Acta Sci. Pol. Agricultura 19(4) 2020, 201–212

www.agricultura.acta.utp.edu.pl pISSN 1644-0625 eISSN 2300-8504 DOI: 10.37660/aspagr.2020.19.4.4

ORIGINAL PAPER

Received: 20.08.2020
Received in revised form: 31.12.2020
Accepted: 31.12.2020

EFFECT OF THE USE OF PRO-ECOLOGICAL TREATMENTS AND PREVIOUS CROP STRAW ON THE WEED INFESTATION OF WINTER WHEAT AND SPRING BARLEY CULTIVATED AS SHORT-TERM MONOCULTURE

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ABSTRACT

Background. Wheat and barley are among the most important crops grown both in Poland and around the world. During their growth period they are exposed to the adverse impact of many pests, including weeds, fungal pathogens and insect pests. Numerous plant protection methods are used to limit their adverse impact.
Material and methods. In a three-year field study, the effect of the application of effective microorganisms (EM) Naturalnie Aktywny and Asahi SL preparations as well as the method of previous crop straw management on the number of weeds in short-term monocultures of winter wheat and spring barley were compared. Using the frame method, on individual experimental treatments, the number of dominant weeds, other weed species and the total number of weeds were randomly quantified immediately before a herbicide application (BBCH 31–32).
Results. The dominant weeds were *Viola arvensis*, *Apera spica-venti*, *Capsella bursa pastoris*, *Stellaria media*, *Chenopodium album* and *Cirsium arvense*. The observed increased weed infestation in the experiments was primarily due to the incorporation of straw into the soil during post-harvest cultivation. The increased weed density due to straw application to the soil was minimized to different extents by the use of effective microorganisms, especially the density of *Apera spica-venti*, *Capsella bursa pastoris*, *Chenopodium album* and all other weeds.
Conclusion. The weed infestation in short-term monocultures of wheat and barley was encouraged by incorporation into the soil of shredded straw. Degradation of this straw by the effective microorganisms applied during post-harvest cultivation led to a reduced total weed infestation and reduced density of *Apera spica venti*, *Capsella bursa pastoris*, *Chenopodium album* and all other weeds.

Key words: Asahi SL, microorganisms, monoculture, spring barley, straw, winter wheat, weeds

INTRODUCTION

Winter wheat and spring barley are exposed to the attack of many agrophages during the growing season. Apart from pathogens and phytophages, their growth and development can also be limited by numerous weeds (Maziarek *et al*., 2015; Tratwal *et al*., 2015). They are particularly sensitive to weed infestation in the early developmental stages (Haliniarz, 2010). Weeds primarily compete with

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field crops for access to nutrients and light. Moreover, they are food, hiding places and wintering place for both phytophagous and useful entomofauna (Marambe and Sangakkara, 1996; Boczek *et al*., 2009).

Frequent cultivation of cereals immediately after each other promotes weed infestation of the stand and the compensation of some weed species (Głowacka, 2006). These phenomena are particularly intense in the first years of a grain monoculture, and their effect is a decrease in yield (Parylak, 1998; Jaskulski *et al*., 2000).

Monocultures lead to the compensation especially of those weeds whose development rhythm is similar to that of field crops (Wesołowski *et al.*, 2003; Gołębiowska and Kaus, 2009; Jabłońska *et al.*, 2012). Intensification of weed infestation in grain monocultures is also favoured by substantial amounts of straw left in the field (Kuś and Smagacz, 2001; Smagacz, 2003). The most important weed species of spring barley include: *Chenopodium album*, *Stellaria media*, *Echinochloa crus-galli* and *Thlaspi arvense* (Stupnicka-Rodzynkiewicz *et al.*, 2004). The dominant weeds in winter wheat are: *Aperaspicaventi*, *Elymus repens*, *Centaurea cyanus*, *Brassica napus*, *Viola arvensis*, *Fumaria officinalis*, *Lamium purpureum* and *Stellaria media* (Weber *et al*., 2014; Małecka-Jankowiak *et al.*, 2015). The sustainable development of agriculture favours the search for effective, non-chemical methods of weed management. Research on the use of effective microorganisms (EM) and biostimulants in plant production has been conducted for many years around the world (Marambe and Sangakkara, 1996; Kositorna and Smoliński, 2008; Jabłońska *et al.*, 2012; Kierzek *et al.*, 2015). Effective microorganisms and the biostimulant Asahi SL are known to improve plant health, increase their yield, improve soil properties to be more beneficial for the growth and development of cultivated crops, as well as increase the resistance of species to rainfall deficiency (Piskier, 2006; Douglas, 2007; Javaid and Shah, 2010; Javaid and Bajwa, 2011), however, their effect on weed infestation is unknown.

The research hypothesis assumed that the use of effective microorganisms and/or a plant growth stimulant in short-term monocultures of winter wheat and spring barley may limit weed infestation with its application to forecrop straw left and incorporated into the soil. The aim of the current study was to determine the changes in the number of weeds in winter wheat and spring barley following the use of effective microorganisms and/or a plant growth stimulator under the conditions of retaining or removing forecrop straw from the field.

