STUDY ON THE EFFICACY OF SOME HERBICIDES FOR WEED CONTROLIN IN LAVANDER FIELD

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***Abstract**: The experimental study was carried out during the period 2013-2014 in a young lavender field on a soil type of leached chernozem in Tsarichino village, Balchik municipality, Dobrich region - Bulgaria. The test was performed by means of a block method with four repetitions; experimental field area - 15 m^2. The experiment included 5 variants and an untreated control: 1) Control – untreated, hand hoeing applied three times; 2) Devrinol 4 F (450 g/l napropamide) at the rate of 400 ml/da; 3) Stomp New 330 EC (330 g/l pendimethalin) at the rate of 400 ml/da; 4) Pledge 50 WP (500 g/kg flumioxazine) at the rate of 8 g/da; 5) Goal 2 E (240 g/l oxyfluorfen) + Dual Gold 960 EC (S-metolachlor 960 g/l) at the rate of 100 + 150 ml/da; 6) Merlin Flex 480 SC (isoxaflutole 240 g/L); antidote (cyprosulfamide 240 g/l) + Adengo (Active substance: isoxaflutole 225 g/l); tiocarbazone-methyl 90 g/l; cyprosulfamide (antidote) 150 g/l at the rate of 42 + 44 ml/da. The aim of the present study was to develop an efficient weed control scheme in a young lavender field, depending on the species composition and density. The analysis of the results showed; the applied herbicides exhibit good efficacy against the annual broad-leaved weeds and a weaker control of the perennial weeds. The best control of the annual and perennial weeds in a young lavender field was reported in the variants with the herbicides Devinol 4 F (450 g/l napropamide) applied at the rate of 400 ml/da and Pledge 50 WP (500 g/kg flumioxazine) at the rate of 8 g/da. The applied soil herbicides did not show a negative effect on the annual growth of the lavender plants.*

***Key words:** lavender, weeds, herbicides, growth plants.*

INTRODUCTION

Lavender is one of the major essential oil-bearing crops under the conditions of Bulgaria. It is grown for the flower spikes, from which three product types are obtained – essential oil, dry lavender and products for ornamental purposes (as a decorative flower), (STANEV, 2010; STANEV AND DZHURMANSKI, 2011). The production of lavender essential oil is the most economically important and Bulgaria is the world leader (BAYDAR , 2009; STANEV ET AL.,2016; YANCHEV, 2017).

Weeds are among the major factors determining to a great extent the yield in terms of quantity and quality. For the proper planning of their control, it is necessary to know the composition of the weed associations, as well as the level of infestation. The effective methods of controlling some weed species contribute to reducing their density and increasing the production efficiency (BASSINO AND BLANC, 1980).

The use of herbicides in lavender fields is one of the most important aspects of agro-technology. According to ANGELOVA AND DOBREVA (2011) the application of soil herbicides Raft 400 SC (400 g/l oxadiargyl, 150 ml/da) and Fen 24 EC (oxyfluorfen 240 g/l, 200 ml/da) in a flowering lavender plantation decreased the spread of weeds by 92% and 87%, respectively, and the yield of the obtained essential oil was higher compared to the untreated control.

The aim of the present study was to design an effective weed control programme in a young lavender field (in the first and second year after planting), depending on the species composition and density.

MATERIAL AND METHODS

Plan material.

The study was carried out in the period 2013-2014 in a young lavender field on leached chernozem soil in Tsarichino village, Balchik municipality, Dobrich region. The experiment included 5 variants and an untreated control: 1) Control – untreated, hand hoeing applied three times; 2) Devrinol 4 F (450 g/l napropamide) at the rate of 400 ml/da; 3) Stomp New 330 EC (330 g/l pendimethalin) at the rate of 400 ml/da; 4) Pledge 50 WP (500 g/kg flumioxazine) at the rate of 8 g/da; 5) Goal 2 E (240 g/l oxyfluorfen) + Dual Gold 960 EC (S-metolachlor 960 g/l) at the rate of 100 + 150 ml/da; 6) Merlin Flex 480 SC (isoxaflutole 240 g/L); antidote (cyprosulfamide 240 g/l) + Adengo (Active substance: isoxaflutole 225 g/l); tiocarbazone-methyl 90 g/l; cyprosulfamide (antidote) 150 g/l at the rate of 42 + 44 ml/da.

