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THE EFFECTS OF EFFECTIVE MICROORGANISMS, A BIOSTIMULANT AND THE TREATMENT METHOD OF FORECROP STRAW ON HEMIMETABOLOUS HERBIVORES IN WINTER WHEAT

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ABSTRACT

Background. Winter wheat is one of the most important field crops grown both in Poland and in the world. While growing it is exposed to the attack of fungal pathogens, weeds and animals, including insects, whose numbers are increasingly being limited by non-chemical methods.
Material and methods. The effects of the application of pro-ecological practices (effective microorganisms – EM Naturalnie Aktywny and biostimulant – Asahi SL products) and of the forecrop straw management methods on the number of noxious hemimetabolous species found were compared in a three-year field study. In developmental stages of winter wheat insects were collected with an entomological net. Their density was compared and the results are presented as individuals per plot.
Results. It was found that the cereal aphid is the most numerous pest feeding on winter wheat, especially during its milk-dough maturity stage. The bird cherry-oat aphid, thrips and Miridae were less numerous. The use of environmentally friendly treatments during wheat growth resulted in a smaller catch of these insects compared to the control. Bird cherry-oat aphid and thrips are more likely to feed on plants growing on plots with plowed straw, and Miridae on those with removed straw. However, the method of use of previous crop straw did not modify the number of cereal aphids.
Conclusion. The use of the products EM Naturalnie Aktywny and Asahi SL during wheat growth will allow for a reduction in the number of herbivores with piercing-sucking mouthparts.

Key words: Asahi SL, effective microorganisms, hemimetabolous herbivores, winter wheat

INTRODUCTION

Cereals, in particular winter wheat, are exposed to the attack of many pests during their growing season. The most important herbivores of monocotyledonous plants include hemimetabolous insect herbivores such as the cereal aphid – *Sitobion avenae* F. and the bird cherry-oat aphid – *Rhopalosiphum padi* L. or the Miridae, as well as insects belonging to the order Thysanoptera. Numerous methods are recommended for controlling them (Walczak, 2007; Jandricic *et al*., 2014; Van Emden and Harrington, 2017).

A threat to wheat crops, and hence a developing problem, is also the widespread use of cereal monocultures. By growing cereals too frequently we are increasingly dealing with a deterioration of the phytosanitary condition of crops, a decrease in soil fertility and the effects of long-term plowing of large

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amounts of straw, which are not always beneficial for the soil (Kuś and Smagacz, 2001; Smagacz, 2003). With the increase in the frequency of cereal cultivation we can also observe an increased occurrence of diseases of the root system (Adamiak *et al*., 2005; Smagacz, 2010) and above-ground parts, intensified and specialized weed infestation (Jaskulski and Jaskulska, 2004), and a growing number of herbivore entomofauna (Hurej *et al*., 2012). Controlling the pests that are increasingly attacking cereal monocultures is associated with greater financial outlays and increasing pressure from the chemically active substances contained in plant protection products on the environment. The search for more environmentally friendly ways to improve the phytosanitary status of crops and their productivity is also justified by the pro-ecological policy of the European Union (Lamparski *et al*., 2013; 2015b).

The introduction of only large amounts of straw into the soil decreases the diversity of soil organic matter and impairs the quality of the microorganism population and their metabolism, often reducing the straw to toxic products. An effect may be adverse changes in the physicochemical properties of the soil and a reduction of its biological activity. The use of microorganism inoculum in such conditions is conducive to the achievement of biological equilibrium by the agroecosystem (Megali *et al*., 2014; 2015; Abiodun *et al*., 2016), especially at the high frequency level of introducing straw into the soil that is characteristic of cereal monocultures. The results from a few studies to date suggest the beneficial effect of effective microorganisms on soil properties, plant growth and the number of harmful organisms, including insect pests. These effective microorganisms thus reduce the negative effects of the cultivation simplifications in monoculture, while limiting the pressure of chemical plant protection products on the environment (Douglas, 2007; Javaid and Shah, 2010; Javaid and Bajwa, 2011; Megali *et al*., 2015). Beneficial soil microorganisms can regulate hormone signaling including the jasmonic acid and ethylene and salicylic acid pathways, thereby leading to gene expression, biosynthesis of secondary metabolites, plant defensive proteins and different enzymes and volatile compounds that may induce defenses against leaf-chewing as well as phloem-feeding insects (Rashid and Chung, 2017). Also the foliar application of plant resistance biostimulators increases the resistance of the agroecosystem to stress factors (Piskier, 2006).

