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SPRING WHEAT YIELD IN SHORT-TERM MONOCULTURE DEPENDING ON THE TILLAGE METHOD, USE OF ORGANIC MATTER AND A BIOSTIMULANT

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Abstract. Three-factorial field experiment on agricultural practices in spring wheat cultivation in short-term monoculture was conducted in the years 2012-2013 in Chełmce (52°61' N; 18°44' E), on the soil of a good rye complex. The experimental factors included: A – tillage method connected with the application of organic matter (five variants with a post-harvest tillage with a grubber and pre-winter plough or without ploughing, and with the use of manure and stubble catch crop biomass – white mustard), B – method of application of post-harvest residues (four variants with the use of straw and effective microorganisms or without), C – application of a biostimulant Asahi SL (two levels). The aim of the study was determination of the effect of these factors on the yield components and grain yield in spring wheat cultivated in the 2nd and 3rd year of monoculture. Grain yield of spring wheat in the first year of research was by 25% higher than in the second year, which to some extent confirms low tolerance of this plant to being cultivated after itself. In the spring wheat monoculture, especially in the third year, grain yield was beneficially affected by the application of manure mixed with soil with a grubber and pre-winter plough, as well as manure and biomass of white mustard mulching the field through winter with tillage reduced to grubbing. The yield-producing effect of shredded straw with an inoculum of effective microorganisms applied into the soil manifested itself only in the initial period of monoculture, the second year, and with no manure application. In case of organic fertilization as well as in the subsequent year of monoculture, the use of straw and effective microorganisms did not affect beneficially the grain yield. Biostimulant Asahi SL, however, caused increase in the grain yield, especially in the third year of spring wheat monoculture and after using manure.

Key words: Asahi, effective microorganisms, grubbing, manure, ploughing, straw, stubble catch crop

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INTRODUCTION

Organic fertilization is one of the most important agricultural practices determining soil properties and reducing unfavorable effects of reduced crop rotation [Giemza--Mikoda *et al*. 2011]. The effect of manure, post-harvest residues or the biomass of catch crops on physical and chemical properties and phytosanitary condition of soil depends on the method of distributing them in the soil, which is determined by tillage. Covering and mixing the organic matter with soil affects the rate of its decomposition and direction of chemical and microbiological changes [Lepiarczyk 2000, Parylak 2004, Blecharczyk *et al*. 2005, Małecka *et al*. 2007, Hu *et al*. 2013, Maltas *et al*. 2013]. The influence of effective microorganisms on changes in organic matter in the soil is currently studied, as well as its microbiological activity and plant health, especially in terms of improving value of plots in cereal crop rotation [Piskier 2006, Kaczmarek *et al*. 2008, Stępień and Adamiak 2009, Kotwica *et al*. 2011]. In literature there are also some critical opinions concerning methodology and results of research on the production- and habitat effects of using some biopreparations [Martyniuk 2011, Martyniuk and Księżak 2011]. Also biostimulants are used to increase plant productivity under unfavorable habitat and agritechnical conditions. These compounds reduce plant's response to the effect of stressors, and beneficially affect their metabolism [Matysiak *et al.* 2011].

In the present study a hypothesis was assumed that introducing organic matter into the soil in the form of manure, catch crops or straw, through different tillage methods, alleviates negative effects of cultivating spring wheat in short-term monoculture. It was also assumed that this effect may be modified by the influence of effective microorganisms and biostimulant, which in view of equivocal results of previous studies should be verified. The aim of the study, however, was finding the effect of different tillage systems connected with the use of organic matter, and also of biostimulant Asahi SL on the yield components and grain yield of spring wheat in a short-term monoculture.