The experiment was set up as a block plot design in four replications, the plot size being 15 m^2. The total studied area was 360 m^2. The field was planted in the spring of 2013. Agrotechnical activities followed the adopted methodology of the crop cultivation.

Tested indicators.

The herbicides were applied before the vegetation period of both the lavender and the weeds, with a backpack sprayer equipped with a herbicide funnel, which provided protection of the crop plants from the direct contact with the chemicals. The herbicide efficacy on the weed density was reported by the quantitative method in number of plants per square meter (SPASOV ET AL., 1994), on the 30^{th}, 60^{th}, 90^{th} and 120^{th} days after treatment. The species composition of the weed plants and their quantity were reported visually. The effect of the applied herbicides on the stem growth of some perennial weeds, as well as on the annual height increment of the lavender plants, was also studied.

RESULTS AND DISCUSSION

In the years of the study 2013 and 2014, a total of 9 weed species were recorded in the lavender field, of which 4 annual: Jimson weed (*Datura stramonium* L.), White goosefoot (*Chenopodium album* L.), Common fumitory (*Fumaria officinalis* L.) and Knot grass (*Polygonum aviculare* L.), as well as 5 perennial species – Bermuda grass (*Cynodon dactylon* L.), Yarrow (*Achillea millefolium* L.), Canada thistle (*Cirsium arvense* L.), Bindweed (*Convolvulus arvensis* L.) and Danewort (*Sambucus ebulus* L.).

The first reporting of the species composition of weeds and their quantity in the studied area (according to the adopted methodology) was carried out in the first decade of May in 2013 and 2014 economic years, prior to the herbicide application. The species found and their quantity are presented in Fig. 1. Analyzing weed density during the two years of the experiment, it becomes obvious that unlike 2013, in 2014 the weeds in the studied area increased by 40,74% before treatment as a result of more rainfall creating favorable conditions for weed development. The data show that the studied areas were mainly occupied by perennial weed species.