This study aims to answer the question of whether the application of such preparations significantly modify the number of pests with piercing-sucking mouthparts.

MATERIAL AND METHODS

The study was carried out during the three-year period from 2011-2014 on a winter wheat field. It was conducted on an individual farm in the Kruszwica community – Kuyavian-Pomeranian Voivodeship, Poland (52°61' N; 18°44' E).

The effects of the EM Naturalnie Aktywny and Asahi SL were tested in the field experiment. Doses and application dates for the preparations:

– (1×EM) – EM Naturalnie Aktywny introduced into the soil during post-harvest cultivation in autumn in a dose of 40 $dm^3 \cdot ha^{-1}$,
– (2×EM) – EM Naturalnie Aktywny introduced into the soil during post-harvest cultivation in autumn in a dose of 20 $dm^3 \cdot ha^{-1}$ and EM Naturalnie Aktywny applied on leaves in a dose of 20 $dm^3 \cdot ha^{-1}$ at BBCH 20–22,
– (1×BA) – biostimulant Asahi SL applied once on leaves in a dose of 1.0 $dm^3 \cdot ha^{-1}$ at BBCH 20–22,
– (2×BA) – biostimulant Asahi SL applied twice on leaves in two dose of 0.5 $dm^3 \cdot ha^{-1}$ at BBCH 20-22 and BBCH 27–29.

The following experimental factors were adopted: I – methods of applying EM Naturalnie Aktywny and biostimulant Asahi SL products (9 levels: 1×EM+1×BA; 1×EM+2×BA; 1×EM+0×BA; 2×EM+1×BA; 2×EM+2×BA; 2×EM+0×BA; 0×EM+1×BA; 0×EM+2×BA and control – 0×EM+0×BA), II – methods of forecrop straw management (2 levels: 1) crushed – left in the field during post-harvest cultivation and 2) removed – from the field during post-harvest cultivation) and III – winter wheat development stages at which entomological material was collected for the study (entomological net).

EM Naturalnie Aktywny is a concentrate of effective microorganisms that improves soil fertility. It has the PZH/HT-1448/2002 certificate and IUNG qualification certificate No. NE/1/2004. EM is a safe product for people, animals and the environment. The composition specified on the packaging is: lactic acid bacteria, photosynthetic bacteria, yeast, cane molasses, and Azotobacter. It does not contain genetically modified components (GMO). It is manufactured under license from EMRO-EM Research Organization Japan.

Asahi SL in accordance with the annex to the decision of the Ministry of Agriculture and Rural Development No. R-357/2010d of 27.12.2010 in the description of operation is a stimulator of growth and yielding of plants in the form of a liquid for dilution with water. It contains the active substances (compounds from the group of nitrophenol derivatives): sodium para-nitrophenolate (0.3%), sodium ortho-nitrophenolate (0.2%) and sodium 5-nitroguayacolate (0.1%). The shelf life of the product is 3 years. It is permissable to use the product in the cultivation of agricultural, vegetable and fruit crops.

The experimental plots were located on soil of the very good rye complex with a granulometric composition of light loam (after a cereal forecrop – 2nd year of winter wheat monoculture). EM Naturalnie Aktywny and Asahi SL products were applied using a self-propelled sprayer.