MATERIAL AND METHODS

The source material includes the results from field experiments conducted in the years 2012-2013. The experiments were carried out on a private farm in Chełmce (52°61' N; 18°44' E). The static (2nd and 3rd year of spring wheat monoculture) three--factorial experiment was set up in a split-plot-split-block design, in 3 replications. The experimental factors included:

A – tillage system connected with the use of organic matter (five variants):
- skimming of the stubble field, pre-winter ploughing, seeder-cultivator unit in spring (variant 1),
- manure, skimming, pre-winter ploughing, seeder-cultivator unit in spring (variant 2),
- grubbing of the stubble field, grubbing, seeder-cultivator unit in spring (variant 3),
- grubbing of the stubble field + stubble catch crop, grubbing, seeder-cultivator unit in spring (variant 4),
- manure, skimming + stubble catch crop, grubbing, seeder-cultivator unit in spring (variant 5);

Manure was used at a rate of 30 $t \cdot ha^{-1}$. Stubble catch crop in the form of white mustard was sown in mid-August, at a rate of 15 kg of $seeds \cdot ha^{-1}$;

B – method of using post-harvest residues:

– leaving shredded straw on the stubble field (SEM-),
– leaving shredded straw on the stubble field + EM (SEM+),
– stubble field, straw removed (EM-),
– stubble field, straw removed + EM (EM+)
(EM – preparation containing effective microorganisms „EM-A" at a dose of 40 $dm^3 \cdot ha^{-1}$);

C – application of a biostimulant:
– application of a biostimulant (A+),
– without application of a biostimulant (A-).
(biostimulant Asahi SL was applied in 2 doses: 0.5 $dm^3 \cdot ha^{-1}$ at the stage BBCH 23--25 and BBCH 39 in spring wheat)

The experiment included 40 objects located on 120 plots, each having an area of 96 m^2. The qualified seed material of spring wheat cv. Tybalt was sown at a density of 450 $grains \cdot m^{-2}$ on the 24th March 2012 and on the 20th April 2013 with row spacing of 14.3 cm, at a depth of 4 cm. The sowing was conducted 4 m with a seeder-cultivator unit consisting of a cyclotiller and a seeder Horsch Pronto 4DC with disc coulters and pressing rolls. In the first year of research, the wheat was sown on the plot after winter wheat, for which the forecrop was also winter wheat, the 2nd year of monoculture. In the second year of research (the 3rd year of monoculture) spring wheat was cultivated on the same plot, retaining the same location of the objects. The experiment was carried out on the soil of a very good rye complex of a granulometric composition of light loam, alkaline reaction (pH in KCl 7.6) and containing C_{org} 2.43%, available forms of PK and Mg 17.3, 20.4 and 5.10 $mg \cdot 100g^{-1}$, respectively. Nitrogen at a rate of 60 kg $N \cdot ha^{-1}$ as well as phosphorus and potassium at doses of 15.7 kg $P \cdot ha^{-1}$ and 76.4 kg $K \cdot ha^{-1}$, respectively, were applied in spring before pre-sowing cultivation. Top-dressing with nitrogen was applied twice: at the stage BBCH 32 at a rate of 60 kg $N \cdot ha^{-1}$ and in the stage BBCH 51 at a rate 50 kg $N \cdot ha^{-1}$. Herbicide Mustang Forte 195 SE (florasulam + aminopyralid + 2.4 D) along with a growth regulator Moddus 250 EC (trinexapac ethyl), were used in the stage BBCH 32, at doses: 0.8 $dm^3 \cdot ha^{-1}$ and 0.8 $dm^3 \cdot ha^{-1}$, respectively. Preparation Swing Top 183 SC (dimoxistrobin + epoxiconazole) constituted fungicide protection and was applied at a dose of 1.5 $dm^3 \cdot ha^{-1}$, in the stage BBCH 39.

Directly before harvest, spike density was determined on each plot, and 20 spikes were collected to assess grain number per spike. Collecting was carried out with a plot combine harvester Wintersteiger, the yield was expressed in $t \cdot ha^{-1}$ with 15% water content, and 1000 grain weight was determined.