MATERIAL AND METHODS

Two static field experiments (with winter wheat and spring barley) were carried out in 2011–2014 using EM Naturalnie Aktywny and Asahi SL. EM Naturalnie Aktywny is a concentrate of effective microorganisms that improves soil fertility. It has the PZH/HT-1448/2002 certificate and the IUNG qualification certificate No. NE/1/2004. EM is a product that is safe for humans, animals and the environment. The composition given on the packaging is: lactic acid bacteria, photosynthetic bacteria, yeast, cane molasses and nitrobacteria. It does not contain genetically modified ingredients (GMO). It is manufactured under license from the EMRO-EM Research Organization, Japan.

Asahi SL, in accordance with the appendix to the decision of the Ministry of Agriculture and Rural Development (MRiRW) No. R-357/2010d of 27.12.2010, in the description of its action, is a stimulator of plant growth and yield in the form of a liquid to be diluted with water. It contains active substances (compounds from the group of nitrophenol derivatives): sodium para-nitrophenolate (0.3%), sodium ortho-nitrophenolate (0.2%) and sodium 5-nitroguajacolate (0.1%). The shelf life of the product is 3 years. It is permissable to use the product in agricultural and in vegetable and fruit plant cultivation.

In summer 2011, after 2 winter wheat harvests (2009/2010 and 2010/2011), a two-factor field experiment was established using a split-plot design. The winter wheat was sown in the autumn of 2011, 2012 and 2013, while spring barley was sown in the spring of 2012, 2013 and 2014.

The experiments quantified the effect of the application method of the preparations EM Naturalnie Aktywny and Asahi SL (factor I) on the weed infestation of the cultivated cereal species under the conditions of retaining or removing the previous crop straw (factor II).

Factor I – application methods of the preparations EM Naturalnie Aktywny and Asahi SL:

- EM – EM Naturalnie Aktywny introduced into the soil during post-harvest cultivation (in autumn) at a dose of 40 $dm^3 \cdot ha^{-1}$,
- 2EM – EM Naturalnie Aktywny introduced into the soil during post-harvest cultivation (in autumn) at a dose of 20 $dm^3 \cdot ha^{-1}$ and EM Naturalnie Aktywny applied in foliar application at a dose of 20 $dm^3 \cdot ha^{-1}$ at BBCH stage 20–22,
- BA – Asahi SL applied once in foliar application at a dose of 1.0 $dm^3 \cdot ha^{-1}$ at BBCH stage 20–22,
- 2BA – Asahi SL applied twice in foliar application at a dose of 2 × 0.5 $dm^3 \cdot ha^{-1}$ at BBCH stage 20–22 and BBCH 27–29,
- EM+BA – EM Naturalnie Aktywny introduced into the soil during post-harvest cultivation (in autumn) at a dose of 40 $dm^3 \cdot ha^{-1}$ + Asahi SL applied once in foliar application at a dose of 1.0 $dm^3 \cdot ha^{-1}$ at BBCH stage 20-22,
- EM+2BA – EM Naturalnie Aktywny introduced into the soil during post-harvest cultivation (in autumn) at a dose of 40 $dm^3 \cdot ha^{-1}$ + Asahi SL applied twice in foliar application, i.e. at a dose of 2 × 0.5 $dm^3 \cdot ha^{-1}$ at BBCH stage 20–22 and BBCH 27–29,
- 2EM+BA – EM Naturalnie Aktywny introduced into the soil during post-harvest cultivation (in autumn) at a dose of 20 $dm^3 \cdot ha^{-1}$ and EM Naturalnie Aktywny applied in foliar application at a dose of 20 $dm^3 \cdot ha^{-1}$ at BBCH stage 20–22 + Asahi SL applied once in foliar application at a dose of 1.0 $dm^3 \cdot ha^{-1}$ at BBCH stage 20–22,
- 2EM+2BA – EM Naturalnie Aktywny introduced into the soil during post-harvest cultivation (in autumn) at a dose of 20 $dm^3 \cdot ha^{-1}$ and EM Naturalnie Aktywny applied in foliar application at a dose of 20 $dm^3 \cdot ha^{-1}$ at BBCH stage 20–22 + Asahi SL applied twice in foliar application at a dose of 2 × 0.5 $dm^3 \cdot ha^{-1}$ at BBCH stage 20–22 and BBCH 27–29,
- control – without EM Naturalnie Aktywny and Asahi SL.

Factor II – the manner of straw management:

- previous crop straw left in the field and introduced into the soil during post-harvest cultivation,
- previous crop straw removed from the field after harvest.

Every experimentation year, in each of the two experiments, 18 treatments were tested using 3 replications. The EM Naturalnie Aktywny and Asahi SL preparations were applied using an AMAZONE UX5200 24m trailed sprayer. Post-harvest cultivation was carried out using a cultivating unit (disc harrow with 2 sections of toothed discs + ring roller).