Agricultural practices were appropriate for medium-intensive cultivation of the cereal plant. A ploughing tillage system was used, nitrogen fertilization was in a dose of 100 kg $N \cdot ha^{-1}$. Phosphorus and potassium fertilization was determined based on the soil richness in absorbable forms of these macronutrients. The qualified seed material of winter wheat cv. Arktis dressed with Maxim Star 025 FS (cyproconazole + difluorobenzene) at a rate of 200 g of product for $\cdot 100\ kg^{-1}$ of grain, was sown at a density of 400 $grains \cdot m^{-2}$ between September 21st and 30th. Over the years of the research, in spring after the start of growth (BBCH 25–29) a herbicide tank-mixture was used: Atlantis 12 OD (iodosulfuron-methyl-sodium + mesosulfuron-methyl) at a dose of 0.45 $dm^3 \cdot ha^{-1}$ + Sekator 125 OD (amidosulfuron + iodosulfuron-methyl-sodium) at a dose of 150 $ml \cdot ha^{-1}$ + Esteron 600 EC (2,4-D) at a dose of 0.45 $dm^3 \cdot ha^{-1}$. In the stage BBCH 32 a mixture of growth regulators was used. It consisted of Antywylegacz 750 SL (chlormequat chloride) and Moddus 250 EC (trinexapac ethyl) at doses of 1.0 and 0.3 $dm^3 \cdot ha^{-1}$, respectively, along with the fungicide Capalo 337,5 SL (epoxiconazole + fenpropimorf + metrafenone) at a dose of 1.5 $dm^3 \cdot ha^{-1}$ in order to reduce the occurrence of fusarium wilt, eyespot and powdery mildew. As a prophylaxis to reduce ear infections (BBCH 49-51) the product Artea 330 EC (propiconazole + cyproconazole) was applied at a dose of 0.5 $dm^3 \cdot ha^{-1}$. Insecticide protection was not used.

Collecting was carried out in 4 development stages of winter wheat: shooting (BBCH 34–37), earing (BBCH 52-58), flowering (BBCH 65–69) milk-dough stage (BBCH 75–85). Nine hits with an entomological net (ø 30 cm) were made on each of the experimental plots. The results are presented as insect density, i.e. the sum of particular groups caught with the use of the entomological net – in individuals per plot ($3 \times 6\ m = 18\ m^2$).

Entomological material was determined according to the keys: Müller (1976), Korcz (1994), Zawirska (1994). Statistical analysis included 3 experimental factors: I – methods of applying EM Naturalnie Aktywny and biostimulant Asahi SL products, II – method of forecrop straw management and III – winter wheat development stages. In the experiment 18 treatments were analysed in 3 replications. The number of individuals caught at individual experimental plots was compared statistically with the use of a program package ANALWAR-5.2-FR. An analysis of variance was performed and the significance of between-treatment differences was assessed using Tukey's test at the significance level $P < 0.05$.

RESULTS AND DISCUSSION

The winter wheat studied in the field experiment was inhabited by such hemimetabolous insect herbivores as: cereal aphid – *Sitobion avenae*, of which on average 57.1 were caught, bird cherry-oat aphid – *Rhopalosiphum padi* – 5.7, Thripidae – 8.9 and Miridae – 7.0 $individuals \cdot plot^{-1}$ (Tables 1–4).

S. avenae did not occur at the shooting stage (Table 1). The number of this important pest was affected only by the pro-ecological practices applied. Analysis of the effect of the effective microorganisms and biostimulant used showed that in all the studied treatments the number of this pest was significantly lower than in the control. No significant differences were found in the number of aphids caught from plots with the straw crushed and the straw removed (56.7 and 57.6 individuals·plot^{-1}, respectively). They were definitely the most numerous during the milk-dough stage of wheat, that is 95.3 individuals·plot^{-1}. However, in the case of *R. padi* (Table 2), significantly different results were obtained than for the cereal aphid. It was found that its maximum intensity fell at the period of winter wheat earing (11.7 individuals·plot^{-1}), and it was no longer caught during the milk-dough stage. The average number for the three developmental stages in which their presence was found was almost 6 individuals·plot^{-1}. Significantly more of this aphid were caught on plots: 0×EM+0×BA – control, 2×EM+1×BA, 2×EM+0×BA and 0×EM+2×BA (6.9, 6.3, 6.1 and 6.1 individuals·plot^{-1}, respectively). The results obtained in the present study are consistent with the results of previous studies in which cereal plants were treated with such products as: effective microorganisms (EM), soil fertilizer UG_{max}, and plant biostimulant Asahi SL on winter wheat (Lamparski *et al.*, 2013; 2015b) or the bioregulator Kelpak in spring wheat and spring barley (Lamparski and Szczepanek, 2013; 2014). Differences in the number of aphids (*S. avenae* and *R. padi*) in all of the treatments studied in this work could be the result of the content of secondary metabolism compounds, especially the total content of phenolic compounds, as the content of these compounds in the control (without effective microorganisms and biostimulant) was low compared to those plots on which these products were used. However, in the case of other tested phenolic compounds – flavonoids (especially for plants previously not damaged by insects), the opposite situation has been noted (Lamparski *et al*., 2015a; 2017).

