		Economic control			2.0	3.5	2.8	2.8
		Factor B						
		Envoke	4-5 leaf	10 g.ha^{-1}	2.2	2.0	2.0	2.1
				15 g.ha^{-1}	2.1	3.0	2.6	2.6
				20 g.ha^{-1}	1.7	2.9	2.5	2.4
		Envoke	budding stage	10 g.ha^{-1}	2.7	3.0	2.8	2.8
				15 g.ha^{-1}	2.6	3.0	2.6	2.7
				20 g.ha^{-1}	2.7	2.6	2.8	2.7
		Envoke	4-5 leaf and budding stages	10 g.ha^{-1} + 10 g.ha^{-1}	2.4	3.0	2.6	2.7
				15 g.ha^{-1} + 15 g.ha^{-1}	2.2	2.7	2.6	2.5
				20 g.ha^{-1} + 20 g.ha^{-1}	2.5	3.0	2.7	2.7
	Helius	Untreated control			2.0	2.2	2.0	2.1
		Economic control			2.9	2.0	2.5	2.5
		Factor B						
		Envoke	4-5 leaf	10 g.ha^{-1}	2.2	3.6	3.0	2.9
				15 g.ha^{-1}	2.7	3.8	3.4	3.3
				20 g.ha^{-1}	2.7	3.0	3.2	3.0
		Envoke	budding stage	10 g.ha^{-1}	2.3	3.0	2.7	2.7
				15 g.ha^{-1}	2.5	2.4	2.6	2.5
				20 g.ha^{-1}	1.7	3.0	2.4	2.4
		Envoke	4-5 leaf and budding stages	10 g.ha^{-1} + 10 g.ha^{-1}	2.4	2.8	2.6	2.6
				15 g.ha^{-1} + 15 g.ha^{-1}	2.6	3.0	2.8	2.8
				20 g.ha^{-1} + 20 g.ha^{-1}	2.3	3.9	3.8	3.3

LSD g:

F.A	p≤5%=0.1	p≤1%=0.2	p≤0.1%=0.3
F.B	p≤5%=0.4	p≤1%=0.5	p≤0.1%=0.7
AxB	p≤5%=0.5	p≤1%=0.7	p≤0.1%=0.9

Regarding the root weight, an analysis of variance was performed (Table 3). It was found that the influence of the variants of the study was 42.9%. It was proven at p≤1%. This on the years of the study was 26.3%, which was proven at p≤0.1%.

The influence of the cultivars, which was 1.4%, and of the variants with the herbicide – 13.2%, was not proven. The interaction of the cultivars with the variants of the herbicide (A×B) was proven – 28.3%, at p≤1%.

Table 3. Analysis of variance for the root weight of cotton seeds

Source of variation	Degrees of freedom	Sum of squares	Influence of factor, %	Mean square	Fisher's criteria	Probability level
Total	65	14.7	100	-	-	-
Years	2	3.8	26.3	1.9	17.9	***
Variants	21	6.3	42.9	0.3	2.7	**
Factor A - Cultivars	1	0.2	1.4	0.2	1.9	ns
Factor B - Variants of the herbicide	10	1.9	13.2	0.1	1.8	ns
AxB	10	4.1	28.3	0.4	3.8	**
Pooled error	42	4.5	30.8	0.1	-	-

*p≤5% **p≤1% ***p≤0.1%

In the cotton cultivar Chirpan-539, the average sprout weight for the study period varied from 13.7 g to 18.0 g (Table 4). The reported sprout weight value in the weeded (i.e. untreated) control was 16.9 g. The obtained value of the indicator from the farm control was 18.0 g. In all variants with the herbicide Envoke, values lower than those of the farm control were reported. This was also established in the individual years of the study.

The sprout weight in the cultivar Helius varied within narrower limits from 13.4 g to 17.2 g. In the untreated control, the measured value of the indicator was 13.4 g. In the economic control, the root weight was 14.3 g. The values of the indicator in the herbicide variants exceeded the value of the economic control.

The application of the herbicide Envoke, during the indicated stages of the cotton development in doses of 10 g.ha^{-1}, 15 g.ha^{-1} and 20 g.ha^{-1}, had an affect on the sprout weight of the seeds in the cultivar Chirpan-539. The herbicide did not aftereffect on the sprout weight in the cultivar Helius.