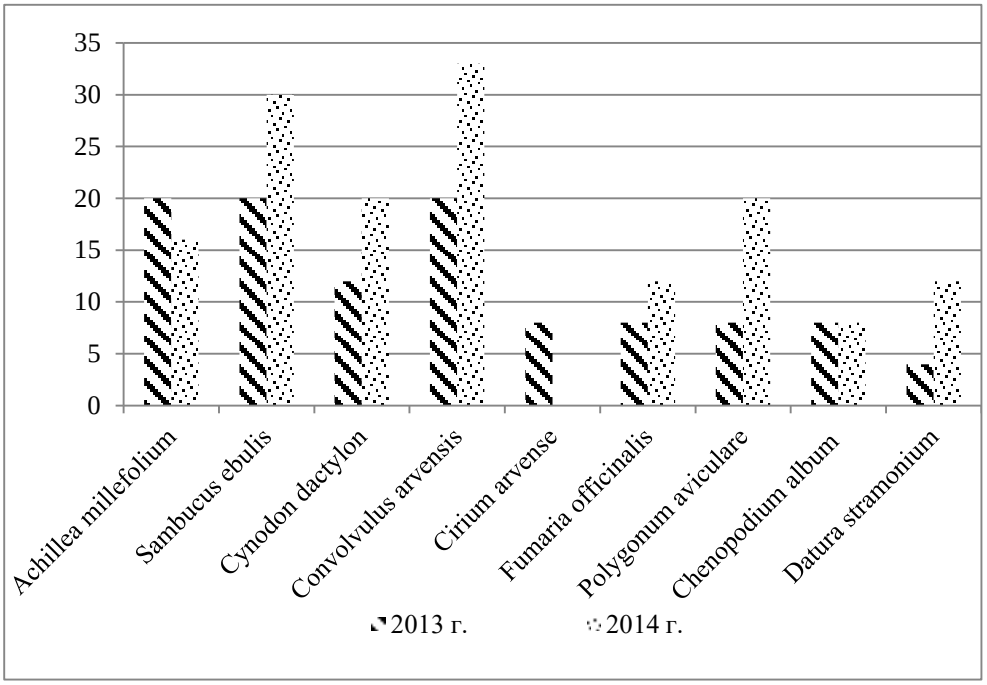

Figure 1. Density weeds (number/m^2) before spray with herbicide

In the first experimental year they reached up to 80 plants per m^2, while in the next 2014, the perennial weeds increased by 25%. In 2013, each of the species bindweed, yarrow and danewort were represented by 25% of all the weeds found, followed by Bermuda grass – 15% and Canada thistle – 10%, while in 2014 Canada thistle plants were not found and the other perennial weeds were 66% of the weed association in the young lavender field (yarrow – 16%, Bermuda grass – 34%, danewort – 30% and Bermuda grass – 20%).

The results of the weed density after application of the herbicides, reported four times in 2013, are presented in Table 1. The data show that on the first reporting date, 30 days after herbicide treatment, the perennial weeds prevailed in all the variants of the experiment, i.e. 28 plants per m^2 in Variant 1 (Control), followed by Variant 6, the lowest density being established in Variant 2 – 4 plants per m^2, respectively. The tendency of prevailing perennial weeds was also confirmed when reporting the general spread of weeds in the different variants. It is important to follow out the ratio of annual and perennial species in the separate variants of the experiment, as that ratio is most likely to give an idea of the effectiveness of the herbicides and their combinations against the weed species found in the young lavender field. In Variants 3 and 4 there was 100% control over annual weeds and the worst effect against annual and perennial weeds was reported in Variant 6, in which the weed density was 12 plants/m^2 for the annual species and 26 plants/m^2 for perennial species, respectively.

On the second reporting date – 60 days after the beginning of the experiment, the highest density of weed plants in the studied field was established in the control variant with hand hoeing – up to 54 plants/m^2, followed by Variant 6 – 47 plants/ m^2. The increase of the total number of weeds in each of the variants compared to the previous reporting date was in the range of 7 to 9 plants/m^2, which represents an increase of 15 to 46%. The increase in the

total number of weeds was mainly at the expense of perennial species. The herbicides used had a positive effect in controlling the annual weeds at a low density within 60 days after application. The lowest weed density was reported in Variant 2, the effectiveness in the Variant compared to the control being 74,07%, followed by the Variants 4 and 5 (66,67% and 57,41%) and the lowest efficiency was reported in Variant 6 – 12,96%.

Table 1.

Density weeds (number/m^2) after spray with herbicide in 2013

Density weeds (number/m^2)		Day after spray	Variants					
			1	2	3	4	5	6
	Annual broad leaved weeds	30	18	4	0	0	1	12
		60	22	5	1	1	4	12
		90	24	10	4	3	5	13
		120	27	12	5	4	7	15
	Perennial weeds	30	28	4	19	12	16	26
		60	32	9	26	17	19	35
		90	42	14	40	26	31	43
		120	47	18	48	29	41	52
	Total annual broad leaved and perennial weeds	30	46	8	19	12	17	38
		60	54	14	27	18	23	47
		90	66	24	44	29	36	56
		120	74	30	53	33	48	67

On the third reporting date – 90 days after applying the soil herbicides, an increase in the total number of weeds in all the variants was established, again the highest being the

number of weeds in the control, followed by Variants 6 (66 and 56 weed plants/m^2, respectively). Those results show the compensatory mechanisms in the lavender field, creating conditions for the rapid development of the weed species spreading in the field. Comparing the rate of increase of the total number of weed plants by variants to the previous reporting date, the following was established: the highest number of new weed plants emerging in the experimental plots, was found in Variant 3. Only in 30 days, 18 new weed plants per m^2 were found in the area of this variant, including 3 annual plants per m^2 and 15 perennial plants per m^2. A similar tendency was found in the other variants of the experiment. As time passed after application of the herbicides, their effect on the controlled weeds decreased, the increased number of weed plants being mainly annual species. That effect was most strongly expressed in Variant 3 (75%), and the longest effect against annual weed species in the studied area on the 90^{th} day after treatment was observed in Variant 5 – 20%.

The results reported 120 days after the beginning of the experiment were similar to the previous reporting dates. The same tendency was confirmed, the control variant being the most weed infested, followed by Variant 6, the other four variants arranged in the same order as on the first reporting date 30 days after treatment with the herbicides. The least number of weeds among the latter variants was established in Variant 2, followed by Variants 4 and 5. The lowest herbicidal effect in the experimental area was established in Variant 6.