The experimental field soil was light loam, containing: C_{org} 1.89%, available forms of P K and Mg, respectively, 14.3, 18.9 and 4.10 $mg \cdot 100\ g^{-1}$ and pH_{KCl} 7.1. The crop production practices in the field experiments were appropriate for the moderately intensive cultivation of winter wheat and spring barley. A plough tillage system was used, nitrogen fertilization was at a rate of 120 $kg\ N \cdot ha^{-1}$. The level of phosphorus-potassium fertilization was determined based on the soil abundance of available forms of these macronutrients. Herbicides were applied at BBCH stage 32–33, i.e. after recording weed infestation measurements (Puma Uniwersal 069 EW 1.2 $dm^3 \cdot ha^{-1}$ + Sekator 125 OD 0.15 $dm^3 \cdot ha^{-1}$). The seed was treated with a fungicide prophylaxis. Insecticides were not applied.

The density of weed species in individual treatments of the experiments was assessed randomly, using the frame method, in an area of 0.5 m^2 – at the end of tillering of cereals (BBCH 29), and before herbicide application. In each of the treatments the total numbers of individual weed species were counted from three replications in the three consecutive years of the study of winter wheat and spring barley (2012, 2013, 2014). The results are presented as the number of dominant weeds and the number of other weed species, as well as the total number of weeds following the method of Dorywalski (1976).

The results obtained were assessed in individual years and subjected to an analysis of variance for multiple experiments, in a design consistent with the implemented experimental design. The syntheses of multiple experiments was performed in a mixed model of combined inaccuracies, in which the experimental factors were treated as constants, while the interactions of factors with years were a component of experimental errors. The computational package FR-ANALWAR-5.3, developed at the Department of Plant Production and Experimental Methods of the Faculty of Agriculture and Biotechnology, the University of Technology and Life Sciences in Bydgoszcz, was used for statistical analysis. Comparisons of the groups of treatment means were made based on Tukey's multiple range test at the significance level $P = 0.05$.

RESULTS AND DISCUSSION

In this study, the mean density (number of weeds·m^{-2}) in the period of analyzing monocultures of winter wheat and spring barley was 167.4 pcs·m^{-2} and 96.6 pcs·m^{-2}, respectively. The dominant weed species in winter wheat monoculture were: *Viola arvensis, Apera spica-venti*, *Capsella bursa pastoris* and *Stellaria media.* Their total percentage in the whole population of the identified weeds was over 73.3%,and the percentages of individual species, respectively: 26.3% – *Viola arvensis*, 19.0% – *Apera spica-venti*, 18.1% – *Capsella bursa pastoris* and 9.7% – *Stellaria media*. The monoculture of spring barley was dominated by: *Capsella bursa pastoris*, *Cirsium arvense, Stellaria media* and *Chenopodium album,* which together accounted for 58.2% of the total number of weeds identified (Tables 2–3, Fig. 4–5).The percentages of dominant species in the total spring barley weed population were, respectively: 21.7% – *Capsella bursa pastoris*, 17.7% – *Cirsium arvense*, 9.6% – *Stellaria media* and 9.1% – *Chenopodium album.* The highest weed infestation of short-term monocultures of the analyzed cereals was observed in 2013, when the total precipitation in the period from March to May was noticeably lower than the mean for the years 1967-2014 and the temperatures were relatively high. Most likely, this was conducive to more abundant development of weeds as they are a species that is more resistant to changing weather conditions (Table 1, Fig. 1–3). Compared to the present study, Małecka-Jankowiak *et al.* (2015) determined a number and fresh weight of weeds in the monoculture of winter wheat, on average for the research period (2005-2007), amounting to 178 pcs·m^{-2} and 196 g·m^{-2}, respectively. They found that *Apera spica-venti* and *Viola arvensis* were the dominant species in the weed community under all of the experimental treatments. After using direct seeding in monoculture a greater occurrence of *Centaurea cyanus* and *Bromus sterilis* was also reported (Małecka-Jankowiak *et al.*, 2015). *Viola arvensis* has been reported as the dominant weed in winter wheat cultivation, while *Centauea cyanus*, *Lamium purpureum* and *Anthemis arvensis* have also been reported as abundant in winter wheat (Weber *et al.*, 2014). Buczek and Bobrecka-Jamro (2015) identified 22 species of weeds in winter wheat crops, with a predominance of short-lived spring and wintering taxa. *Chenopodium album*, *Galium aparine*, *Apera spica-venti*, *Matricaria maritima* ssp. *inodora*, *Stellaria media* and *Convolvulus arvensis* and *Cirsium arvense* were reported as perennial species (Buczek and Bobrecka-Jamro 2015). The dominant weeds in durum wheat listed by Woźniak (2007) were similar to those observed in the present study. Krawczyk and Sulewska (2012) reported *Centaurea cyanus*, *Viola arvensis* and *Matricaria maritima* ssp. *inodora* as the most common weeds in the cultivation of winter wheat.