Table 4. Aftereffect of the herbicide Envoke on the sprout weight of cotton seeds (2022-2024)

Factor A		Variants of the study			Sprout weight of cotton seeds, g			
					2022	2023	2024	Mean
Cultivars	Chirpan-539	Untreated control			17.6	16.3	16.8	16.9
		Economic control			18.3	17.7	18.0	18.0
		Factor B						
		Envoke	4-5 leaf	10 g.ha^{-1}	16.4	18.6	13.2	15.4
				15 g.ha^{-1}	16.4	15.6	15.8	15.9
				20 g.ha^{-1}	13.1	14.4	13.7	13.7
		Envoke	budding stage	10 g.ha^{-1}	15.3	15.8	14.6	15.2
				15 g.ha^{-1}	16.6	15.1	16.2	16.0
				20 g.ha^{-1}	17.0	15.0	15.2	15.7
		Envoke	4-5 leaf and budding stages	10 g.ha^{-1} + 10 g.ha^{-1}	16.3	14.7	15.6	15.2
				15 g.ha^{-1} + 15 g.ha^{-1}	16.1	14.4	14.3	14.9
				20 g.ha^{-1} + 20 g.ha^{-1}	17.1	13.7	15.4	15.4
	Helius	Untreated control			15.3	11.4	13.5	13.4
		Economic control			19.4	9.3	14.3	14.3
		Factor B						
		Envoke	4-5 leaf	10 g.ha^{-1}	17.5	14.8	15.8	16.0
				15 g.ha^{-1}	17.1	17.0	17.4	17.2
				20 g.ha^{-1}	15.7	18.0	15.4	16.7
		Envoke	budding stage	10 g.ha^{-1}	15.7	16.8	16.6	16.4
				15 g.ha^{-1}	15.8	14.9	13.8	14.8
				20 g.ha^{-1}	15.0	14.8	15.2	15.0
		Envoke	4-5 leaf and budding stages	10 g.ha^{-1} + 10 g.ha^{-1}	16.8	14.2	14.6	15.2
				15 g.ha^{-1} + 15 g.ha^{-1}	15.1	15.0	14.8	15.0
				20 g.ha^{-1} + 20 g.ha^{-1}	18.3	15.0	16.8	16.7

LSD g:

F.A	p≤5%=0.5	p≤1%=0.6	p≤0.1%=0.8
F.B	p≤5%=1.1	p≤1%=1.5	p≤0.1%=1.9
AxB	p≤5%=1.6	p≤1%=2.1	p≤0.1%=2.7

Regarding the sprout weight, from the analysis of variance (Table 5) it was found that the influence of the study variants was the greatest – 59.5%. It was proven at p≤0.1%. The years of the study had an influence 10.4%, proven at p≤1%. The cultivars influence by 0.6%, but this had not been proven. The influence of the variants with the herbicide was 9.8%, but it had also not been proven. With 49.1%, with a reliability of p≤0.1% of the results obtained, the interaction of the cotton cultivars with the tested variants of the herbicide (A×B) had been proven.

Table 5. Analysis of variance for the sprout weight of cotton seeds

Source of variation	Degrees of freedom	Sum of squares	Influence of factor, %	Mean square	Fisher's criteria	Probability level
Total	65	125.2	100	-	-	-
Years	2	12.9	10.4	6.4	7.2	**
Variants	21	74.5	59.5	3.5	3.9	***
Factor A - Cultivars	1	0.7	0.6	0.7	0.8	ns
Factor B - Variants of the herbicide	10	12.5	9.8	1.2	1.3	ns
AxB	10	61.4	49.1	6.1	5.8	***
Pooled error	42	37.6	30.1	0.8	-	-

*p≤5% **p≤1% ***p≤0.1%

CONCLUSIONS

The vegetation treatment of the cotton cultivars Chirpan-539 and Helius with the herbicide Envoke in doses of 10 g.ha^{-1}, 15 g.ha^{-1} and 20 g.ha^{-1} and at different stages of the crop development had no affect on the root weight of the cotton seeds.

An aftereffect of the herbicide Envoke on the sprout weight in the cultivar Chirpan-539 was established.

In cultivar Helius, the tested herbicide did no effect on the sprout weight of the cotton seeds.

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