Research results were elaborated statistically with the use of a program package ANALWAR-5.2-FR. Analysis of variance was used in a proper model for experimental design, and the multi-way analysis for the combined error model, finding F calculated based on the reproduced error increased by an interaction of the factor with years. Tukey's test was used to evaluate significance of differences in the means. The effect of particular yield components on differences in yields between experimental plots was determined with Rudnicki's method [2000]. With regard to the static character of the experiment, diverse weather conditions and a possible increasing effect of monoculture, the results are presented separately for both research years.

RESULTS AND DISCUSSION

Weather conditions in the growing season of spring wheat differed significantly in both research years (Table 1). In April and May 2012, rainfall totals were lower than in the long-term period (1967-2012) with slightly higher mean air temperatures. However, mid- and late June as well as early- and mid-July were abundant in rainfall. April 2013, in turn, was slightly cooler than usually but with a rainfall total and distribution similar to long-term values. Higher rainfall than usually occurred in May and July, and lower in June, especially in mid-June.

Table 1. Rainfall totals [mm] and mean monthly air temperatures (°C) in the growing season of spring wheat. Data from the point in Głębokie (52°61' N; 18°44' E)
Tabela 1. Sumy opadów atmosferycznych [mm] i średnie miesięczne temperatury powietrza (°C) w okresie wegetacji pszenicy jarej; dane z punktu w Głębokim (52°61' N; 18°44' E)

Year Rok	Trait Cecha	Decade Dekada	Month – Miesiąc					
			March marzec	April kwiecień	May maj	June czerwiec	July lipiec	August sierpień
2012	rainfall opady $dm^3 \cdot m^{-2}$	I	1.2	5.3	3.2	9.1	21.5	23.1
		II	0.0	6.9	10.5	60.8	42.8	3.3
		III	6.8	4.1	15.6	33.8	4.5	10.6
		I-III	8.0	16.3	29.3	103.7	68.8	37.0
	temperature temperatura, °C		5.1	9.3	15.3	16.1	19.6	18.7
2013	rainfall opady $dm^3 \cdot m^2$	I	3.3	2.3	4.6	22.6	35.6	32.2
		II	4.7	4.1	24.7	2.1	48.9	18.5
		III	13.6	14.8	45.2	26.6	27.4	4.7
		I-III	21.6	21.2	74.5	51.3	111.9	55.4
	temperature temperatura, °C		-2.7	7.5	14.4	17.4	18.9	18.7
1967- -2012	rainfall opady, $dm^3 \cdot m^{-2}$		28.0	27.0	52.0	69.0	81.0	60.0
	temperature temperatura, °C		2.6	7.9	13.6	16.6	18.6	18.1

Tillage method and related to it organic matter application had a significant, though different, effect on the spike density in spring wheat in both research years (Table 2). In 2012, i.e. in the second year of monoculture of spring wheat, introducing manure, as well as manure plus catch crop biomass into the soil, irrespective of tillage practices, resulted in obtaining a higher spike density than after using other tillage variants. Particularly important difference occurred in case of simultaneous use of straw and effective microorganisms. The lowest spike density, lower than under the effect of stubble catch crop biomass (variant 4), occurred on plots where skimming and pre--winter ploughing were used (variant 1), and only with grubbing (variant 3) without introducing additional organic matter into the soil. In the third year of monoculture (2013), incorporating manure and manure with white mustard biomass into the soil, also beneficially affected spike density, although to a lesser degree than in the first year of research, and irrespective of using straw and effective microorganisms. Spike density in spring wheat on the plot where tillage was conducted only with the use of a grubber, and where white mustard was sown (variant 4), did not, however, differ significantly from the spike density on other plots. Turska *et al*. [2011] found a beneficial effect of using catch crop cultivation in spring wheat monoculture on all yield components, including spike density, which is in accordance with the results obtained in the first year of our research. Rymuza *et al*. [2012], however, indicate that yield components in spring wheat depend on the type of sown catch crop.

