

## **PREVIOUS CROP VALUE OF POST-HARVEST RESIDUES AND STRAW OF SPRING WHEAT, FIELD PEA AND THEIR MIXTURES FOR WINTER TRITICALE PART II. WINTER TRITICALE YIELD**

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**Abstract.** The study carried out in 2005-2007 estimated the effect of the kind of previous crop (spring wheat, field pea, spring wheat-field pea mixture) and the method of previous crop biomass application in the field (post-harvest residues, post-harvest residues + straw) on the yield of winter triticale, yield structure elements and total nitrogen content in grain. Grain yield and total nitrogen content in the grain of winter triticale cultivated following field pea and spring wheat-field pea mixtures was significantly higher compared with the previous crop of spring wheat. The higher winter triticale grain yield was a result of a greater number of ears per 1 m<sup>2</sup>, and of kernels per ear as well as a higher weight of 1000 kernels. An increase in the proportion of field pea in the mixture with spring wheat increased winter triticale grain yield and total nitrogen content. An application of post-harvest residues and straw of the examined previous crops significantly increased winter triticale grain yield, yield components, and total nitrogen content compared with residues alone.

**Key words:** forecrop, grain yield, nitrogen content in grain, straw, yield structure components

### **INTRODUCTION**

Previous crop requirements of triticale are considerably higher than those of rye, but similar to those of winter wheat [Mazurek and Kuś 1992, Panse et al. 1994, Zając et al. 2006]. Triticale as a synthetic cereal combining features of demanding wheat and tolerant rye, shows various degree of sensitivity to the unfavorable previous crop [Mazurek and Kuś 1992, Gutteridge et al. 1993, Kuś and Siuta 1995, Chrzanowska-Drożdż 1997, Sadowski and Krześlak 1997, Smagacz 1998, 1999, Sadowski et al. 2000, Zając et al. 2006]. In the study by Smagacz [1998], carried out in the soil of the very good rye complex, winter triticale was sown after winter wheat or triticale (as the second ear plant in monoculture) yielded by 10-12% lower in comparison to triticale

cultivated after potatoes. The basic cause of a decrease in yield was infestation by culm base diseases. According to Mazurek and Kus [1992] a decrease in grain yield of winter triticale sown after triticale and rye, in relation to cultivation after legumes, ranges from 14 to 37%, depending on the cultivar and the soil and climatic conditions.

Legumes, as plants regenerating in cereal crop rotations, apart from the phytosanitary aspect, provide considerable amounts of nitrogen for sequential plants [Maidl et al. 1996, Sadowski et al. 2000]. Crop rotations with legumes are one of the basic conditions of maintaining soil fertility [Izaurrealde et al. 1995]. It may be expected that legumes in mixtures with cereals will grow the previous crop qualities of the stand, for instance by improving chemical, physical and phytosanitary properties of soil, and consequently, the yield of the sequential plants. This allows putting forward a hypothesis about a higher yield level of cereals cultivated in stands after cereal-legume mixtures than after cereals in pure sowing.

The aim of this study was to compare the yield of winter triticale grown in stands after spring wheat, field pea and spring wheat-field pea mixtures, where only post-harvest residues and post-harvest residues with previous crop straw were ploughed in.

## MATERIAL AND METHODS

Information concerning the experiment, the place of its realization, soil and climate conditions and the statistical calculations of the experimental data was presented in the first part of this study [Buraczyńska and Ceglarek 2011].