The inhabitation of winter wheat plants by aphids in the analysed years of the present study was not very high and did not exceed the economic damage threshold (Walczak, 2007; Zalecenia Ochrony Roślin, 2018/2019). This may be due to the fact that the intensity of the occurrence of these major cereal pests is generally influenced by weather conditions (Gałęzewski, 2008; Kaniuczak, 2014).

The number of Thripidae was affected by both pro-ecological practices and the method of forecrop straw management (Table 3). Compared to the control all treatments with the EM and Asahi SL biostimulant, both for each of the individual development stages of spring wheat and the average, had a lower number of thrips caught. These studied organisms were most numerous during the flowering stage, and fewer of them were caught during the milk-dough stage of winter wheat (12.2 and 10.2 individuals·plot^{-1}, respectively). It was found that significantly more Thripidae occur when wheat plants grow on plots where the forecrop straw has been crushed, compared to plots with the straw removed (9.9 and 8.0 individuals·plot^{-1}, respectively). On average, 9 individuals·plot^{-1} of these species were caught. Pests discussed in the present study that belong to the order of Thysanoptera are mentioned by numerous authors as important herbivores in the crops of cereals and grasses (Jackowski and Hurej, 2000; Szeflińska, 2002; Hurej *et al.*, 2009). As with aphids also other insects with piercing-sucking mouthparts react to variable content of both phenolic compounds and flavonoids (Lamparski *et al*., 2015a; 2017). In other experiments (Lamparski and Szczepanek, 2013; 2014; Lamparski *et al.*, 2013) similar effects of some other products (Kelpak, UG_{max}) have been found in relation to Thysanoptera. For example it was found during these experiments that the application of Kelpak bioregulator reduced the average number of Thysanoptera caught during the examined periods of wheat generative development in relation to the control. Thripidae were the dominant family of the insects in question and after the use of Kelpak a reduction of their number at the flowering and milk-dough stages of spring wheat was demonstrated (Lamparski and Szczepanek, 2013). The soil fertilizer (UG_{max}) favourably modified the number of the thrips – *Frankiniella intosa* Trybom (Thripidae) at the milky-dough stage of winter wheat (Lamparski *et al*., 2013). There was also a reduction in the Thripidae caught at the stages from earing to milk-dough maturity of barley treated with doses of Kelpak compared to the no application variant (Lamparski and Szczepanek, 2014).

Table 1. Effect of pro-ecological procedures and forecrop straw treatment method on the catch abundance of the cereal aphid – *Sitobion avenae* at development stages of winter wheat under field conditions (mean of the study years) (individuals/plot)

I – treatments	II – forecrop straw	III – plant development stage			Mean
		earing	flowering	milk-dough stage	
1×EM+1×BA	crushed	7.0	35.0	89.3	43.8
	removed	2.8	73.3	97.3	57.8
	Mean	4.9	54.2	93.3	50.8
1×EM+2×BA	crushed	2.7	82.3	90.7	58.6
	removed	3.0	66.5	93.8	54.4
	Mean	2.8	74.4	92.3	56.5
1×EM+0×BA	crushed	2.3	81.8	92.2	58.8
	removed	3.3	69.8	91.8	55.0
	Mean	2.8	75.8	92.0	56.9
2×EM+1×BA	crushed	3.8	53.7	63.0	40.2
	removed	3.2	58.3	91.3	50.9
	Mean	3.5	56.0	77.2	45.6
2×EM+2×BA	crushed	3.8	75.0	91.5	56.8
	removed	3.5	67.5	93.3	54.8
	Mean	3.7	71.3	92.4	55.8
2×EM+0×BA	crushed	4.2	80.5	100.2	61.6
	removed	4.8	66.5	93.7	55.0
	Mean	4.5	73.5	96.9	58.3
0×EM+1×BA	crushed	5.1	67.5	94.3	55.7
	removed	4.0	76.7	104.3	61.7
	Mean	4.6	72.1	99.3	58.7
0×EM+2×BA	crushed	5.2	82.8	102.8	63.6
	removed	3.8	69.7	102.8	58.8
	Mean	4.5	76.3	102.8	61.2
0×EM+0×BA	crushed	4.0	91.3	119.2	71.5
	removed	5.5	99.7	103.8	69.7
	Mean	4.8	95.5	111.5	70.6
Mean	crushed	4.2	72.2	93.7	56.7
	removed	3.8	72.0	96.9	57.6
	Mean	4.0	72.1	95.3	57.1
$HSD_{0.05}$ I = 2.95; II = ns; II/I = 3.67; I/II = 4.63; III = 0.42; III/I = 1.26; I/III = 3.06; III/II = 0.59; II/III = 1.26					

