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Possibility for weed control by using of an organic product with herbicidal effect

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***Abstract**.* The possibility for weed control in noncropped areas (stubbles) by using an organic product with herbicidal effect (Segador), alone and combined with low dose of synthetic herbicide (Roundup, 360 g/L glyphosate), was investigated. The individual application of Segador at a dose of 18 l/ha suppressed completely the annual grassy weeds and also showed a very good effect against broadleaf weeds and perennial grassy weeds (85–95 % efficacy), therefore could be recommended for organic farming. The combined application of Segador with Roundup at different doses significantly increased the efficacy of the herbicidal mixture. Its application depended on the predominant weed species in the cultivated area. The combination of Segador and Roundup, each one at a dose of 6 l/ha, provided good control of annual weeds and *Sorghum halepense*, but a certain resistance showed some perennial broadleaf species (*Convolvulus arvensis, Rumex crispus* and *Cynodon dactylon*) as the efficacy was in the limits 75–97 %. Increasing the dose of Segador up to 12 L/ha in combination with Roundup 6 L/ha suppressed *Rumex crispus* and *Cynodon dactylon* and increased the efficiency in *Convolvulus arvensis* to 95 %. Full control of annual and perennial weeds, provided the organic product Segador 18 L/ha + herbicide Roundup 6 L/ha, as the effect of the mixture was equalized with that of Roundup at a dose of 12 L/ha. The low dose of application of Roundup in combination with different doses of Segador minimized the use of synthetic herbicide and is recommended for conventional production.
***Keyword**:* bioherbicide, weed control, efficacy, noncropped areas.

Introduction

Biological production of cereals in Bulgaria has expanded continuouslyduring the past 10 years. Weed control in this production is important for realization of permanent and satisfactory grain yield. This is imposed by the prohibition of applying chemical products that can eliminate their competitive impact on crops [DONKOVA, 2015].

Weeds reduce crop yields more than other pests [OERKE, 2005]. On the one hand, they reduce the yields directly, in competition with the crops regarding the main environmental factors–nutrients, water, light, space [NAJWA et al., 2012], and on the other hand, they can suppress the seed germination and initial development of plants through allelopathic interference [STOIMENOVA et al., 2008]. The great species diversity and their high biological plasticity continue to be a major problem related to the weeds, enabling their fast spread and adaptation [OERKE, 2005].

An increasing problem is the invasion of perennial weeds because of a great regenerative ability of their underground organs and high seed productivity. The control of weeds from this biological group is extremely difficult [DIMITROVA, 2009]. Good phytosanitary effect in organic production conditions is ensured by a set of agricultural activities: observing the crop rotation, introduction of legumes and winter intermediate crops for plant cover as well mechanical weed control methods [ILIEVA and MITOVA, 2014].

Khan and Khan define bioherbicides as economically efficient, environmentally friendly and easy to apply [KHAN and KHAN 2012]. It is believed that they provide the opportunity for control of herbicide–resistant weeds, as the possibility for resistance development is smaller [AULD and MORIN, 1995].

The active ingredients of bioherbicides are phytopathogenic microorganisms, phytotoxic aqueous extracts of herbage biomass or natural extracts [IMAIZUMI et al., 1998; KHALIQ et al., 1999; CHEEMA et al., 2003a; ANJUM and BAJWA, 2007a, 2007b; CHARUDATTAN and HIEBERT, 2007; ASH, 2009a, 2009b].

In contrast to the chemical herbicides, the action of most bioherbicides is directed towards relatively few weeds [CRUMP et al., 1999]. The interaction between chemical herbicides and bioherbicides has been reported as an approach to improving the spectrum of weed control [BANNON et al., 1990].

Some researchers [IQBAL et al., 2009; RAZZAQ et al., 2010; RAZZAQ et al., 2012] consider that the combinations of phytotoxic crop water extracts with lower doses of herbicides are particularly promising. In addition, it should be noted, that the bioherbicides will not replace the chemical herbicides or other weed control methods. They should be incorporated in an integrated weed management strategy, which is a part of the existing technologies for crop cultivation [MEDD, 1992].