A field experiment with winter triticale was established in the split-block design, in three replications. The area of the plot for harvesting was 20 m<sup>2</sup>. Two factors were investigated: previous crop (100% – spring wheat, spring wheat-field pea mixtures with the proportion of components: 75 + 25%, 50 + 50%, 25 + 75%, 100% – field pea), method of the previous crop biomass application in the plot (post-harvest residues, post-harvest residues + straw). On the treatments where only post-harvest residues of the previous crop was plowed in, straw was collected from the plot. In the variants with straw, straw cut during harvest was left in the plot. Spring wheat straw was plowed in with an addition of nitrogen (0.7% in relation to the straw weight). Winter triticale of the cultivar Witon, dressed with the preparation Baytan Universal 19.5 WS, was sown from 10<sup>th</sup> to 20<sup>th</sup> September at a density of 400 seeds per 1 m<sup>2</sup>. Before sowing, phosphorus fertilizers were applied at a rate of 26 kg P·ha<sup>-1</sup> and potassium fertilizers – 75 kg K·ha<sup>-1</sup>. Nitrogen fertilizers were sown at two dates: in spring after starting of vegetation – 55 kg N·ha<sup>-1</sup> and at the stage of shooting – 40 kg N·ha<sup>-1</sup>. Apyros 75 WG + Atpolan 80 EC were applied to control weeds, and Decis 2.5 EC and Fastac 100 EC for pest control. Winter triticale was harvested in full maturity from 20 to 31 July or from 1 to 10 August. The grain yield at the humidity 15%, the number of ears per 1 m<sup>2</sup>, the number of kernels per ear and 1000 kernel weight were estimated and the total nitrogen content in grain was determined (with the Kjeldahl method).

## RESULTS

The grain yield of winter triticale was significantly diversified by the weather conditions, the kind of the previous crop and the method of previous crop biomass application in the field (Table 1). Significantly the highest grain yield of winter triticale

was obtained in 2005, when precipitation in June was similar to the long-term average, and in May and July was higher. Additionally, in 2004 the compared previous crops left larger weight of post-harvest residues and straw than in the other years of the study, which probably affected the yield level of winter triticale in 2005. The significantly lower grain yield of winter triticale was observed in 2006, with a monthly air temperature in the period January – March considerably lower than the long-term average and precipitation shortage from January to July (50.4% of the long-term average total for this period). The difference in grain yield of winter triticale between those years was  $3.70 \text{ t}\cdot\text{ha}^{-1}$ . The grain yield of winter triticale in stands after spring wheat-field pea mixtures (75 + 25%, 50 + 50%, 25 + 75%) and after field pea was significantly higher, by 0.51; 0.88; 1.21 and  $1.10 \text{ t}\cdot\text{ha}^{-1}$ , respectively, i.e. by 9.3; 16.1; 22.2 and 20.1%, respectively, than the yield in the stand after spring wheat. Decreasing the proportion of spring wheat and increasing the proportion of field pea in the mixture had a significant effect on the growth in grain yield of winter triticale. Winter triticale grain yield in stands after spring wheat-field pea mixtures with the proportion of components 25 + 75% i 50 + 50% did not differ significantly, and in the stand after the mixture with the proportion of components 75 + 25% was significantly (by  $0.59 \text{ t}\cdot\text{ha}^{-1}$ , respectively) than the yield in the stand after field pea. The effect of the previous crop on winter triticale grain yield depended on the weather conditions. In 2006, when from January to July monthly total precipitations were less than the long-term averages, the proportion of spring wheat and field pea in mixtures, being the previous crop of winter triticale, did not modify significantly the winter triticale grain yield. The grain yield of winter triticale in the stand after spring wheat-field pea mixture with the proportion of components 75 + 25% was similar to the yield in the stand after spring wheat. Application of post-harvest residues under winter triticale together with the straw of the previous crop, increased significantly winter triticale grain yield in relation to the post-harvest residues alone in each year of the study (on average by  $0.68 \text{ t}\cdot\text{ha}^{-1}$ , i.e. 11.6%). The effect of the previous crop on winter triticale grain yield was modified by the amount of the previous crop biomass. On the treatments with the post-harvest residues of the previous crop, a decrease in proportion of spring wheat in the mixture with field pea from 50 to 25% did not diversify significantly the grain yield of winter triticale. The highest grain yield of winter triticale was obtained in stands after field pea and spring wheat-field pea mixtures with the proportion of components 50 + 50% and 25 + 75%. In the variants with straw, in turn, a decrease in proportion of spring wheat and an increase in proportion of field pea in mixtures increased significantly the grain yield of winter triticale. The spring wheat-field pea mixture with the proportion of components 25 + 75% and field pea in pure sowing had the most favorable effect on a growth in winter triticale grain yield.