The results for the weed density after application of the herbicides from the four reporting dates in 2014 (Table 2) show a relatively higher total weed infestation in the studied areas compared to 2013. A very good effect of the herbicides on the annual weed species was established on the first reporting date (30 days after the herbicide treatment) compared to the control, especially in the second, third and sixth variants where 100% control of those weeds was achieved. Less effect was observed in variants four and five, in which single plants of knot grass were found. In general, the effect of the herbicides on the perennial weeds was low and not well expressed as on annual weed species.

The total number of weeds recorded 60 days after the beginning of the experiment was higher for both perennial and annual weeds, compared to the results reported 30 days after treatment. The increase ranged from 7 to 10 weed plants per m^2. The highest weed density was established in the control variant – 61 plants/m^2, including 17 plants/m^2 of annual species and 44 plants/m^2 of perennial species, i.e. 28% to 72%, respectively. Referring to the effectiveness of the applied herbicides against annual weed species, the third and sixth variants again showed a total control of the weeds in the lavender field.

On the third reporting date, 90 days after the beginning of the experiment, there was an increase of weed infestation with perennial weeds, especially in the control variant (69 plants/m^2. The ratio of annual to perennial species was 25 to 75%. Regarding the reported results of the total weed spread in the studied plots compared to the control, the variants were arranged in the following order: the lowest total weed infestation was found in Variant 2, followed by Variant 4 and finally Variant 3. The results reported 90 days after treatment with the soil herbicides gave grounds to conclude that the indicated rates have a 90-day period of post-effect on the weed species reported in the study. Compared to the previous reporting date, i.e. 60 days after the beginning of the experiment, it was found that there was no change in the number of weed plants, even in the control. The lack of newly developed plants in the control may indicate that there were no conditions for weed emergence and development, as a result of which they did not appear in the other variants of the experiment, too.

The data obtained 120 days after the beginning of the experiment did not differ significantly from the outlined tendency in the experiment, namely an increase in total weed infestation in

Table 2.

Density weeds (number/m^2) after spray with herbicide in 2014

Density weeds (number/m^2)		Day after spray	Variants					
			1	2	3	4	5	6
	Annual broad leaved weeds	30	14	0	0	4	1	0
		60	17	3	0	5	1	0
		90	17	1	0	5	1	0
		120	20	3	0	8	1	1
	Perennial weeds	30	35	19	37	20	28	31
		60	44	25	47	26	37	40
		90	52	32	53	32	45	46
		120	58	35	61	41	53	51
	Total annual broad leaved and perennial weeds	30	49	19	37	24	29	31
		60	61	28	47	31	38	40
		90	69	33	53	37	46	46
		120	78	38	61	49	54	52

all the variants, mainly due to the increase of the perennial weeds. Regarding the effect in the studied variants compared to the control, it can be concluded that the best effect on the annual weed species in the lavender field, reported 120 days after treatment, was obtained in Variant 3 (100% efficiency), followed by Variants 5 and 6 (95% efficiency), Variant 2 (90% efficiency) and Variant 4 (60% efficiency). Concerning the results for the general weed infestation in the lavender field, the best effect compared to the control was reported in Variant 2, followed by Variant 4, Variant 6, Variant 5 and last comes Variant 3.

Data about the annual growth of bindweed and danewort (Table 3), recorded in two periods – 30 and 120 days after herbicide treatment, showed that all the herbicides used inhibited the growth of *Convolvulus arvensis* L. stems. The effect was established during the two experimental years. From data obtained during the two-year period of the study, it can be concluded that the herbicide product Pledge had the strongest suppressing effect on the stem growth of the weed (stems were by 31.34% and 32.79% shorter compared to the control), followed by Devrinol 4 F (57.38% and 52.24%, respectively). Out of all the herbicides applied, Devrinol 4 F showed the strongest suppressing effect on the growth of danewort plants (*Sambucus ebulus* L.). The results showed 78.26% and 61.29% shorter stems compared to the control during the two years of the study.

Table 3.