Table 2. Spike density in spring wheat (spike·m^{-2}) depending on: A – the tillage system, B – the use of post-harvest residues, and C – the application of a biostimulant.
Tabela 2. Obsada kłosów pszenicy jarej (szt.·m^{-2}) w zależności od sposobu uprawy roli – A, stosowania resztek pożniwnych – B i aplikacji biostymulatora – C

Year Rok	Level of B and C Poziom B i C	Tillage variant – Wariant uprawy					Mean – Średnia	
		1	2	3	4	5		
2012	SEM-	532	687	550	589	687	mean (B) średnia (B)	609
	SEM+	566	733	586	634	731		650
	EM-	511	627	531	574	636		576
	EM+	511	654	534	578	633		582
	mean (A) średnia (A)	530	675	550	594	672		604
	$LSD_{0.05}$ – $NIR_{0,05}$	A 25.3 B 52.2 B/A 59.0 A/B 38.5						
	A+	538	689	557	605	686	mean (B) średnia (B)	615
	A-	522	662	543	582	657		593
	$LSD_{0.05}$ – $NIR_{0,05}$	C 21.1 C/A ns – ni A/C ns – ni						
2013	SEM-	549	637	550	556	637	mean (B) średnia (B)	586
	SEM+	583	683	586	600	681		627
	EM-	527	577	531	540	586		552
	EM+	528	604	534	545	583		559
	mean (A) średnia (A)	546	625	550	560	622		581
	$LSD_{0.05}$ – $NIR_{0,05}$	A 78.0 B 65.1 B/A ns – ni A/B ns – ni						
	A+	555	639	557	572	636	mean (C) średnia (C)	592
	A-	538	612	543	549	607		570
	$LSD_{0.05}$ – $NIR_{0,05}$	C ns – ni C/A ns – ni A/C ns – ni						

„EM-" – plots without straw or the application of effective microorganisms – obiekty bez słomy i aplikacji efektywnych mikroorganizmów; „EM+" – plots without straw, with the application of effective microorganisms – obiekty bez słomy, z aplikacją efektywnych mikroorganizmów
„SEM-" – plots with the forecrop straw left, without the application of effective microorganisms – obiekty z pozostawioną słomą przedplonu, bez aplikacji efektywnych mikroorganizmów; „SEM+" – plots with the forecrop straw left and with the application of effective microorganisms – obiekty z pozostawioną słomą przedplonu i z aplikacją efektywnych mikroorganizmów
„A-" – without the application of a biostimulant – bez aplikacji biostymulatora; „A +" – with the application of a biostimulant – z aplikacją biostymulatora
ns – ni – non-significant differences – różnice nieistotne

Spike density in spring wheat in the subsequent years of short-term monoculture depended on the method of using post-harvest residues. On plots where straw was incorporated into the soil along with effective microorganisms, it was significantly higher than after harvesting straw, irrespective of the application of EM preparation. In the first year of research, beneficial effect of straw with effective microorganisms, however, occurred only on plots where manure was used (variant 3 and 5). In that year, i.e. the second year of monoculture, also application of the biostimulant Asahi SL increased the number of spikes per unit of area. This factor, unlike tillage method and the use of post-harvest residues, beneficially affected grain number per spike and 1000 grain weight (Table 3). Although differences in the value of yield components as a result of using biostimulant Asahi SL were not major, 2.8-4.8%, yet they were statistically significant. Grain yield of spring wheat in the first year of research (the second year of monoculture, i.e. 2012) was 6.42 $t \cdot ha^{-1}$, and was by 1.29 $t \cdot ha^{-1}$, i.e. 25.1%, higher than in the subsequent year (the third year of monoculture) (Table 4). This response may be seen in the negative effect of prolonging monoculture of spring wheat. However, Parylak [2005], based on the field experiment, indicates that cultivating wheat after itself, compared with cultivation in a crop rotation, caused decrease in the yield by 17%. According to this author, reduction in tillage, especially after abandoning completely post-harvest treatment, unfavorably affects the wheat yield in monoculture. Agenbag [2012] sees the cause of a higher wheat yield in the crop rotation than in monoculture, among other things in a better balance of organic carbon, yet, depending on the tillage system. In our research on plots where shredded straw was left and the tillage was reduced to grubbing, a large amount of post-harvest residues remained on the soil surface, which Małecka *et al*. [2007] as well as Parylak [2004] consider a direct cause of developing fungal infections. The occurrence of fungal infections, however, is one of the most important causes of reducing the yield, especially in reduced tillage systems [Horneby 1998, Solarska 2008].