The number of winter triticale ears per  $1 \text{ m}^2$  (Table 2), the number of kernels per ear (Table 3) and 1000 kernel weight of winter triticale (Table 4) were significantly diversified by the weather conditions, the kind of the previous crop and the method of the previous crop biomass application in the field. In 2007, with the precipitation distribution and air temperature in the spring-summer period the most similar to the long-term averages, significantly the largest number of winter triticale ears per  $1 \text{ m}^2$  was observed. In 2005 and 2006, the number of winter triticale ears per  $1 \text{ m}^2$  was smaller than in 2007 by 45 and 129, respectively. Significantly the largest number of kernels per ear and 1000 kernel weight were recorded in 2005, and significantly the smallest in 2006, when the whole growing season, except for August, was characterized by precipitation shortage, and July was very warm. Cultivation of winter triticale after

spring wheat-field pea mixtures and after field pea ensured a significantly higher ear density and the number of kernels per ear than that in the stand after spring wheat. Of the previous crops compared, only the spring wheat-field pea mixture with the proportion of components 75 + 25% did not increase significantly 1000 grain weight of winter triticale in relation to spring wheat. The effect of the spring wheat-field pea mixtures with the proportion of components 50 + 50% and 25 + 75% on the number of ears of winter triticale per 1 m<sup>2</sup>, the number of kernels per ear and 1000 kernel weight of winter triticale did not differ significantly from the effect of field pea. In contrast, the number of winter triticale ears per 1 m<sup>2</sup>, the number of kernels per ear and 1000 kernel weight of winter triticale in the stand after the spring wheat-field pea mixture with the proportion of components 75 + 25% were significantly lower than those after field pea. Interaction of years with the previous crop was proved in regard to the number winter triticale ears per 1 m<sup>2</sup>, and 1000 kernel weight of winter triticale. An addition of straw to post-harvest residues of previous crops significantly increased the number of ears of winter triticale per 1 m<sup>2</sup> (on average by 32), the number of kernels per ear (on average by 0.8) and 1000 kernel weight of winter triticale (on average by 0.5 g). The effect of the method of previous crop biomass application on the yield structure elements of winter triticale was differentiated by the weather conditions. Also an interaction was observed between the kind of the previous crop and the method of the previous crop biomass application in relation to the number of winter triticale ears per 1 m<sup>2</sup> was observed. On the treatments with the post-harvest residues of the previous crops, an increase in the proportion of field pea in the mixture with spring wheat from 25 to 50% and from 50 to 75% did not diversify significantly the ear density of winter triticale. In the variants with straw, along with an increase in the proportion of field pea in the mixture with spring wheat, the number of winter triticale ears per 1 m<sup>2</sup> increased significantly.

The total nitrogen content in winter triticale grain was significantly modified by rainfall and thermal conditions and the experimental factors (Table 5). The precipitation deficiency during the growing season of 2006 and a higher air temperature in July as compared with the long-term average favored accumulation of nitrogen in winter triticale grain. Winter triticale grain was characterized by a significantly lower nitrogen content in 2007, and by the lowest nitrogen content in 2005, when the total precipitation in June was similar to the long-term average, and in May and July considerably higher. The significantly lowest total nitrogen content was found in winter triticale grain sown in the stand after spring wheat. Cultivation of winter triticale in stands after spring wheat-field pea mixtures (75 + 25%, 50 + 50%, 25 + 75%) and after field pea had a significant effect on a growth in the total nitrogen content in winter triticale grain (by 0.3; 0.9; 1.2 and 1.6 g·kg<sup>-1</sup> DM, respectively), as compared with cultivation in the stand after spring wheat. A decrease in the proportion of spring wheat and an increase in field pea in the mixture, being the previous crop of winter triticale, significantly increased the total nitrogen content in its grain. Winter triticale grain sown in the stand after field pea was characterized by the significantly largest total nitrogen content. From interaction of years with previous crop it follows that in 2006, with the lowest precipitation from January to July in the years of the study, the difference in nitrogen content in grain of winter triticale cultivated in the stand after spring wheat and the spring wheat-field pea mixture with the proportion of components 75 + 25% was within the margin of experimental error. Plowing in of post-harvest residues with straw of previous crops under winter triticale, significantly increased the total nitrogen content in grain in relation to post-harvest residues alone (on average by 0.6 g·kg<sup>-1</sup> DM). This regularity was observed in all the years of the study.

