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HERBICIDE CONTROL OF WILD HEMP (CANNABIS SATIVA L.) AT SUNFLOWER GROWN BY "EXPRESS SUN" TECHNOLOGY

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Abstract

The Wild hemp (Cannabis sativa L.) is relatively rare weed in Bulgaria. Its presence in high density in the sunflower fields makes the production difficult and sharply decreases yields. To solve this problem a field trail in sunflower (*Helianthus annuus L.*) field infested with the weed Wild hemp in high density was conducted. The experiment was carried out during the vegetation periods of the sunflower from 2010 to 2014. The trail was stated on the agricultural land of village Krumovo, near Plovdiv, Bulgaria. The sunflower plants were grown by "ExpressSun" technology. The primly used herbicide is Express 50 SG (containing 500 g/kg tribenuron-methyl). For better Wild hemp control as partner products in our study, the adjuvant Trend 90 and the herbicide Pledge 50 WP (containing 500 g/kg flumioxazine) in dose of 7 g/da were used. The trail was conducted in four replications and the size of the plots was 28 m². The evaluated herbicides were applied in three different dates and in different doses. The obtained data for the efficacy of the herbicides were compared with the untreated dredged and not dredged controls. The efficacy of the herbicides against the weeds by the quantitative method (number of weeds per 1 m²) and the percentage of efficacy (%) by the visual scale of EWRS (European Weed Research Society) were reported three times annually. The influences of the examined factors on the sunflower seed yields were also studied. The results from the study showed that the wild hemp control is extremely difficult and for the best way to control this weed, a system of herbicide application in the correct time is required.

Keywards: *wild hemp, sunflower, herbicides, efficacy, yields*

Introduction

The Wild hemp (*Cannabis sativa L.*) is late spring weed and is observed mainly in spring field crops and in orchards (Small *et al.,* 2003). This weed species has aboveground biomass reaching 2 - 3 m of height, as well as powerful and deep root system. The Wild hemp infests a lot of different crops. At the rice fields in the northern part of western Bulgaria it is very aggressive weed that makes great economic damages (Duary and Mukherjee, 2003). The existence of Wild hemp as secondary emerged weed in unevenly topped winter wheat crop is also observed. Reisinger *et al.* (2005) reported that the Wild hemp is significantly more competitive compared to the culture. That leads to ineffective use of the present soil moisture and available nutrients. Ved Prakash *et al.* (2000) recorded that at the onion (*Allium cepa L.*) fields in the North-west Himalia the main weed species are Wild hemp (*Cannnabis sativa L.*), Java grass (*Cyperus rotundus*) and Gallant soldier (Galinsoga parviflora). The weeding is decreasing the yields with 81,2 %. The Wild hemp is relatively rare weed in Bulgaria. Its presence in high density in the sunflower fields makes the production difficult and sharply decreases yields (Osman *et al.,* 2014). For the Wild hemp control different methods are applied. Many authors recommend the biological control by using mycoherbicides. For this aim several virulent strains of Fusarium oxysporum f. sp. cannabis are studied and evaluated (Noviello et al., 1990; Tiourebaev et al., 2001). Páli *et al.* (2007) established that

trough fiercely burning the seeds of the wild hemp (*Cannabis sativa L.*) significantly decreases their viability. The information about the chemical control of the Wild hemp at sunflower as well as at the other crop is still limited. Pandey (1989) established that the infestation with Wild hemp at maize is controlled by usage of metribuzin at dose of 0.5 kg/ha, pendimethalin at dose of 1.0 kg/ha and two times earthing up on the 25th and on the 45th day after sowing. At the conventional technology of sunflower growing, none of the registered herbicide products cannot control the Wild hemp. Weed control at sunflower should be performed at the optimal phases of the crop before the critical period for decreasing the morphological parameters is reached (Simic et al., 2011). The introduction of the ”Express sun” technology marks a new stage at weed control at sunflower production (Delchev and Georgiev., 2015).

The aim of the present study was to establish the possibilities for herbicide control of Wild hemp (*Cannabis sativa L.*) at sunflower grown by ”ExpressSun” technology.

Materials and Methods

The experiment was carried out during the vegetation periods of the sunflower from 2010 to 2014 (without 2013), on field infested with Wild hemp in high density. The sunflower plants were grown by ”ExpressSun” technology. The trail was stated on the agricultural land of village Krumovo, near city of Plovdiv, Bulgaria. The primly used herbicide was Express 50 SG, containing 500 g/kg tribenuron-methyl. For better hemp control as partner products in our study, the adjuvant Trend 90 and the herbicide Pledge 50 WP (active substance - flumioxazine 500 g/kg) in dose of 7 g/da were used. At variant 6 the herbicide Pledge 50 WP was applied immediately after sowing, and Express 50 SG was sprayed at phenofhase from the emergence of 2-4 leaves of the sunflower (at variants 3 to 6) and from the emergence of 6-8 leaves (at variants 5 and 6). In the first three years of the study the sunflower hybrid “PR64 E83” was grown, and in the last experimental year (2014) the hybrid “PR64 LE25” was sowed.