The influence of herbicides on the length of the stems of some weeds, cm

Variants	Convolvulus arvensis				Sambucus ebulus			
	2013		2014		2013		2014	
	30 day after spray	120 day after spray	30 day after spray	120 day after spray	30 day after spray	120 day after spray	30 day after spray	120 day after spray
1	4	61	22	67	10	23	13	31
2	5	35	18	35	3	11	10	19
3	21	30	24	51	7	26	15	31
4	4	20	6	21	7	17	23	36
5	14	34	18	56	12	26	12	28
6	10	40	33	51	15	25	13	32

For the other variants, it can be stated that the herbicides applied at the rates mentioned, under the conditions of the experiment, did not exert a suppressive effect on the growth of danewort weed plants (*Sambucus ebulus* L.).

The data about the effect of soil herbicides on lavender plant growth showed that those products did not have a negative impact on the annual growth increment (Fig. 2).

In the first year of the experiment, all the treated variants exceeded the control by 25% to 50% and the largest annual increment was reported in Variant 4 (6 cm). In 2014, a larger stem increment of the crop plants was established in all the variants than in 2013, which is explained by the age of the plants. In all the herbicide-treated variants they had 14% to 43% larger stem increment than the control.

The application of the herbicide Pledge 50 WP at the rate of 8 g/da showed the most favorable effect on the growth of lavender plants, exceeding the control by 6 cm.

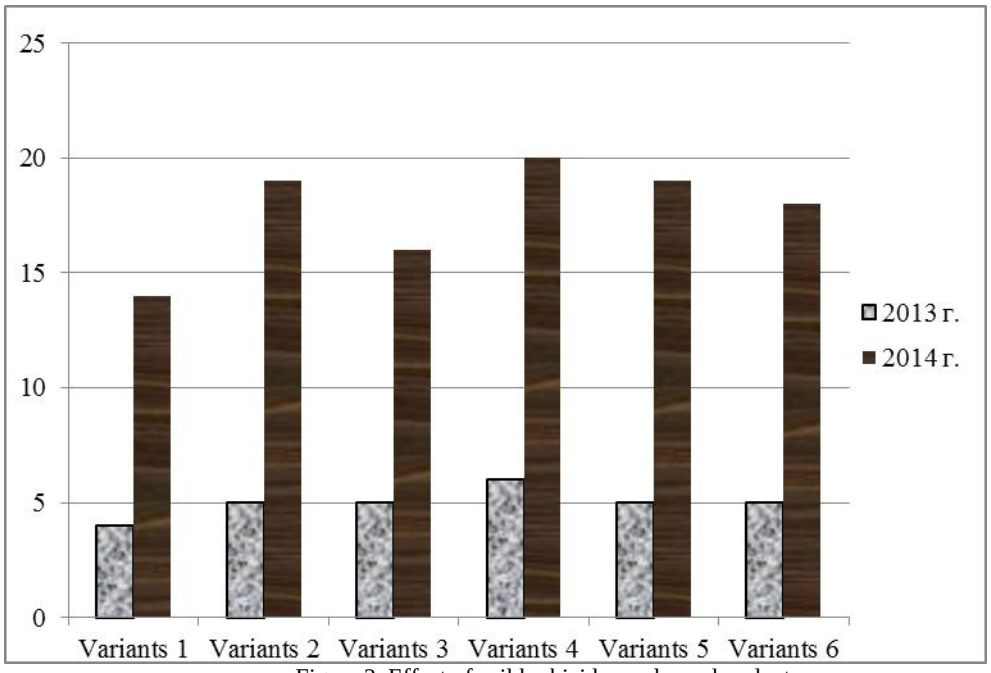

Figure 2. Effect of soil herbicides on lavender plant

CONCLUSIONS

The applied herbicides showed good efficacy against annual broadleaf weeds and an expected weaker control over perennial weed species.

The best control of the annual and perennial weeds in a young lavender field was achieved in the variants with the herbicides Devinol 4 F (450 g/l napropamide) applied at the rate of 400 ml/da and Pledge 50 WP (500 g/kg flumioxazine) at the rate of 8 g/da.

The studied soil herbicides at the rates applied at the respective plant development stages and combinations, did not have a negative effect on the annual growth of the lavender plants in the frames of the present experiment.

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