Table 1. Total monthly rainfall and mean monthly air temperature for the many-year period 1967–2014 according to the data reported by the SDOO in Głębokie

Weather factor	Month											
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Total rainfall, mm	25	21	28	27	52	68	81	59	41	37	34	31
Mean air temperature, °C	-2.0	-1.0	2.6	8.0	13.6	16.6	18.7	18.1	13.4	8.4	3.4	-0.4

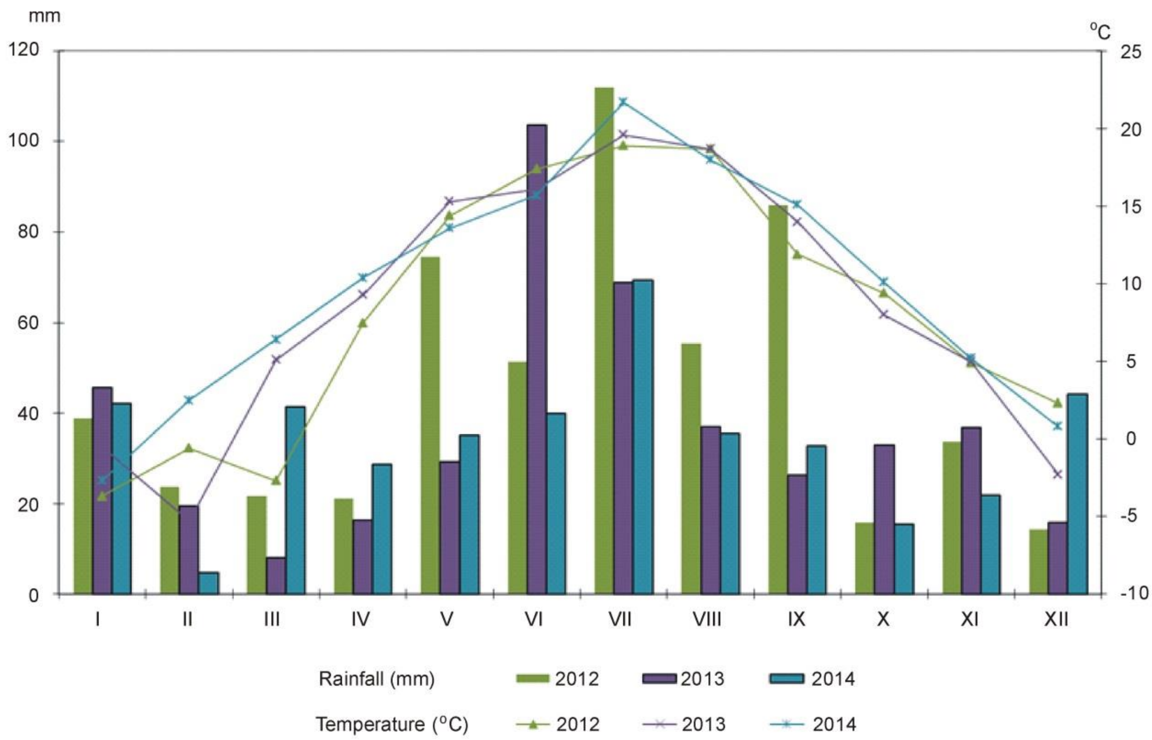

Fig. 1. Total monthly rainfall and mean monthly air temperature in the field for experimental years, according to the data reported by the SDOO in Głębokie

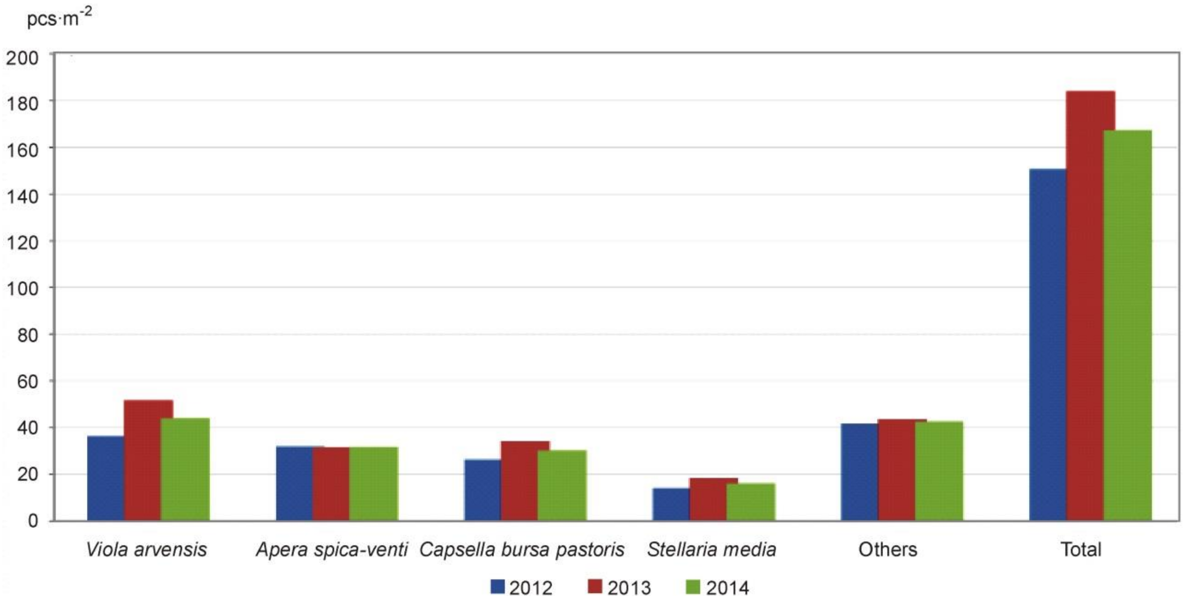

Fig. 2. The number of dominant weeds, other weeds and the total number of weeds in the individual years of short-term monoculture of winter wheat (pcs·m^{-2})