Table 3. Grain number per spike and 1000 grain weight in spring wheat depending on the application of a biostimulant
Tabela 3. Liczba ziaren w kłosie i masa tysiąca ziaren pszenicy jarej w zależności od aplikacji biostymulatora

Biostimulant Biostymulator	Grain number per spike, grain Liczba ziaren w kłosie, szt.		1000 grain weight, g Masa tysiąca ziaren, g	
	2012	2013	2012	2013
A-	28.8	27.3	40.5	39.0
A+	29.6	28.6	42.2	40.7
Mean – Średnia	29.2	28.0	41.3	39.9
$LSD_{0.05}$ – $NIR_{0,05}$	0.8	0.8	0.7	1.3

„A-” – without the application of a biostimulant – bez aplikacji biostymulatora; „A +” – with the application of a biostimulant – z aplikacją biostymulatora

Grain yield of spring wheat both in the second and third year of monoculture depended on the type of organic matter incorporated into the soil through various tillage treatments. The highest yield occurred after ploughing under manure with skimming, sowing white mustard in the catch crop and spring tillage with the use of a grubber (variant 5), and as a result of manure fertilization after harvesting the forecrop, the use of skimming and pre-winter ploughing (variant 2) (Table 4). The yield obtained on other plots was lower, though not significantly, on each one in both years. In the first year of research only skimming, and next pre-winter ploughing (variant 1) caused decrease in the yield compared with variant 5 with the use of manure and catch crop biomass. In the second year of research, a significantly higher yield than under the effect of the first tillage variant was obtained as a result of cultivating stubble catch crop, despite reducing tillage to grubbing (variant 4). Woźniak and Gros [2014] prove that in the systems with tillage, even the reduced one, spring wheat yields are higher than in no-till systems.

Table 4. Grain yield in spring wheat depending on: A – the tillage system, B – the use of post-harvest residues, and C – the use of a biostimulant, Mg·ha^{-1}

Tabela 4. Plon ziarna pszenicy jarej w zależności od sposobu uprawy roli – A, stosowania resztek pożniwnych – B i aplikacji biostymulatora – C, Mg·ha^{-1}

Year Rok	Level of B and C Poziom B i C	Tillage variant – Wariant uprawy					Mean – Średnia	
		1	2	3	4	5		
2012	SEM-	5.81	7.05	6.57	6.30	7.23	mean (B) średnia (B)	6.59
	SEM+	6.39	7.35	6.77	6.74	7.36		6.92
	EM-	5.01	7.15	4.89	5.82	7.20		6.01
	EM+	5.17	6.97	5.35	5.79	7.41		6.14
	mean – średnia (A)	5.60	7.13	5.90	6.16	7.30		6.41
	$LSD_{0.05}$ – $NIR_{0,05}$	A 1.67 B 0.61 B/A 0.94 A/B 1.83						
	A+	5.79	7.18	6.17	6.23	7.40	mean (C) średnia (C)	6.55
	A-	5.39	7.08	5.62	6.09	7.21		6.28
	$LSD_{0.05}$ – $NIR_{0,05}$	C 0.21 C/A ns – ni A/C ns – ni						
2013	SEM-	4.01	5.64	4.05	4.99	5.67	mean (B) średnia (B)	4.87
	SEM+	4.56	6.67	5.03	5.74	6.36		5.67
	EM-	4.12	5.86	3.89	5.13	5.93		4.99
	EM+	4.14	5.85	3.88	5.19	5.92		5.00
	mean – średnia (A)	4.21	6.01	4.21	5.26	5.97		5.13
	$LSD_{0.05}$ – $NIR_{0,05}$	A 0.46 B ns – ni B/A ns – ni A/B ns – ni						
	A+	4.43	6.40	4.46	5.43	6.27	mean (C) średnia (C)	5.40
	A-	3.99	5.61	3.97	5.09	5.66		4.86
	$LSD_{0.05}$ – $NIR_{0,05}$	C 0.22 C/A 0.29 A/C 0.50						