The present study was conducted to investigate the possibilities for weed control in noncropped area (stubble) by using an organic product with herbicidal effect, alone and combined with low dose of synthetic herbicide.

Material and methods

The field experiment was conducted in a non–cropped area (stubble) after harvest of winter cereal crop (rye) grown in organic production conditions, under natural weed infestation, during the period 2013–2015. Block design method was used with three replications and size of the experimental plot of 5 m^2.

The survey was conducted with an organic product with herbicide action Segador (manufacturer AISA, Spain) at doses of 600, 1200 and 1800 mL/da.

The product is a complex of natural hydroxyphosphate in the form of emulsion and natural surfactant depressor of water activity, characterized by rapid herbicidal effect in some broadleaf weeds and grassy weeds. It contains water–soluble phosphorus (P_2O_5) 25.5 %, water–soluble zinc (Zn) 0.20 % and has total action. As a standard was used Roundup (360 g/L glyphosate) applied at two doses of 600 and 1200 mL/da (doses are applied with a working solution of 50 L/da).

With aim to reduce the weed density and to increase the herbicide effect of the organic product was also studied and combined application of Segador with Roundup at 3 doses, respectively: Segador 600 mL/da + Roundup 600 mL/da; Segador 1200 mL/da + Roundup 600 mL/da, Segador 1800 mL/da + Roundup 600 mL/da.

The control was untreated, with weeds. A total 9 variants were investigated: 1. Control (untreated); 2. Segador 600 mL/da; 3. Segador 1200 mL/da; 4. Segador 1800 mL/da; 5. Roundup 600 mL/da; 6. Roundup 1200 mL/da; 7. Segador 600 mL/da + Roundup 600 mL/da; 8. Segador 1200 mL/da + Roundup 600 mL/da; 9. Segador 1800 mL/da + Roundup 600 mL/da.

The treatment was carried out 30 days after rye harvesting, at the stage of budding of broadleaf weeds and earing of grassy weeds [DIMITROVA, 2009].

The efficacy of organic product and herbicide against weeds was assessed on the 21st day after their application [DIMITROVA, 2009] according to a 100 % visual scale (0–100 % destroyed weeds) of EWRS (European Weed Research Society). An additional indicator for determining the efficacy of a herbicide from the viewpoint of its use is the change in the chlorophyll content of the weeds, determined 2–6 days after treatment [PAVLOVIĆ et al., 2014]. In the conditions of present experiment, the pigment content in the leaves of one of the main weed *Sorghum halepense* L. (Pers.) was determined 5 days after treatment in all variants. The used method was the one of Zelenskiy and Mogileva [ZELENSKIY and MOGILEVA, 1980].

The visual–route method was applied to determine the total weed infestation before the treatments.

The assessment was carried out on a 4–degree scale (0–clear of weeds, 2–weak weed infestation 1–5 %, 2–average weed infestation 5–25 %, 3–strong weed infestation 25–50 %, 4–very strong weed infestation over 50 %/) [FETVAJIEVA, 1972; KALINOVA et al., 2006].

The species composition and weed density were recorded by permanent 1 m^2 sampling plots in 10 replications.

Results and discussion

Before treatment, the degree of weed infestation was high (score 3), and the weed species found were as follows: *Setaria glauca* L. (37.7 %), *Echinochloa crus–galli* L. (2.1 %), *Chenopodium album* L. (2.1 %), *Solanum nigrum* L. (0.8 %), *Erigeron canadense* L. (2.7 %), *Sinapis arvensis* L. (1.0 %), *Amaranthus retroflexus* L. (2.3 %), *Portulaca oleracea* L. (0.7 %), *Polygonum aviculare* L. (2.5 %), *Fallopia convolvulus* L. (0.7 %), *Mercurialis annua* L. (1.0 %), *Sorghum halepense* L. (Pers.) (27.5 %), *Cynodon dactylon* L. (5.4 %), *Convolvulus arvensis* L. (9.7 %), *Rumex crispus* L. (3.2 %) and *Cirsium arvense* L. (0.6 %) (Figure 1).