The trail was conducted in four replications with size of the harvesting plot 28 m². The evaluated herbicides were applied in three different dates and in different doses (2 и 4 g/da). The obtained data for the efficacy of the herbicides were compared with untreated dredged two times controls (variant 2), as well as untreated not dredged controls. The efficacy of the herbicides against the weeds by the quantitative method (number of weeds per 1 m²) and the percentage of efficacy (%) by the visual scale of EWRS (European Weed Research Society) were reported three times annually. The influence of the tested factors on the yield of sunflower was also evaluated. In the trail intercrop tillage during the vegetation was not performed. The fields for the experiment were selected so that the prevailing weed infestation to be from the weed Wild hemp. The control of the single specimens from the other existing weeds on the field was accomplished by their removal by hand. The removing of the weeds was done to phenophase 8-10 leaves of the plants. Statistical analysis of collected data was performed by using Duncan’s multiple range test (1955) of SPSS program. Statistical differences were considered significant at $p<0.05$.

Results and Discussion

The number of the Wild hemp specimens in the untreated control varied from 17,3 to 50,9 per m^2 in the different years (Table 1). This variant showed the enormous competitive abilities of Wild hemp in its uncontrolled coexistence with sunflower. In comparison to the untreated control, in the twice dredged control (variant 2) the number of the Wild hemp plants was 4 times lower and varied from 3,9 to 9,4 specimens per 1 m^2 (Table 1). The most unsatisfied herbicide effect on the examined weed was observed at variant 3 (Express 50 SG at dose of 4

g/da). According to Jursik *et al.* (2011), by applying adjuvants together with herbicides, the biological efficacy and crop selectivity of the used product is going to be improved. This statement was proved in our study. The adding of the adjuvant Trend 90 significantly improved the efficacy against the Hemp. In a study performed by Delchev (2013), the herbicide tank mixture of Express + Stratos Ultra by "ExpressSun" technology led to complete control of all annual and perennial grass and broadleave weeds. In our experiment, by the application of Express 50 SG at dose of 2 + 4 g/da in combination with the adjuvant Trend 90 twice during the vegetation, over 90 % efficacy against Wild hemp was achieved. By the system of twice treatment the just emerged specimens of the weed were affected in maximum rate. After the second treatment, the secondary emerged weed plants were significantly affected. The highest herbicide effect against the Wild hemp was recorded at variant 6 (Pledge 50 WP + Express 50 SG + Trend 90, applied tree times) (Table 1). The results were the highest at phenophase cotyledons to 2-4 leaves of the plants. After the treatment of the sunflower plants with Express 50 SG at the time when the Wild hemp was at phenophase "rosette", the efficacy of the studied herbicide was sharply decreased.

The observations and reports for selectivity in the first three years of the study showed that the examined herbicide products had limited signs of fitotoxicity for sunflower. The visible indication of stress at the crop was expressed in meaningful lightening of the leaves that was continuing for 7-10 days. After this period the fitotoxicity signs completely disappeared. Between 2 and 5 % from the heterozygous hybrid "PR64 E83" did not form normal sunflower heads after the treatment with Express 50 SG. With implementation of the new homozygous hybrid "PR64 LE25" in 2014, any visible indications of fitotoxicity were not observed.

The highest yields in the experiment were obtained in 2014 (Table 2). The reasons for this fact were complex. On the first place, the summer of the concrete year was with the highest precipitation (the total precipitation for the period from April to August was 361,7 mm). On the second place was the implementation of the hybrid "PR64 LE25" that have high productivity potential and higher resistance to the applied herbicide in comparison to the hybrid used in the previous three years of the study ("PR64 E83"). The Pants of the new generation of hybrids do not undergo a state of stress after the application of Express 50 SG. At the older generation heterozygous hybrids the stress is expressed in short-term yellowing of the leaves after the treatment, a slight development delay, as well as blocking of the flowering of up to 5 % of sunflower plants.