for explanations, see Table 2 – objaśnienia pod tabelą 2

Such results are confirmed in the research of Woźniak [2005], who claims that ploughing under catch crop biomass to a lesser degree compensates for cultivating spring wheat in monoculture than manure fertilization.

In our studies, incorporating straw into the soil had a beneficial effect on the spring wheat yield only in the first year, especially when inoculation with effective microorganisms was used (Table 4). The beneficial effect of straw with EM inoculation on the spring wheat yield, however, did not occur when manure was used in the series of cultivating measures after harvesting the forecrop. In both years of research, however, the use of a biostimulant Asahi SL had a beneficial effect on the spring wheat yield. In the first year, its application resulted in a 4.3% yield increase, in the second year this effect was 11.1%, and was the highest on plots with manure application (Table 4). Thus, it may be assumed that application of this preparation alleviates effects of cultivating spring wheat in monoculture.

Increase in the spring wheat yield under the influence of organic matter such as manure and catch crop biomass, as well as straw, and application of EM incorporated into the soil through tillage treatments, compared with other plots, resulted mainly from a higher spike density, and to a much lesser degree from a change in the grain number per spike or 1000 grain weight (Table 5). Positive effect of using the biostimulant Asahi SL in the first year of study was mainly connected with an increase in 1000 grain weight, and with a change in all yield components to a similar degree in the second year.

Table 5. Difference in yields (Mh·ha^{-1}) between the means of particular levels of factors and share (%) of the yield components in this difference
Tabela 5. Różnica plonów (Mg·ha^{-1}) pomiędzy średnimi poszczególnych poziomów czynników i udział (%) elementów plonowania w tej różnicy

Factor – Czynnik	Level Poziom		2012				2013			
			yield difference różnica plonu	spike density obsada kłosów	grain number per spike liczba ziaren w kłosie	1000 grain weight masa 1000 ziaren	yield difference różnica plonu	spike density obsada kłosów	grain number per spike liczba ziaren w kłosie	1000 grain weight masa 1000 ziaren
Tillage system – Uprawa roli	2	1	1.54	99.0	5.20	-4.10	1.80	91.6	7.20	1.20
	3	1	0.30	71.7	19.4	8.90	0.00	-273	287	86.7
	4	1	0.57	122	-14.1	-7.80	1.05	86.2	21.0	-7.20
	5	1	1.71	102	-0.90	-1.20	1.76	97.2	4.50	-1.70
	3	2	-1.24	-110	-5.10	14.8	-1.80	-69.0	-24.7	-6.30
	4	2	-0.97	-77.2	-26.7	4.00	-0.75	-92.2	10.3	-18.1
	5	2	0.17	156	-108.8	53.2	-0.04	76.2	-82.6	-93.6
	4	3	0.27	183	-50.1	-32.6	1.05	72.3	45.5	-17.8
	5	3	1.41	111	-4.70	-6.30	1.76	93.6	15.3	-8.90
	5	4	1.14	92.9	7.60	-0.50	0.71	116	-15.6	-0.50
Stosowanie residues resztek pożniwnych	SEM+	SEM-	0.33	95.7	0.00	4.30	0.80	69.7	23.5	6.80
	EM-	SEM-	-0.58	-64.2	-32.8	-2.90	0.12	-95.2	0.00	195
	EM+	SEM-	-0.45	-95.7	11.7	-16.0	0.13	-95.3	140	55.7
	EM-	SEM+	-0.91	-74.1	-22.0	-3.90	-0.68	-76.0	-28.5	4.50
	EM+	SEM+	-0.78	-95.1	7.0	-11.9	-0.67	-84.0	-13.6	-2.40
	EM+	EM-	0.13	-18.2	125.4	-7.20	0.01	-57.6	194	-36.2
Asahi	Asahi -	Asahi +	-0.27	-13.9	-20.9	-65.2	-0.54	-26.2	-36.7	-37.1