Table 1. Winter triticale grain yield, t·ha<sup>-1</sup>  
 Tabela 1. Plon ziarna pszenżyta ozimego, t·ha<sup>-1</sup>

Previous crop Przedplon	2005			2006			2007			Mean – Średnia 2005-2007		
	Method of biomass application – Sposób pozostawiania masy organicznej*											
	R	R + S	mean średnia	R	R + S	mean średnia	R	R + S	mean średnia	R	R + S	mean średnia
Spring wheat 100% – pszenica jara 100%	6.37	7.05	6.71	3.68	3.82	3.75	5.67	6.15	5.91	5.24	5.67	5.46
Spring wheat 75% + field pea 25%	7.04	7.87	7.46	3.88	4.07	3.98	6.16	6.81	6.48	5.69	6.25	5.97
Pszenica jara 75% + groch siewny 25%	7.48	8.65	8.06	3.99	4.25	4.12	6.44	7.24	6.84	5.97	6.71	6.34
Spring wheat 50% + field pea 50%	7.81	9.21	8.51	4.11	4.41	4.26	6.74	7.74	7.24	6.22	7.12	6.67
Pszenica jara 50% + groch siewny 50%	7.63	8.77	8.20	4.20	4.46	4.33	6.71	7.59	7.15	6.18	6.94	6.56
Spring wheat 25% + field pea 75%	7.27	8.31	7.79	3.97	4.20	4.09	6.34	7.11	6.72	5.86	6.54	–
Pszenica jara 25% + groch siewny 75%												
Field pea 100% – groch siewny 100%												
Mean – Średnia												
LSD <sub>0,05</sub> – NIR <sub>0,05</sub> for – dla:												
years – lat												
previous crop – przedplonu												
interaction – interakcji:												
years × previous crop – lata × przedplon												
method of biomass application – sposób pozostawiania masy organicznej												
interaction – interakcji:												
years × method of biomass application – lata × sposób pozostawiania masy organicznej												
previous crop × method of biomass application – przedplon × sposób pozostawiania masy organicznej												
years × previous crop × method of biomass application – lata × przedplon × sposób pozostawiania masy organicznej												

ns – ni – non-significant differences – różnica nieistotna

\* R – residues – reszki, R + S – residues + straw – reszki + słoma

Table 2. Number of winter triticale ears per 1 m<sup>2</sup>  
 Tabela 2. Liczba kłosów pszenżyta ozimego na 1 m<sup>2</sup>

Previous crop Przedplon	2005			2006			2007			Mean – Średnia 2005-2007		
	Method of biomass application – Sposób pozostawiania masy organicznej*											
	R	R + S	mean średnia	R	R + S	mean średnia	R	R + S	mean średnia	R	R + S	mean średnia
Spring wheat 100% – pszenica jara 100%	434	462	448	381	391	386	485	510	498	433	454	444
Spring wheat 75% + field pea 25%	463	497	480	393	405	399	508	541	524	455	481	468
Pszenica jara 75% + groch siewny 25%												
Spring wheat 50% + field pea 50%	476	524	500	401	418	410	520	560	540	466	501	483
Pszenica jara 50% + groch siewny 50%												
Spring wheat 25% + field pea 75%	490	546	518	408	426	417	536	586	561	478	519	499
Pszenica jara 25% + groch siewny 75%												
Field pea 100% – groch siewny 100%	484	529	506	413	429	421	530	575	552	476	511	493
Mean – Średnia	469	512	490	399	414	406	516	554	535	461	493	–
LSD <sub>0.05</sub> – NIR <sub>0.05</sub> for – dla:												
years – lat					7							
previous crop – przedplonu					11							
interaction – interakcji:												
years × previous crop – lata × przedplon					16							
method of biomass application – sposób pozostawiania masy organicznej					5							
interaction – interakcji:												
years × method of biomass application – lata × sposób pozostawiania masy organicznej											8	
previous crop × method of biomass application – przedplon × sposób pozostawiania masy organicznej											14	
years × previous crop × method of biomass application – lata × przedplon × sposób pozostawiania masy organicznej											ns – ni	

ns – ni – non-significant differences – różnica nieistotna

\* R – residues – reszki, R + S – residues + straw – reszki + słoma

Table 3. Number of kernels per winter triticales ear  
Tabela 3. Liczba ziaren w kłosie pszenżyta ozimego