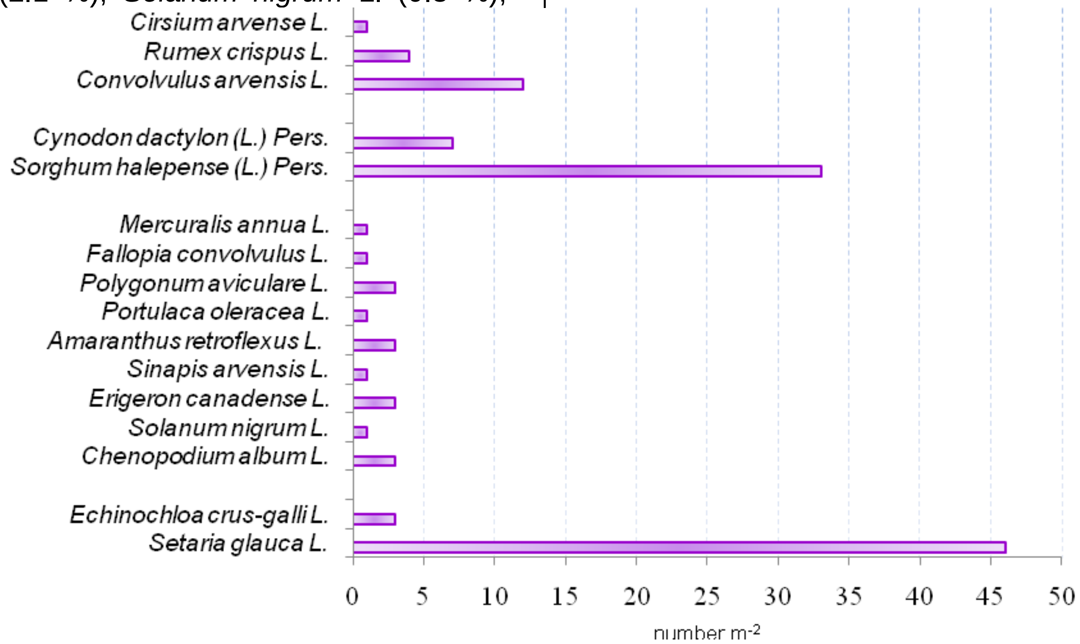

Figure 1. Species composition and density of weeds in stand of biologically grown rye, average for the period

The weed percentages showed that the dominant were grass weeds, which, according to Mitkov and Tonev are determined as much more harmful than broadleaf weeds [MITKOV and TONEV 2014].

The average weed density was 122 numbers per m^2. The results of the study of the organic product with herbicidal action are presented in Table 1.

Segador, applied at a dose of 12 L/ha, showed a low efficacy against the weeds from various groups: from 18 to 50 % in annual weeds and from 8 to 25 % in perennial weeds.

Most affected and suppressed in their development at this dose were *Solanum nigrum* and *Mercurialis annua.*

An even weaker was the effect of Segador at a dose of 6 L/ha: very slight efficiency against *Chenopodium album, Solanum nigrum and Mercurialis annua* (25 %) and single chlorotic spots and damages on the aboveground parts of *Setaria glauca, Echinochloa crus–galli, Amaranthus retroflexus, Sorghum halepense, Cynodon dactylon, Cirsium arvensis* and *Rumex crispus*.

The organic product, applied at a dose of 600 mL/da, did not exhibit a herbicidal action against most of the broadleaf weeds.

The treatment with Segador at the highest dose (18 L/ha) suppressed the annual grassy weeds, the species *M. annua and R. crispus*, and showed a very good effect against broadleaf weeds and perennial grassy weeds (85–95 % efficacy).

The efficacy of Segador against *C. dactylon* (85 %) was weaker pronounced compared to that in *S. halepense* (95 %). Roundup at a dose of 6 L/ha manifested a

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high efficacy (100 %) in regard to annual weeds as well as *S. halepense*.