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

Table 2. Effect of pro-ecological procedures and forecrop straw treatment method on the catch abundance of the bird cherry-oat aphid – *Rhopalosiphum padi* at development stages of winter wheat under field conditions (mean of the study years) (individuals/plot)

I – treatments	II – forecrop straw	III – plant development stage			Mean
		shooting	earing	flowering	
1×EM+1×BA	crushed	1.7	9.3	2.0	4.3
	removed	1.7	7.3	2.0	3.7
	Mean	1.7	8.3	2.0	4.0
1×EM+2×BA	crushed	1.3	13.0	5.2	6.5
	removed	1.0	10.0	4.3	5.1
	Mean	1.1	11.5	4.8	5.8
1×EM+0×BA	crushed	1.7	9.3	5.2	5.4
	removed	2.0	10.0	2.8	4.9
	Mean	1.8	9.7	4.0	5.2
2×EM+1×BA	crushed	1.0	15.3	3.3	6.6
	removed	1.0	13.3	3.7	6.0
	Mean	1.0	14.3	3.5	6.3
2×EM+2×BA	crushed	1.1	14.3	3.3	6.3
	removed	0.7	10.2	2.0	4.3
	Mean	0.9	12.3	2.6	5.3
2×EM+0×BA	crushed	1.7	13.3	4.7	6.6
	removed	1.8	12.7	2.7	5.7
	Mean	1.8	13.0	3.7	6.1
0×EM+1×BA	crushed	1.7	12.3	5.3	6.5
	removed	1.0	9.5	6.2	5.6
	Mean	1.3	10.9	5.8	6.0
0×EM+2×BA	crushed	1.0	12.7	6.0	6.6
	removed	1.0	12.2	3.7	5.6
	Mean	1.0	12.4	4.8	6.1
0×EM+0×BA	crushed	4.0	16.8	3.7	8.2
	removed	2.8	9.3	5.0	5.7
	Mean	3.4	13.1	4.3	6.9
Mean	crushed	1.7	12.9	4.3	6.3
	removed	1.4	10.5	3.6	5.2
	Mean	1.6	11.7	3.9	5.7
$HSD_{0.05}$ I = 0.90; II = 0.24; II/I = 0.71; I/II = 1.13; III = 0.21; III/I = 0.62; I/III = 1.05; III/II = 0.29; II/III = 0.31					

EM – effective microorganisms, BA – biostimulant Asahi

Table 3. Effect of pro-ecological procedures and forecrop straw treatment method on the catch abundance of Thripidae at development stages of winter wheat under field conditions (mean of the study years) (individuals/plot)