Previous crop Przedplon	2005			2006			2007			Mean – Średnia 2005-2007		
	Method of biomass application – Sposób pozostawiania masy organicznej*									R	R + S	
	R	R + S	mean średnia	R	R + S	mean średnia	R	R + S	mean średnia			
Spring wheat 100% – pszenica jara 100%	33.9	34.6	34.2	30.4	30.7	30.6	32.4	33.0	32.7	32.2	32.8	32.5
Spring wheat 75% + field pea 25%	34.9	35.8	35.4	30.7	31.1	30.9	33.0	33.9	33.4	32.9	33.6	33.2
Pszenica jara 75% + groch siewny 25%												
Spring wheat 50% + field pea 50%	35.5	36.7	36.1	30.9	31.4	31.2	33.5	34.3	33.9	33.3	34.1	33.7
Pszenica jara 50% + groch siewny 50%												
Spring wheat 25% + field pea 75%	35.9	37.3	36.6	31.0	31.8	31.4	33.8	34.8	34.3	33.6	34.6	34.1
Pszenica jara 25% + groch siewny 75%												
Field pea 100% – groch siewny 100%	35.8	36.8	36.3	31.2	31.8	31.5	33.7	34.6	34.2	33.6	34.4	34.0
Mean – Średnia	35.2	36.2	35.7	30.8	31.4	31.1	33.3	34.1	33.7	33.1	33.9	–

LSD<sub>0.05</sub> – NIR<sub>0.05</sub> for – dla:

years – lat

previous crop – przedplonu

interaction – interakcji:

years × previous crop – lata × przedplon

method of biomass application – sposób pozostawiania masy organicznej

interaction – interakcji:

years × method of biomass application – lata × sposób pozostawiania masy organicznej

previous crop × method of biomass application – przedplon × sposób pozostawiania masy organicznej

years × previous crop × method of biomass application – lata × przedplon × sposób pozostawiania masy organicznej

ns – ni – non-significant differences – różnice nieistotne

\* R – residues – resztki, R + S – residues + straw – resztki + słoma

Table 4. Weight of 1000 kernels of winter triticale, g  
Tabela 4. Masa 1000 ziaren pszenżyta ozimego, g

Previous crop Przedplon	2005			2006			2007			Mean – Średnia 2005-2007		
	Method of biomass application – Sposób pozostawiania masy organicznej*											
	R	R + S	mean średnia	R	R + S	mean średnia	R	R + S	mean średnia	R	R + S	mean średnia
Spring wheat 100% – pszenica jara 100%	43.1	44.0	43.6	31.7	31.8	31.8	36.0	36.4	36.2	36.9	37.4	37.2
Spring wheat 75% + field pea 25%	43.6	44.3	44.0	32.1	32.3	32.2	36.7	37.2	37.0	37.5	37.9	37.7
Pszenica jara 75% + groch siewny 25%												
Spring wheat 50% + field pea 50%	44.2	44.9	44.6	32.2	32.4	32.3	37.0	37.7	37.4	37.8	38.3	38.1
Pszenica jara 50% + groch siewny 50%												
Spring wheat 25% + field pea 75%	44.4	45.2	44.8	32.5	32.6	32.6	37.2	38.0	37.6	38.0	38.6	38.3
Pszenica jara 25% + groch siewny 75%												
Field pea 100% – groch siewny 100%	44.1	45.0	44.6	32.6	32.7	32.6	37.6	38.2	37.9	38.1	38.6	38.4
Mean – Średnia	43.9	44.7	44.3	32.2	32.4	32.3	36.9	37.5	37.2	37.7	38.2	–