for explanations, see Table 2 – objaśnienia pod tabelą 2

CONCLUSIONS

1. Grain yield of spring wheat in the second year of research was by 25% higher than in the third year. This, beside the effect of weather conditions over the years of research, confirms low tolerance of this plant to being cultivated after itself.

2. Application of manure mixed with soil with the use of a grubber, and pre-winter ploughing, as well as manure and the white mustard biomass mulching the field through winter, with reducing tillage to grubbing, had a beneficial effect on the grain yield in the spring wheat monoculture, especially in the third year.

3. The yield-producing effect of shredded straw incorporated into the soil with an inoculation of effective microorganisms only manifested itself in the first year of study when no manure was used. In case of organic fertilization and in the subsequent year of study, the use of straw and effective microorganisms did not affect beneficially the grain yield.

4. Biostimulant Asahi SL caused increase in the grain yield, especially in the second year of study, i.e. in the third year of spring wheat monoculture and after using manure.

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PLONOWANIE PSZENICY JAREJ W KRÓTKOTRWAŁEJ MONOKULTURZE W ZALEŻNOŚCI OD SPOSOBU UPRAWY ROLI, STOSOWANIA MASY ORGANICZNEJ I BIOSTYMULATORA

Streszczenie. Trójczynnikowe doświadczenie polowe nad agrotechniką pszenicy jarej w krótkotrwałej monokulturze wykonano w latach 2012-2013 w Chełmcach (52^{o}61' N; 18^{o}44' E), na glebie kompleksu żytniego dobrego. Czynnikami doświadczenia były: A – sposób uprawy roli związany ze stosowaniem masy organicznej (pięć wariantów z uprawą pożniwną gruberem oraz orką przedzimową lub bez orki oraz ze stosowaniem obornika i biomasy międzyplonu ścierniskowego – gorczycy białej), B – sposób stosowania resztek pożniwnych (cztery warianty ze stosowaniem słomy i efektywnych mikroorganizmów lub bez), C – aplikacja biostymulatora Asahi SL (dwa poziomy). Celem badań było określenie wpływu tych czynników na elementy plonowania i plon ziarna pszenicy jarej uprawianej w 2. i 3. roku monokultury. Plon ziarna pszenicy jarej w pierwszym roku badań był o 25% większy niż w drugim roku, co w pewnym stopniu potwierdza małą tolerancję tej rośliny na uprawę po sobie. W monokulturze pszenicy jarej, zwłaszcza w trzecim roku, korzystnie na plon ziarna wpłynęło stosowanie obornika wymieszanego z glebą gruberem i orki przedzimowej, a także obornika i biomasy gorczycy białej mulczującej pole przez zimę przy ograniczeniu uprawy roli do gruberowania. Plonotwórcze oddziaływanie wnoszonej do gleby rozdrobnionej słomy ze szczepionką efektywnych mikroorganizmów ujawniło się tylko w początkowym okresie monokultury, w drugim roku i gdy nie stosowano obornika. W przypadku nawożenia organicznego oraz w kolejnym roku monokultury stosowanie słomy i efektywnych mikroorganizmów nie wpłynęło korzystnie na plon ziarna. Biostymulator Asahi SL spowodował natomiast wzrost plonu ziarna, zwłaszcza w trzecim roku monokultury pszenicy jarej i po zastosowaniu obornika.

Słowa kluczowe: Asahi, efektywne mikroorganizmy, gruberowanie, międzyplon ścierniskowy, obornik, orka, słoma

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