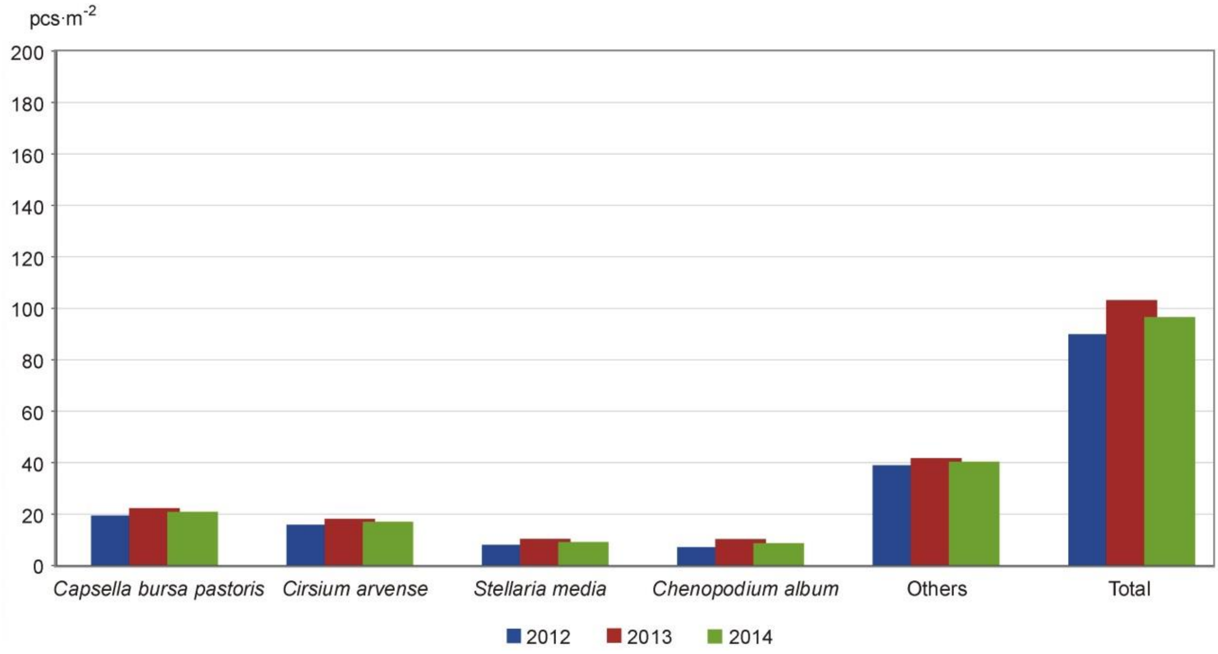

Fig. 3. The number of dominant weeds, other weeds and the total number of weeds in the individual years of short-term monoculture of spring barley (pcs·m^{-2})

Table 2. The mean (of three years of study) density (number·m^{-2}) of dominant and other weeds as affected by different treatments in the short-term monoculture of winter wheat

I – treatments	II – previous crop straw	Mean density (number·m^{-2}) of dominant and other weeds				
		Viola arvensis	*Aperaspica-venti*	*Capsella bursa pastoris*	*Stellaria media*	other weeds
1	2	3	4	5	6	7
EM	crushed	41.6	33.4	32.4	16.6	44.0
	removed	41.8	25.9	28.1	13.6	36.3
	Mean	41.7	29.6	30.2	15.1	40.1
2EM	crushed	48.3	42.0	32.2	19.1	52.1
	removed	41.5	30.3	26.7	15.5	36.3
	Mean	44.9	36.1	29.5	17.3	44.2
BA	crushed	46.3	34.6	30.9	16.5	58.8
	removed	44.0	24.6	31.2	17.4	32.5
	Mean	45.1	29.6	31.1	16.9	45.6

Table 2 continued

1	2	3	4	5	6	7
2BA	crushed	48.8	35.0	33.5	16.4	55.0
	removed	42.9	25.0	27.6	17.6	33.0
	Mean	45.8	30.0	30.5	17.0	44.0
EM+BA	crushed	40.8	34.8	32.3	17.6	44.3
	removed	43.5	27.1	28.0	13.5	33.9
	Mean	42.1	30.9	30.2	15.6	39.1
EM+2BA	crushed	39.6	34.6	32.8	15.1	43.3
	removed	42.0	27.9	28.2	14.0	33.8
	Mean	40.8	31.3	30.5	14.6	38.5
2EM+BA	crushed	47.1	42.5	32.8	17.9	53.5
	removed	44.0	28.1	26.9	14.0	34.0
	Mean	45.6	35.3	29.8	15.9	43.8
2EM+2BA	crushed	45.5	39.5	33.6	19.1	51.5
	removed	42.3	28.5	26.3	15.8	32.5
	Mean	43.9	34.0	30.0	17.4	42.0
Control	crushed	49.0	33.6	32.3	15.8	57.5
	removed	44.5	25.4	29.1	17.5	37.3
	Mean	46.8	29.5	30.7	16.6	47.4
Mean	crushed	45.2	36.7	32.6	17.1	51.1
	removed	42.9	27.0	28.0	15.4	34.4
	Mean	44.1	31.8	30.3	16.3	42.7
$HSD_{0.05}$ I		4.76	6.17	ns	ns	3.81
II		ns	7.20	4.34	1.45	12.34
II/I		5.64	ns	ns	ns	12.86
I/II		6.63	ns	ns	ns	5.87