I – treatments	II – forecrop straw	III – plant development stage				Mean
		shooting	earing	flowering	milk-dough stage	
1×EM+1×BA	crushed	5.2	9.0	17.3	12.3	11.0
	removed	2.7	9.2	11.3	8.5	7.9
	Mean	3.9	9.1	14.3	10.4	9.4
1×EM+2×BA	crushed	4.3	8.5	11.3	13.3	9.4
	removed	3.5	8.5	8.7	9.2	7.5
	Mean	3.9	8.5	10.0	11.3	8.4
1×EM+0×BA	crushed	3.5	9.3	13.2	9.7	8.9
	removed	3.7	9.5	15.3	8.7	9.3
	Mean	3.6	9.4	14.3	9.2	9.1
2×EM+1×BA	crushed	4.5	11.8	14.3	9.8	10.1
	removed	5.5	7.5	6.8	8.5	7.1
	Mean	5.0	9.7	10.6	9.2	8.6
2×EM+2×BA	crushed	5.3	8.8	9.0	11.2	8.6
	removed	3.2	8.5	12.0	7.3	7.8
	Mean	4.3	8.7	10.5	9.3	8.2
2×EM+0×BA	crushed	5.8	9.2	15.0	9.7	9.9
	removed	3.7	8.3	8.3	7.8	7.0
	Mean	4.8	8.8	11.7	8.8	8.5
0×EM+1×BA	crushed	3.2	8.0	11.5	8.7	7.8
	removed	2.0	8.3	10.8	8.3	7.4
	Mean	2.6	8.2	11.2	8.5	7.6
0×EM+2×BA	crushed	4.0	10.7	8.0	15.5	9.5
	removed	2.3	8.0	8.2	8.2	6.7
	Mean	3.2	9.3	8.1	11.8	8.1
0×EM+0×BA	crushed	7.0	11.3	22.0	13.7	13.5
	removed	3.8	14.0	15.5	12.7	11.5
	Mean	5.4	12.7	18.8	13.2	12.5
Mean	crushed	4.8	9.6	13.5	11.5	9.9.
	removed	3.4	9.1	10.8	8.8	8.0
	Mean	4.1	9.4	12.2	10.2	8.9
$HSD_{0.05}$ I = 0.72; II = 0.23; II/I = 0.69; I/II = 0.99; III = 0.27; III/I = 0.82; I/III = 1.06; III/II = 0.38; II/III = 0.36						

EM – effective microorganisms, BA – biostimulant Asahi

Table 4. Effect of pro-ecological procedures and forecrop straw treatment method on the catch abundance of Miridae at development stages of winter wheat under field conditions (mean of the study years) (individuals/plot)

I – treatments	II – forecrop straw	III – plant development stage				Mean
		shooting	earing	flowering	milk-dough stage	
1×EM+1×BA	crushed	0.0	3.3	15.8	12.0	7.8
	removed	0.0	2.7	14.5	10.8	7.0
	Mean	0.0	3.0	15.2	11.4	7.4
1×EM+2×BA	crushed	0.0	2.3	13.8	10.2	6.6
	removed	0.7	2.3	18.7	8.3	7.5
	Mean	0.3	2.3	16.3	9.3	7.0
1×EM+0×BA	crushed	0.0	3.0	11.8	6.8	5.4
	removed	0.7	2.7	12.8	9.3	6.4
	Mean	0.3	2.8	12.3	8.1	5.9
2×EM+1×BA	crushed	0.0	4.0	11.0	10.0	6.3
	removed	0.0	3.3	8.0	12.3	5.9
	Mean	0.0	3.7	9.5	11.2	6.1
2×EM+2×BA	crushed	0.0	2.0	13.8	11.5	6.8
	removed	0.0	2.3	18.5	12.3	8.3
	Mean	0.0	2.2	16.2	11.9	7.6
2×EM+0×BA	crushed	1.3	0.7	7.0	9.2	4.5
	removed	0.0	3.8	11.3	8.5	5.9
	Mean	0.7	2.3	9.2	8.8	5.2
0×EM+1×BA	crushed	0.7	3.0	11.3	8.3	5.8
	removed	0.0	0.7	17.5	12.5	7.7
	Mean	0.3	1.8	14.4	10.4	6.8
0×EM+2×BA	crushed	1.3	4.7	11.7	10.3	7.0
	removed	0.0	2.7	14.3	11.5	7.1
	Mean	0.7	3.7	13.0	10.9	7.1
0×EM+0×BA	crushed	0.0	6.0	15.5	16.0	9.4
	removed	0.0	3.3	21.8	15.7	10.2
	Mean	0.0	4.7	18.7	15.8	9.8
Mean	crushed	0.4	3.2	12.4	10.5	6.6
	removed	0.2	2.7	15.3	11.3	7.3
	Mean	0.3	2.947	13.9	10.9	7.0
$HSD_{0.05}$ I = 0.75; II = 0.25; II/I = 0.74; I/II = 1.04; III = 0.23; III/I = 0.69; I/III = 0.99; III/II = 0.32; II/III = 0.34						