Dimitrova also reported for achieved 100 % efficacy against *S. halepense* even at lower rates (4–5 L/ha) of application of Roundup (360 g/L glyphosate) [DIMITROVA, 2009].

Table 1.

Efficacy of Segador and the standart Roundup (360 g/L glyphosate) against broadleaf and grass weeds

Variants		Segador 6 L/ha	Segador 12 L/ha	Segador 18 L/ha	Roundup 6 L/ha	Roundup 12 L/ha	$LSD_{0.05}$
Annual grassy weeds	*Setaria glauca* L.	5a*	25b	100ns	100ns	100ns	4.06
	Echinochloa crus–galli L.	5a	18b	100ns	100ns	100ns	10.57
Annual broadleaf weeds	*Chenopodium album* L	25a	27a	95b	100ns	100ns	2.44
	Solanum nigrum L.	25a	50b	95ns	100ns	100ns	16.26
	Erigeron canadense L.	0a	23b	90c	100ns	100ns	4.06
	Sinapis arvensis L.	0a	25b	90ns	100ns	100ns	18.18
	Amaranthus retroflexus L	5a	33b	95ns	100ns	100ns	14.40
	Portulaca oleracea L.	0a	25b	88c	90cd	100d	12.19
	Polygonum aviculare L	0a	25b	90ns	100ns	100ns	18.17
	Fallopia convolvulus L.	0a	25b	90ns	100ns	100ns	17.28
	Mercuralis annua L.	25a	50b	100ns	100ns	100ns	32.51
Perennial grassy weeds	*Sorghum halepense* L. Pers.	9a	25a	95ns	100ns	100ns	10.41
	Cynodon dactylon L. Pers.	5a	23b	85ns	90ns	100d	9.09
Perennial broadleaf weeds	*Convolvulus arvensis* L.	5ns	10ns	85c	70b	100d	9.41
	Rumex crispus L.	10a	23a	100ns	95ns	100ns	14.65
	Cirsium arvense L.	0a	8b	90c	95cd	100d	6.50

*Values within a column followed by same letters are not significantly different
ns – not significant differences

In our study, Roundup at dose of 6 l/ha was insufficient in terms of some perennial weeds (*C. arvensis, R. crispus, C. dactylon* and *C. arvense*), for which the efficacy had values of 70, 90 and 95 % respectively.

Total destruction of weeds from all groups in the treated area was achieved after application of Roundup at 12 L/ha.

The combined use of Segador with Roundup at three doses of application significantly increased the efficacy of the herbicidal mixture (Table 2).

Table 2.

Efficacy of a mixture of Segador and the standart Roundup (360 g/l glyphosate) against broadleaf and grass weeds

Variants		Segador 6L/ha+ Roundup 6 L/ha	Segador 12Ll/ha + Roundup 6L/ha	Segador 18L/ha+ Roundup 6 L/ha	$LSD_{0.05}$
Annual grassy weeds	*Setaria glauca* L.	100ns	100ns	100ns	0.02
	Echinochloa crus–galli L.	100ns	100ns	100ns	0.22
Annual broadleaf weeds	*Chenopodium album* L	100ns	100ns	100ns	0.03
	Solanum nigrum L.	100ns	100ns	100ns	0.13
	Erigeron canadense L.	100ns	100ns	100ns	0.00
	Sinapis arvensis L.	100ns	100ns	100ns	0.00
	Amaranthus retroflexus L	100ns	100ns	100ns	0.15
	Portulaca oleracea L.	100ns	100ns	100ns	0.15
	Polygonum aviculare L	100ns	100ns	100ns	0.12
	Fallopia convolvulus L.	100ns	100ns	100ns	0.04
	Mercuralis annua L.	100ns	100ns	100ns	0.06
Perennial grassy weeds	*Sorghum halepense* L. Pers.	100ns	100ns	100ns	0.13
	Cynodon dactylon L. Pers.	99ns	100ns	100ns	3.89
Perennial broadleaf weeds	*Convolvulus arvensis* L.	76a	95b	100c	2.60
	Rumex crispus L.	96a	100b	100b	2.91
	Cirsium arvense L.	93a	95ab	100b	5.20

*Values within a column followed by same letters are not significantly different
ns – not significant differences

The combination of the organic product with Roundup, each of that applied at a dose of 6 l/ha, provided full destruction of annual weeds and *S. halepense*. A lower efficacy was observed in perennial broadleaf species, such as the efficacy of the tank mixture in regard to them was in the limits 76–96 %.