EM – effective microorganisms, BA – biostimulant Asahi
ns – not significant differences

Table 3. The mean density (number·m^{-2}) of dominant and other weeds as affected by different treatments in the short-term monoculture of spring barley

I – treatments	II – previous crop straw	Mean density (number·m^{-2}) of dominant and other weeds				
		Capsella bursa pastoris	*Cirsium arvense*	*Stellaria media*	*Chenopodium album*	other weeds
1	2	3	4	5	6	7
EM	crushed	20.8	16.4	10.4	8.4	40.3
	removed	15.8	12.1	8.3	7.0	34.6
	Mean	18.3	14.3	9.3	7.7	37.4
2EM	crushed	24.3	18.9	11.1	10.0	49.9
	removed	19.8	16.3	8.0	7.0	34.0
	Mean	22.0	17.6	9.6	8.5	41.9
BA	crushed	24.8	20.1	10.4	12.8	54.4
	removed	19.5	17.3	8.5	7.3	31.5
	Mean	22.1	18.7	9.4	10.0	42.9
2BA	crushed	24.3	20.0	9.8	12.9	52.0
	removed	19.6	18.6	8.6	7.1	31.8
	Mean	21.9	19.3	9.2	10.0	41.9
EM+BA	crushed	21.4	17.3	10.8	8.9	41.1
	removed	17.1	13.4	8.5	7.3	30.6
	Mean	19.3	15.3	9.6	8.1	35.9
EM+2BA	crushed	20.9	17.3	10.1	8.6	40.8
	removed	16.8	12.1	8.4	7.0	33.1
	Mean	18.8	14.7	9.3	7.8	36.9
2EM+BA	crushed	23.6	17.9	9.8	9.9	50.4
	removed	19.8	15.4	8.4	7.1	32.6
	Mean	21.7	16.6	9.1	8.5	41.5
2EM+2BA	crushed	23.6	18.8	9.9	11.1	50.3
	removed	19.6	16.3	8.3	7.3	31.3
	Mean	21.6	17.5	9.1	9.2	40.8
Control	crushed	26.3	21.5	9.5	12.1	55.0
	removed	20.1	18.4	8.1	6.8	34.0
	Mean	23.2	19.9	8.8	9.4	44.5

Table 3 continued

1	2	3	4	5	6	7
Mean	crushed	23.3	18.7	10.2	10.5	48.2
	removed	18.7	15.5	8.3	7.1	32.6
	Mean	21.0	17.1	9.3	8.8	40.4
$HSD_{0.05}$ I		1.92	2.66	ns	1.67	4.04
II		3.48	2.34	1.36	2.54	11.53
II/I		ns	ns	ns	2.83	12.05
I/II		ns	ns	ns	2.27	5.91

EM – effective microorganisms, BA – biostimulant Asahi
ns – not significant differences