EM – effective microorganisms, BA – biostimulant Asahi

The effect of the applied experimental factors on the number of Miridae – the family of the order Hemiptera, was also analysed (Table 4). Their number in the years of observation was 7 individuals·plot^{-1}. Their maximum catch was during the flowering stage of winter wheat (13.9 individuals·plot^{-1}). Miridae were most frequently caught on treatments of 0×EM+0×BA – control (9.8 individuals·plot^{-1}). The calculations carried out showed that significantly more Miridae occur when wheat plants grow on plots where the forecrop straw has been removed, compared to plots with crushed straw (7.3 and 6.6 individuals·plot^{-1}, respectively). Similar effects of other pro-ecological products have been found in relation to these insects. In many cases an additional potential benefit of effective microorganisms includes increased defence against herbivore attack (Megali *et al.*, 2015). In other studies a decrease in the number of Hemiptera was noted at the stages from earing to milk-dough maturity of barley treated with doses of Kelpak compared to the variant without such application (Lamparski and Szczepanek, 2014). The use of the EM-A effective microorganisms inoculum in winter wheat has been found to reduce the catch of *Aelia acuminata*, both during earing and flowering (Lamparski *et al.*, 2013; 2015b).

CONCLUSIONS

At the analysed developmental stages of winter wheat the studied plots were inhabited by the cereal aphid and in much smaller quantities by the bird cherry-oat aphid, Thripidae and Miridae. The bird cherry-oat aphid most frequently inhabited wheat during its earing, thrips and Miridae during its flowering, and the cereal aphid during milk-dough maturity. The use of EM Naturalnie Aktywny and Asahi SL products in the field cultivation of winter wheat resulted in a lower number of noxious insects caught that have hemimetabolous metamorphosis, compared to the control. The method of forecrop straw management modified the number of insects caught (with the exception of the cereal aphid). The use of the products EM Naturalnie Aktywny and Asahi SL in the field cultivation of winter wheat may be an alternative to chemical methods of reducing the number of pests with piercing-sucking mouthparts.

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WPŁYW EFEKTYWNYCH MIKROORGANIZMÓW, BIOSTYMYLATORA I SPOSOBU TRAKTOWANIA SŁOMY ROŚLINY PRZEDPLONOWEJ NA LICZEBNOŚĆ HEMIMETABOLICZNYCH FITOFAGÓW W PSZENICY OZIMEJ

Streszczenie

Pszenica ozima należy do najważniejszych roślin uprawianych zarówno w Polsce, jak i na świecie. W okresie wzrostu i rozwoju jest narażona na atak wielu agrofagów, jak patogeny grzybowe, chwasty oraz zwierzęta, w tym owady. Do ograniczania ich liczebności 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 szkodliwych hemimetabolicznych owadów. W fazach rozwojowych pszenicy ozimej owady pobierano czerpakiem entomologicznym. Porównywano zagęszczenie owadów, a wyniki przedstawiono w sztukach na poletko. Spośród hemimetabolicznych fitofagów najliczniej odławiano mszycę zbożową, a w znacznie mniejszej ilości mszycę czeremchowo-zbożową, wciornastkowate i tasznikowate. Aplikacja preparatów w pszenicy przekładała się na mniejszy odłów owadów w porównaniu z kontrolą. Sposób użytkowania słomy przedplonu modyfikuje liczebność badanych owadów (z wyjątkiem mszycy zbożowej). Mszyca czeremchowo-zbożowa najliczniej zasiedla pszenicę podczas jej kłoszenia, wciornastkowate i tasznikowate podczas kwitnienia, a mszyca zbożowa podczas dojrzałości mleczno-woskowej. Stosowanie preparatów EM Naturalnie Aktywny i Asahi SL w uprawie polowej pszenicy ozimej stanowić może alternatywny w stosunku do metody chemicznej sposób ograniczania liczebności fitofagów o kłująco-ssącym aparacie gębowym.

Słowa kluczowe: Asahi SL, Efektywne Mikroorganizmy, hemimetaboliczne fitofagi, pszenica ozima