This reduced efficacy has been overcome in some extent by increasing the dose of organic product: the combination Segador 12 L/ha + Roundup L/ha destroyed completely *R. crispus* and increased the efficacy in *C. arvensis* and *C. arvense* to 95 %. Both combinations (Segador 6 L/ha + Roundup 6 L/ha; Segador 12 L/ha + Roundup 6 L/ha) showed a higher efficacy in terms of perennial weeds (except *C. arvense*) than the individual application of Roundup at a dose of 6 L/ha. Destruction of the weed species of all groups was found after treatment with the mixture Segador 18 L/ha + Roundup 6 L/ha, whose action was equal to that of Roundup at a dose of 12 L/ha. The pigment content analysis in the leaves of *S. halepense* (Table 3), 5 days after individual and combined application of Segador at different doses, showed a decrease in all variants compared to the pigment content in control, in the limits from 0.8 to 89.8 %.

Table 3.

Pigment content in the leaves of *S. halepense* after application of Segador and the standart Roundup, mg/100 fresh mass

Variants	Chlorophyll A	Chlorophyll B	Chlorophyll A+B	Carotenoids
1	63.23f*	33.72e	96.94g	22.24e
2	61.14fg	33.68e	94.82fg	22.60e
3	59.55f	32.47e	92.02f	26.23f
4	16.47c	12.04b	28.51c	8.60b
5	47.64e	29.33d	76.97e	22.23e
6	11.92b	7.12a	19.04b	10.53c
7	20.90d	14.15c	35.05d	13.77d
8	18.25cd	10.82b	29.07c	12.91d
9	0.30a	6.70a	7.00a	5.17a
$LSD_{0.05}$	3.29	1.46	3.24	1.26

1. Control (untreated); 2. Segador 6 L/ha; 3. Segador 12 L/ha; 4. Segador 18 L/ha; 5. Roundup 6 L/ha; 6. Roundup 12 L/ha; 7. Segador 6 L/ha + Roundup 6 L/ha; 8. Segador 12 L/ha + Roundup 6 L/ha; 9. Segador 18 Ll/ha + Roundup 6 L/ha

*Values within a column followed by same letters are not significantly different

This reduction was the least expressed after treatment with Segador at doses of 6 and 12 L/ha–with 1.5 and 0.8 %, which corresponded to its low efficacy. Considerably more substantial was the decrease after Roundup treatment at doses of 6 and 12 L/ha – 16.8 and 75.2 %, respectively. With a similar value of decline near to the value after application of the high dose of Roundup was the treatment with Segador at a dose of 18 L/ha. The combined use of Roundup (6 L/ha) with increasing doses of Segador decreased the pigment content in the leaves of *S. halepense* with 59.0 to 89.8 %. The reduction in variant 9 (Segador 18 L/ha + Roundup 6 L/ha) was stronger expressed, than the reduction in variant 6 (Roundup 12 L/ha), which is indicative for the effectiveness of the combination and its rapid initial action.

The weed control is one of the challenges facing organic production. Very often the scientific researches reported that the quantity and weed species in this production system was increased compared to conventional system, especially in the initial period of conversion [KAUPPILA, 1990; MITOVA and DONKOVA, 2014]. In stand of winter wheat grown organically, Donkova established a low density of weeds (56 pieces/m^2) and variation in species composition between 12–15 species [DONKOVA 2015]. Substantially higher density was observed by Nenova and collab. under conditions of organic farming in wheat (122 pcs./m^2) and winter oats (100 pcs./m^2) [NENOVA et al.2011]. Ilieva and Mitova reported 120 pieces weeds / m^2 in organically grown rye, as predominating are annual weeds, presented by *S. glauca* and *P. aviculare* [ILIEVA and MITOVA, 2014].