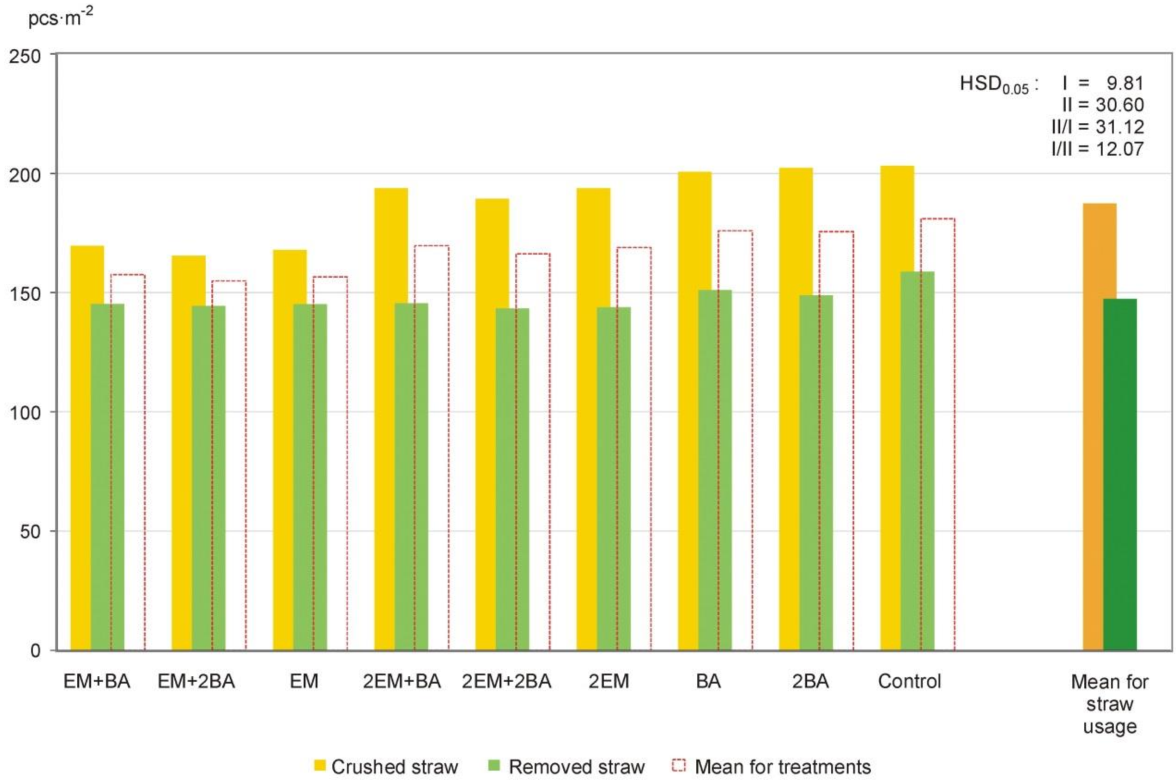

Fig. 4. The total number of weeds depending on the method of applying EM Naturalnie Aktywny and biostimulant Asahi SL in the short-term monoculture of winter wheat – means for the study years (pcs·m^{-2})

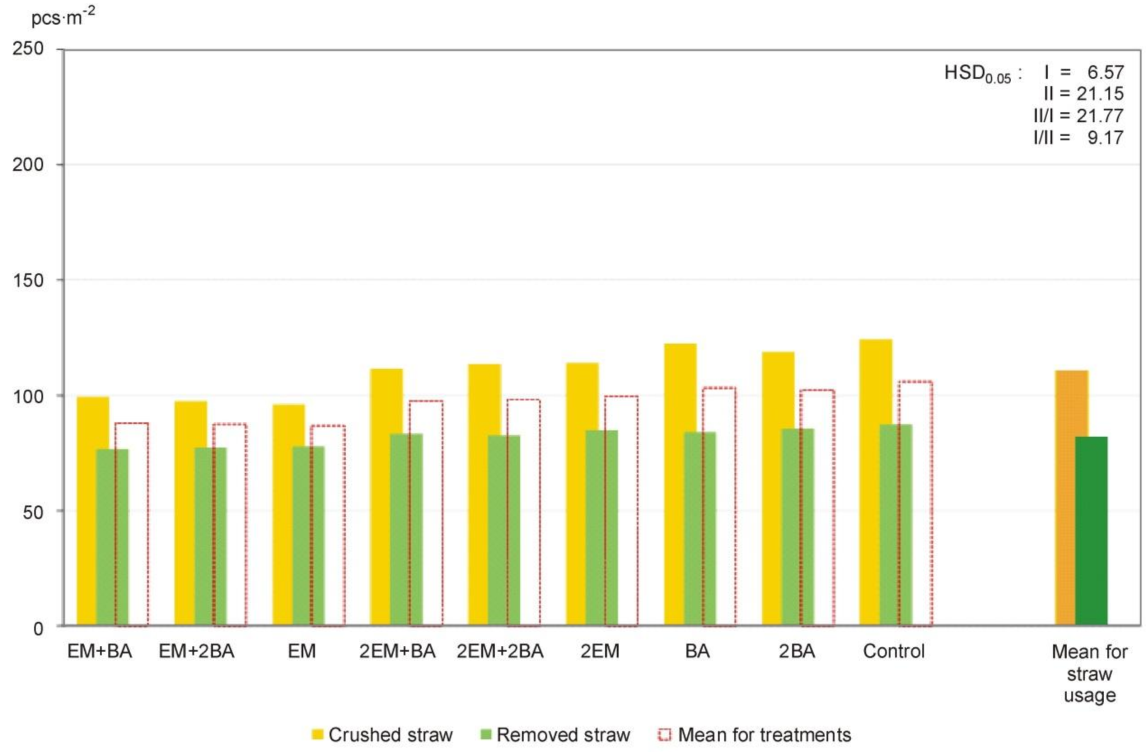

Fig. 5. The total number of weeds depending on the method of applying EM Naturalnie Aktywny and biostimulant Asahi SL in the short-term monoculture of spring barley – means for the study years (pcs·m^{-2})