Yield generally decreased with increased duration of weed interference (Elezovic *et al.*, 2012). In our trail the average yield for the period of investigation from the untreated and undredged controls was with 2,49 to 3,67 times lower in comparison to the variants with applied herbicides. During every experimental year, with statistically proved lowest yields among the treated variants, was the variant with single application of Express 50 SG without the adjuvant Trend 90 (Table 2). The epicuticular wax is the most significant barrier to the penetration of watersoluble herbicides (DiTomaso, 1999). The presence of epicuticular wax on the Wild hemp's leaves should be overwhelmed so the herbicide can get into the plant tissues. Our observations showed that with the aging of the Wild hemp, the weed was becoming more resistant to Express 50 SG and the necessity of the adjuvant application was more obvious. The lowest yield from the untreated control in 2011 corresponds to the highest level of weed infestation with Wild hemp (Table 2). Another important factor was undoubtedly the precipitation in this season. The total precipitation for the period April-August 2011 was 184.1 mm.

Table1. Efficacy of the studied herbicides

Variants	Doses g(ml)/da	2010		2011		2012		2014		2010/2014	
		Num./ m²	Efficacy (%)	Num./ m²	Efficacy (%)	Num./ m²	Efficacy (%)	Num./ m²	Efficacy (%)	Num./ m²	Efficacy (%)
1. Untreated control	-	38,4	0	50,9	0	17,3	0	34,8	0	35,4	0
2. Earthed up control	-	5,0	90,0	9,4	89,3	3,9	87,3	5,5	90,0	6,0	89,2
3. Express 50 SG	4	13,4	70,0	17,6	65,3	10,4	70,0	13,7	69,0	13,8	68,6
4. Express 50 SG + Trend 90	4 + 25	9,6	74,7	14,3	75,7	7,1	80,7	9,5	76,7	10,1	77,0
5. Express 50 SG + Trend 90 (Applied two times)	(2+25) + (4 + 25)	6,1	90,3	6,9	87,7	3,8	90,7	4,9	88,3	5,4	89,3
6. Pledge 50 WP + Express 50 SG + Trend 90 (Applied tree times)	7+(2+25) +(4+25)	3,1	93,7	3,3	92,0	0,8	96,3	2,8	94,3	2,5	94,1

Table 2. Comparative analyses of the sunflower yields for the period 2010-2014 (kg/da)

Herbicides	Doses g(ml)/da	2010		2011		2012		2014		2010/2014	
		With U.c.	By Duncan's multiple range test	With U.c.	By Duncan's multiple range test	With U.c.	By Duncan's multiple range test	With U.c.	By Duncan's multiple range test	With U.c..	By Duncan's multiple range test
1. Untreated control	-	**76**	**a**	**68**	**a**	**99**	**a**	**107.5**	**a**	**87.63**	**a**
2. Earthed up control	-	260.00*	c	285.00*	e	285.00*	e	360.00*	c	297.50*	d
3. Express 50 SG	4	218.00*	b	119.00*	b	160.00*	b	298.50*	b	218.88*	b
4. Express 50 SG + Trend 90	4 + 25	255.00*	b	217.00*	c	207.00*	c	311.00*	b	247.50*	c
5. Express 50 SG + Trend 90 (Applied two times)	(2+25) + (4 + 25)	288.00*	d	243.50*	d	253.00*	d	368.50*	c	288.25*	d
6. Pledge 50 WP + Express 50 SG + Trend 90 (Applied tree times)	7+(2+25)+(4+25)	328.00*	e	292.00*	e	298.00*	e	370.00*	c	322.00*	e

Legend: All variants with * (star) are with proved difference compared with the untreated control. The values that are in one column and that have different letters (a, b, c etc.) are with proved difference at $p<0.05$; U.c. = Untreated control

Conclusions

The results from the trails showed that the control of the Wild Hemp (*Cannabis sativa L*.) by the "ExpressSun" technology was extremely difficult and for the best way to control this weed, a system of herbicide application in the correct time is required. The Wild Hemp could decrease sunflower seed yields from 2,49 to 3,67 times in comparison to the variants with herbicide application.

When the product Express 50 SG was applied alone the herbicide control of the Wild Hemp was insufficient that had negative effect on sunflower yields.

The adding of the adjuvant Trend 90 to Express 50 SG increased the efficacy of the product during the fourth experimental years. The combined usage of the herbicide and the adjuvant led to increase of the yields over 13 % when compared with the alone herbicide spraying.

The application of Express 50 SG twice during period of 10 - 14 days increased the herbicide efficacy against Wild hemp with 10 - 15 % when compared with the alone application. As a result, there was yield increase on average over 16,5 %.

The highest and stable efficacy against the Wild hemp and the highest yields were achieved after the application of the herbicide combination of Pledge 50 WP + Express 50 SG + the adjuvant Trend 90 applied three times during the vegetation.

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