The general importance of this group, expressed through the relative share in the total weed infestation was significant (62 %, determined by number). In a similar survey of organic rye, Maneva and Atanasova found 112.7 weed numbers/m^2 as main weeds were *Setaria* *sp.* (46 numbers), *F. convolvulus* (48 numbers) and *P. aviculare* (14 numbers) [MANEVA and ATANASOVA, 2014]. These data are similar to those obtained in the present experiment: a value of 122 weeds/m^2, as well as a high participation of *S. glauca* (46 numbers). It should be borne in mind, however, the fact, that the species composition and level of weed infestation is determined not only by the crop and production system, but also by a number of other environmental and agrotechnical factors: weather conditions, soil type, predecessor, sowing rate, fertilization, *etc*. [TITYANOV, 2006]. The best-known examples of natural herbicides are phytotoxic water extracts from herbage of sorghum (*Sorghum bicolor* (L.) Moench.) (sorgaab) and sunflower (*Helianthus annuus* L.) (sunfaag). Sorgaab showed good results in cotton, soybean, wheat and rice.

The highest efficacy of this extract has been found in rice–reduction of biomass of *E. cruss–galli* by 40 %. Sunfaag has been widely used in wheat, although it has not eliminated all weed species in the field. In particular, its application reduced the biomass of *Chenopodium album* and *Rumex dentatus* by 70 % and 97 %, respectively. Khan and Khan also reported for achieved good weed control in wheat after application of water extracts of *Phragmites au*stralis and *Helianthus annuus* (gave 68 and 65 % weed control, respectively), as the effect of *Phragmites australis* exceeds that of the herbicide, used as a control (Logran Extra 64 WG) [KHAN and KHAN, 2012, BUTU, *et al.*, 2014, BUTNARIU, 2012].

In conditions of this study Segador at a dose of 1800 mL also demonstrated a similar effect to that of Roundup at dose 600 mL in regard of the perennial weeds.

Despite the good prospects for biological control of weeds, some authors [MITOVA and DONKOVA, 2014] are skeptical regarding the opportunities for effective control of the weeds in organic farming.

According Soltys and collab. in most bioherbicides lacks a sufficient "aggression" to be overcome the resistance of weeds and to be achieved an adequate control [SOLTYS et al. 2013]. Cheema and collab. recommended organic compounds having herbicidal properties to be combined with phytotoxic extracts at lower doses. This, on one side, may improve the efficacy of phytotoxic extracts and on other side may provide the opportunities of reducing the herbicidal doses and hence the cost of weed control could be lowered, promoting sustainable environmental safety [CHEEMA et al. 2003a. BUTNARIU, *et al.*, 2016, VARDANIAN, *et al.*, 2018].

These findings are in line with the findings of Iqbal and Cheema [IQBAL and CHEEMA 2007]. They reported an effective control of purple nutsedge *Cyperus rotundus* by utilizing natural plant extracts from various crops (sorghum, sunflower and brassica) in field conditions.

Their results showed that 12 and 15 L/ha plant water extracts, mixed with a reduced rate of glyphosate, decreased purple nutsedge density by 59 to 99 %, which was achieved by reducing glyphosate application rate by up to 67 %. Similar results also were obtained by other researchers. The recommended dose of isoproturon, for weed control in wheat, has been reduced by 50–60 % if used in combination with sorgaab at 12 L/ha [CHEEMA et al., 2003b, CAUNII, *et al.*, 2015, BUTNARIU, *et al.*, 2015]. One treatment with Sorgaab 12 L/ha with combination with sulfosulfuron (½ dose, 15 g a.i./ha) suppressed *Phalaris minor* L. density by 82–91 %. The corresponding suppression in weed density with a full dose of sulfosulfuron was 91–95 % [JAMIL et al., 2007, RODINO, *et al.*, 2014].

Our results confirm the possibility of effective control of some main cereal and broadleaf weeds, both through individual application of organic product Segador at a dose of 1800 mL/da, and also through combining different doses Segador (600, 1200, 1800 mL/da) with Roundup at a dose of 600 mL/da.