LSD<sub>0.05</sub> – NIR<sub>0.05</sub> for – dla:

years – lat

previous crop – przedplonu

interaction – interakcji:

years × previous crop – lata × przedplon

method of biomass application – sposób pozostawiania masy organicznej

interaction – interakcji:

years × method of biomass application – lata × sposób pozostawiania masy organicznej

previous crop × method of biomass application – przedplon × sposób pozostawiania masy organicznej

years × previous crop × method of biomass application – lata × przedplon × sposób pozostawiania masy organicznej

ns – ni – non-significant differences – różnice nieistotne

\* R – residues – resztki, R + S – residues + straw – resztki + słoma

0.3

0.5

0.7

0.2

0.3

ns – ni

ns – ni



Table 5. Total nitrogen content in winter triticale grain, g·kg<sup>-1</sup> DM  
 Tabela 5. Zawartość azotu ogółem w ziarnie pszenżyta ozimego, g·kg<sup>-1</sup> s.m.

Previous crop Przedplon	2005			2006			2007			Mean – Średnia 2005-2007		
	Method of biomass application – Sposób pozostawiania masy organicznej*											
	R	R + S	mean średnia	R	R + S	mean średnia	R	R + S	mean średnia	R	R + S	mean średnia
Spring wheat 100% – pszenica jara 100%	17.0	17.6	17.3	21.4	21.6	21.5	17.8	18.3	18.1	18.7	19.2	19.0
Spring wheat 75% + field pea 25%	17.3	18.0	17.7	21.6	21.8	21.7	18.2	18.8	18.5	19.0	19.5	19.3
Pszenica jara 75% + groch siewny 25%												
Spring wheat 50% + field pea 50%	18.1	19.0	18.6	22.0	22.3	22.2	18.7	19.3	19.0	19.6	20.2	19.9
Pszenica jara 50% + groch siewny 50%												
Spring wheat 25% + field pea 75%	18.5	19.5	19.0	22.1	22.5	22.3	18.9	19.6	19.3	19.8	20.5	20.2
Pszenica jara 25% + groch siewny 75%												
Field pea 100% – groch siewny 100%	18.7	19.9	19.3	22.6	23.0	22.8	19.2	20.1	19.7	20.2	21.0	20.6
Mean – Średnia	17.9	18.8	18.4	21.9	22.2	22.1	18.6	19.2	18.9	19.5	20.1	–

  

LSD <sub>0.05</sub> – NIR <sub>0.05</sub> for – dla:	
years – lat	0.1
previous crop – przedplonu	0.2
interaction – interakcji:	
years × previous crop – lata × przedplon	0.3
method of biomass application – sposób pozostawiania masy organicznej	0.1
interaction – interakcji:	
years × method of biomass application – lata × sposób pozostawiania masy organicznej	0.1
previous crop × method of biomass application – przedplon × sposób pozostawiania masy organicznej	ns – ni
years × previous crop × method of biomass application – lata × przedplon × sposób pozostawiania masy organicznej	ns – ni