The total number of weeds, the number of dominant weeds and other weeds in the present study were generally significantly differentiated by the methods of applying EM Naturalnie Aktywny and biostimulant Asahi SL and straw management (Tables 2–3, Fig. 4–5). Introducing straw into the soil during post-harvest cultivation favoured greater weed infestation in both of the cereals. The various methods of applying EM Naturalnie Aktywny and the biostimulant were most effective in reducing the total weed infestation while their effect on the infestation by dominant weeds differed for individual species depending on the straw management method. The unfavourable phytosanitary effect of soil fertilization with straw in the short-term monoculture of winter wheat was mitigated by the use of effective microorganisms, especially in the case of weed infestation by *Apera spica-venti* and the other weeds (Table 2). In spring barley, similar effects were observed with regard to weed infestation with *Chenopodium album* and the other weeds. In the study by Jabłońska *et al*. (2012), the preparations used to stimulate the development of spring triticale plants (EM-Farming and Biojodis) caused an increase (statistically insignificant) of weed infestation compared to the control treatment, both at the tillering and flowering stages of spring triticale. However, at the flowering stage of triticale the weed infestation decreased on all of the tested plots, in relation to the assessment of weed infestation performed in spring (at tillering), which they attributed to the greater competitiveness of the developing plants. Faltyn and Kordas (2009) found an ambiguous effect of effective microorganisms on the weed infestation of the analyzed species in spring wheat. The possibility of limiting weed infestation in the fields by limiting mineral fertilization and improving the properties of the soil in which effective microorganisms can participate has been suggested (Stielow, 2003), thereby emphasizing their indirect role in the regulation of weed infestation in farmlands.

In the present study, the influence of the methods of applying the plant growth biostimulant Asahi SL on the number of weeds in the short-term monoculture of winter wheat was not statistically confirmed (Table 1, Fig. 1). This is indirectly confirmed by the lack of a significant increase in the effectiveness of herbicides used in conjunction with biostimulants in the studies of other authors in the cultivation of sugar beet (Kositorna and Smoliński 2008), onions and carrots (Dobrzański *et al.*, 2008).

CONCLUSIONS

The weed infestation of the winter form of wheat and the spring form of barley cultivated under short-term single-species monocultures was favoured by the use of soil fertilization with crushed straw. This unfavourable effect was limited by abandoning fertilization with straw or by applying effective microorganisms as the preparation EM Naturalnie Aktywny to the remaining straw during post-harvest cultivation. Such action allowed to reduce the total weed infestation and to limit the number of *Apera spica venti, Capsella bursa pastoris, Chenopodium album* and the other weeds.

ACKNOWLEDGEMENTS

The study was funded by National Science Centre, Poland (Grant no. PB-7295/B/P01/2011/40).

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WPŁYW STOSOWANIA ZABIEGÓW PROEKOLOGICZNYCH I SŁOMY NA ZACHWASZCZENIE ŁANU PSZENICY OZIMEJ I JĘCZMIENIA JAREGO UPRAWIANYCH W KRÓTKOTRWAŁEJ MONOKULTURZE

Zboża kłosowe, jak pszenica i jęczmień, należą do najważniejszych roślin uprawianych zarówno w Polsce, jak i na świecie. W okresie wegetacji narażone są na niekorzystne oddziaływanie wielu agrofagów, w tym chwastów, patogenów grzybowych oraz szkodników. Do ograniczania ich gradacji wykorzystuje się liczne metody ochrony roślin. W trzyletnich badaniach polowych porównywano wpływ aplikacji preparatów EM Naturalnie Aktywny i Asahi SL oraz sposobów zagospodarowania słomy rośliny przedplonowej na liczebność chwastów w krótkotrwałych monokulturach pszenicy ozimej i jęczmieniu jarym. Metodą ramkową, na poszczególnych obiektach doświadczalnych, oceniano losowo, bezpośrednio przed wykonaniem zabiegów herbicydowych (BBCH 31–32), liczebność chwastów dominujących, liczebność pozostałych gatunków chwastów oraz liczebność chwastów łącznie. W efekcie przeprowadzonych pomiarów stwierdzono znaczącą liczebność chwastów w łanach analizowanych zbóż. Dominowały w nich *Viola arvensis*, *Apera spica-venti*, *Capsella bursa pastoris*, *Stellaria media*, *Chenopodium album* oraz *Cirsium arvense*. Zaobserwowane w doświadczeniach zwiększone zachwaszczenie zbóż było przede wszystkim skutkiem wnoszenia do gleby słomy w trakcie uprawy pożniwnej. Ten skutek nawożenia gleby słomą był łagodzony, jednak w różnym stopniu, przez stosowanie efektywnych mikroorganizmów, zwłaszcza w przypadku zachwaszczenia przez *Apera spica-venti*, *Capsella bursa pastoris*, *Chenopodium album* oraz chwasty pozostałe. Zachwaszczeniu zbóż uprawianych w warunkach krótkotrwałych monokultur sprzyjało stosowanie nawożenia gleby rozdrobnioną słomą. Jej usuwanie w połączeniu z aplikacją w trakcie uprawy pożniwnej efektywnych mikroorganizmów, pozwoliło zmniejszyć zachwaszczenie ogółem oraz ograniczyć liczebność *Apera spica venti*, *Capsella bursa pastoris*, *Chenopodium album* oraz chwastów pozostałych.

Słowa kluczowe: Asahi SL, chwasty, Efektywne Mikroorganizmy, jęczmień jary, monokultura, pszenica ozima, słoma