In the presence of weed infestation with annual species is recommended application of Segador with Roundup each one at doses of 600 mL/da, and in case of perennial species (*C. dactylon*, *C. arvensis*, *R. crispus*)–the combination of Segador 1200 mL/da + Roundup 600 mL/da. Full control of annual and perennial weeds, provides the organic product Segador 1800 mL/da + herbicide

Roundup 600 mL/da. The low dose of application of Roundup in combination with Segador minimizes the use of the synthetic herbicide and is recommended for conventional production conditions.

According to Dimitrova, in order to achieve a long–term effect in controlling weeds in non–cropped areas, afterwards is necessary to continue their control with soil tillages [DIMITROVA 2001, BUTNARIU, *et al.*, 2006, GEORGIEVA, *et al.*, 2018]. A good and reliable indicator for determination of the efficiency of the applied herbicides from the aspect of its justified use is the change in the chlorophyll contents of weeds [PAVLOVIĆ et al., 2014, IANCULOV, *et al.*, 2004]. Pavlović and collab. have found in *C. album* and *A. retroflexus* plants a significant reduction in total chlorophyll content after atrazine application [PAVLOVIĆ et al. 2006, PETRACHE, *et al.*, 2014]. The herbicide acted as a stress factor in the process of chlorophyll synthesis, stimulating decomposition. In a similar way, the effect of glyphosate has been monitored in *Beta vulgaris* [MADSEN et al., 1995], and the effect of clodinafop in *Hordeum murinum* and *Avena sativa* [ABBASPOOR and STREIBIG, 2005].

These experiments have shown that the determination of chlorophyll content is a reliable and sensitive method of monitoring physiological changes in plants under the impact of herbicides. In present study conditions, 5 days after treatment with organic and synthetic herbicide, the pigment content in *Sorghum halepense* leaves was severely reduced [BUTNARIU, *et al.*, 2005, BARBAT, *et al.*, 2013].

A particular attention should be given to the fact, that the changes in the pigment content after use of Segador 1800 mL/da are comparable with the changes after treatment with Roundup 1200 mL/da (a decrease by 73.9 and 81.1 % compared to the control), which is indicative for the herbicidal action of the organic product.

Generally, in all treated variants, the most significant was the decrease in the content of chlorophyll A (53.3 % averagely) followed by the decrease in the content of chlorophyll B and carotenoids (45.8 and 31.4 %, respectively) [DINEV, 1998, BUTU, *et al.*, 2014]. The more essential change in the content of chlorophyll A, is determined by the established higher sensitivity of chlorophyll A to external impacts.

Conclusions

The results obtained in the present study indicated good possibilities for weed control in noncropped areas (stubbles) by using an organic product with herbicidal effect, alone and combined with low dose of synthetic herbicide Roundup.

The individual application of Segador at a dose of 18 L/ha suppressed the annual grassy weeds, the species *M. annua* and *R. crispus*, and also showed a very good effect against broadleaf weeds and perennial grassy weeds (85–95 % efficacy), therefore could be recommended for organic farming conditions. The combined application of Segador with Roundup at different doses significantly increases the efficacy of the herbicidal mixture. Its application depends on the predominant species in the area.

The combination of Segador and Roundup, each one at a dose of 6 l/ha, provided full control of annual weeds and *Sorghum halepense*, but a certain persistance showed some perennial broadleaf species (*C. arvensis, R. crispus* and *C. dactylon*) as the efficacy of this mixture in regard to them is in the limits 75–97 %. Increasing the dose of organic product up to 12 l/ha in combination with Roundup 6 l/ha suppressed *R. crispus* and *C. dactylon* and increased the efficiency in *C. arvensis* to 95 %.

Full control of annual and perennial weeds, provided the organic product Segador 18 L/ha + herbicide Roundup 6 L/ha, as the effect of the mixture was equalized with that of Roundup at a dose of 12 L/ha. The low dose of application of Roundup in combination with different doses of Segador minimized the use of the synthetic herbicide and is recommended for conventional production.

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