ns – ni – non-significant differences – różnice nieistotne

\* R – residues – resztki, R + S – residues + straw – resztki + słoma

## DISCUSSION

In the experiment under discussion, just as in the studies of other authors [Mazurek and Kuś 1992, Kuś and Siuta 1995, Chrzanowska-Drożdż 1997, Sadowski and Krześlak 1997, Szempliński 1997, Siuta et al. 1998, Smagacz 1998, Wesołowski and Gregorczyk 1999, Zajac 1999, Sadowski et al. 2000, Zajac et al. 2006], the height of winter triticale grain yield was significantly dependent on the kind of the previous crop. The yield of winter triticale grain obtained in the stand after field pea was higher by 20.1% than that in the stand after spring wheat. Also according to many researchers [Paprocki and Zieliński 1966, Mazurek and Kuś 1992, Izaurralde et al. 1995, Chrzanowska-Drożdż 1997, Sadowski and Krześlak 1997, Szempliński 1997, Siuta et al. 1998, Wesołowski and Gregorczyk 1999, Zajac 1999, Sadowski et al. 2000], a favourable residual effect of legumes on plant yield is reflected in a large increase in yield in relation to the cereal previous crop. In the study by Wesołowski and Gregorczyk [1999], conducted in the soil of the very good rye complex, an increase in winter triticale grain yield in the stand after field pea, as compared with the stands after winter wheat, winter rye and spring barley, was 21.1; 32.3 and 20.8%, respectively. In the experiment by Zajac [1999], realized in soil of the very good wheat complex, winter triticale grain yield in the stand after faba bean was higher by 43.9% than in the stand after spring triticale. A positive effect of the stand after legumes on cereals results both from the amount of nitrogen left in the soil and from the improvement of physical soil properties, a reduction in weed infestation and a lower occurrence of pathogens [Batalin 1960, Paprocki and Zieliński 1966, Maidl et al. 1996, Wesołowski and Gregorczyk 1999, Piekarczyk 2007].

Apart from legumes, some cereal-legume mixtures can be valuable elements of crop rotations, smoothing negative effects of frequent cultivation of cereals in monocrops [Rudnicki and Kotwica 1994, Rudnicki and Wasilewski 2000, Wanic and Nowicki 2000, Kotwica 2006]. From the author's study it follows that introduction of field pea to spring wheat, even in a small quantity, ensures a positive residual effect. A spring wheat mixture with the 25% proportion of field pea increased winter triticale grain yield by 9.3%, as compared with spring wheat. The value of the stand left by mixtures depends on a selection of components, proportions in the stand, varietal features, a level of yield, and soil conditions [Paprocki and Zieliński 1966, Rudnicki and Kotwica 1994, Siuta et al. 1998, Rudnicki and Wasilewski 2000, Wanic and Nowicki 2000, Kotwica 2006]. In the present experiment decreasing the proportion of spring wheat and increasing the proportion of field pea in the mixture sown resulted in a growth in winter triticale yield. Among the compared mixtures, the stands after spring wheat-field peas mixtures with the proportions of components 50 + 50% i 25 + 75% distinguished themselves in respect of the effect on winter triticale grain yield. On these treatments, winter triticale grain yield did not differ significantly from that in the stand after field pea. Similarly, in the study by Siuta et al. [1998], winter triticale grain yield in the stand after the mixture of oat with 67% proportion of field pea or blue lupine was similar to the yield in stands after legumes cultivated in pure sowing. This fact is connected with the stand value. The post-harvest residues of legumes are characterized by a narrower ratio of carbon to nitrogen than cereal residues. Thus the sequent plants can to a higher degree use the nitrogen released by them [Římovský 1987]. In stands after cereal-legume mixtures with a higher proportion of legumes one can expect introduction to the biological circulation of a greater amount of mineral elements in post-harvest residues and straw, as well as a better general conditions of soil.

In the author's study in stands after spring wheat-field pea mixtures (75 + 25%, 50 + 50%, 25 + 75%) and after field pea, a larger number of winter triticale ears per 1 m<sup>2</sup>, the number of kernels per ear and 1000 kernel weight of triticale were observed. A favorable effect of legume previous crops on the yield structure elements of winter triticale in relation to cereal previous crops was proved by other authors [Chrzanowska-Drożdż 1997, Szempliński 1997, Wesółowski and Gregorczyk 1999, Zając 1999, Zając et al. 2006].

Under the soil and climatic conditions of the present experiment, field pea and spring wheat-field pea mixtures significantly increased the total nitrogen content in winter triticale grain, in relation to spring wheat. However, the highest content of total nitrogen was found in the winter triticale grain cultivated in the stand after field pea. Similarly, in the study by Szurpnicka-Poltarzewska and Koc [1997] application of yellow lupine as a previous crop for winter triticale had a significant effect on a growth in the total nitrogen content in grain in relation to winter triticale. A higher content of nitrogen in grain of cereals cultivated in stands after legumes and cereal-legume mixtures indicates a relatively strong and long-lasting effect of their biomass rich in nitrogen [Szempliński 1997, Zając et al. 2006].

In the experiment conducted on the treatment where post-harvest residues of the compared previous crops were plowed in along with their straw, the winter triticale grain yield was significantly higher than that on the treatment with post-harvest residues. An increase in winter triticale grain yield after the application of the straw of the previous crop ranged from 8.2% in the stand after spring wheat to 14.5% in the stand after the spring wheat-field pea mixture with the proportion of components 25 + 75%. A significant increase in cereal grain yield after plowing in straw was also observed by Gorzelný [1986] and Kuduk [1981]. In the study by Smagacz [2005], in turn, fertilization with straw did not cause a significant differences in spring barley grain yield. An effect of plowed in straw on plant yields and soil properties depends on soil, climatic and cultivation conditions [Kuduk 1979, 1981, Gorzelný 1986, Siuta 1999, Spiak et al. 2000, Smagacz 2005]. In the present experiment, post-harvest residues together with previous crop straw significantly increased the total nitrogen content in winter triticale grain, as compared with post-harvest residues. Other authors [Kuduk 1979, 1981, Gorzelný 1986, Śniady et al. 1997] came to the same conclusion, explaining this with a higher content of nitrogen in soil fertilized with straw [Kuduk 1979, Gorzelný 1986].

Mineral elements contained in post-harvest residues are a considerable yield-forming factor, especially in various forms of sustainable agriculture, where mineral fertilizers are not applied at all or their application in a very moderate amounts is recommended [Malicki 1997].

## CONCLUSIONS

1. Larger grain yield and a higher total nitrogen content in grain was observed after cultivation of winter triticale in stands after field pea and spring wheat-field pea mixtures in comparison with spring wheat. An addition of straw to the post-harvest residues of previous crops had a significant influence on the growth of winter triticale grain yield and the total nitrogen content in grain. An increase in winter triticale grain yield resulted from a larger number of ears per 1 m<sup>2</sup>, the number of kernels per ear and the 1000 kernel weight.

2. Adopting grain yield and the total nitrogen content in grain as a criterion, the best previous crops for winter triticale were field pea and the spring wheat-field pea mixture with the proportion of components 25 + 75%.

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## **WARTOŚĆ PRZEDPLONOWA RESZTEK POŹNIWNYCH I SŁOMY PSZENICY JAREJ, GROCHU SIEWNEGO ORAZ ICH MIESZANEK DLA PSZENŻYTA OZIMEGO CZ. II. PLON PSZENŻYTA OZIMEGO**

**Streszczenie.** W badaniach przeprowadzonych w latach 2005-2007 określono wpływ rodzaju przedplonu (pszenicy jarej, grochu siewnego, mieszanki pszenicy jarej z grochem siewnym) oraz sposobu pozostawiania masy organicznej przedplonu na polu (resztki poźniwne, resztki poźniwne + słoma) na plon ziarna pszenżyta ozimego, elementy struktury plonu oraz zawartość azotu ogółem w ziarnie. Plon ziarna i zawartość azotu ogółem w ziarnie pszenżyta ozimego uprawianego w stanowiskach po grochu siewnym i mieszankach pszenicy jarej z grochem siewnym były istotnie większe niż w stanowisku po pszenicy jarej. Większy plon ziarna pszenżyta ozimego stwierdzony w wyżej wymienionych stanowiskach wynikał z większej liczby kłosów na 1 m<sup>2</sup>, liczby ziaren w kłosie i masy 1000 ziaren. W miarę zwiększania w przedplonie udziału grochu siewnego w mieszance z pszenicą jarą zwiększał się plon ziarna i zawartość azotu ogółem w ziarnie pszenżyta ozimego. Zastosowanie pod pszenżyto ozime resztek poźniwnych porównywanych przedplonów łącznie z ich słomą powodowało istotny wzrost plonu ziarna, elementów struktury plonu i zawartości azotu ogółem w ziarnie, w stosunku do resztek poźniwnych.

**Słowa kluczowe:** komponenty struktury plonu, plon ziarna, przedplon, słoma, zawartość azotu w ziarnie

Accepted for print – Zaakceptowano do druku: 12.03.2011