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Grain yield, grain quality and weed infestation of winter wheat after various previous crops

Plonowanie, jakość ziarna oraz zachwaszczenie pszenicy ozimej po różnych przedplonach

Abstract. Grain yield and quality as well as the weed infestation of winter wheat grown after potatoes, peas and winter wheat were evaluated in the study. The experiment was established in a system of randomized blocks, in three replications. The experimental results were statistically processed via the analysis of variance method. Coefficients of Pearson's linear correlation between grain yield and its components, grain quality parameters, and the number and air-dry weight of weeds were also calculated. Grain yields of winter wheat were higher when it was grown after potato and pea than after winter wheat. In addition, winter wheat grains harvested from plots with potato and pea as previous crops had a higher total protein content and a higher sedimentation index than those harvested from plots with winter wheat as the previous crop. However, the study years affected the protein, gluten and starch contents of winter wheat grain to a greater extent than the previous crops did. A higher number of weeds with a higher air-dry weight was recorded on the post-winter wheat than on the post-potato and post-pea plots. Negative values of correlation coefficients were computed between the number of weeds and their air-dry weight and grain yield, number of spikes, grain weight per spike, 1000 grain weight, total protein content of the grain, and the value of sedimentation index as well as between weed number and wet gluten content of the grain.

Keywords: grain yield, grain quality parameters, previous crop, weed control

INTRODUCTION

The productivity of cereals is the co-effect of cultivar-specific traits, habitat conditions and agricultural practices [Tracy and Davis 2009, Woźniak and Soroka 2018,

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Mohammadi et al. 2020, Banach et al. 2021, Sułek et al. 2023]. Many research works [Hemmat and Eskandari 2004, Kirkegaard et al. 2004, Dziki et al. 2017] have indicated that the yield and quality of wheat grain are highly dependent on the previous crop. The legumes [Gawęda et al. 2018, Meena and Lal 2018] and the root plants fertilized with organic fertilizers [Rasool et al. 2008] have proved best as previous crops for cereals. Legumes live in symbiosis with *Rhizobium* bacteria capable of fixing free nitrogen from the air. As Peoples et al. [2009] reported, they accumulate between 30 and 40 kg of nitrogen in 1 t of dry matter of their roots and aboveground parts. Therefore, they increase the yield of the follow-up plants and, thereby, the efficiency of the entire crop rotation link. Organic matter from crop residues and mulch plays a key role in maintaining soil productivity [Lu et al. 2000, Woźniak 2022]. As posited by Li et al. [2014], plant residues left on the field surface enhance the biological activity of the soil, enrich it with organic carbon, and improve its water absorption. Their other beneficial effects include reduction of water evaporation from the field surface, increasing stability of soil aggregates, and ensuring high enzymatic activity of the soil [Lal 2009, Liu et al. 2016, Woźniak and Kawecka-Radomska 2016, Wang et al. 2019, Pranagal and Woźniak 2021]. Crop residues also decrease weed density and biomass [Lu et al. 2000, Siddique et al. 2012, Woźniak 2022], and create a favorable habitat for beneficial insects [Pullaro et al. 2006, Roger-Estrade et al. 2010].

Soil and its chemical, physical and biological properties, as well as plant productivity, are promoted by natural fertilizers, especially manure (FYM) [Liu et al. 2016, Singh and Singh 2017]. It provides nutrients readily available to plants and its certain part undergoes complex chemical processes in the soil mediated by microorganisms, resulting in humus production. However, it should be remembered that large amounts of weed diasporas are also brought into the soil along with manure, thereby affecting the state and extent of field infestation with weeds [Lal et al. 2016, Nath et al. 2022].

Taking into account literature data and agricultural practice, a hypothesis was formulated assuming that the previous crops of winter wheat determine: (1) yield of winter wheat grain, (2) quality parameters of the grain, (3) number and air-dry weight of weeds and the species composition of weeds in winter wheat stands. It may also be hypothesized that better productivity and grain quality of winter wheat can be obtained when it is grown after potato and peas than after winter wheat. In addition, higher grain yields and better grain quality are due to lesser weed infestation of the wheat crop. Such conditions are offered by root plants and legumes used as previous crops. The aim of the present study was to assess the grain yield, grain quality, and weed infestation of winter wheat grown after potatoes, peas, and winter wheat.

MATERIAL AND METHODS

Experimental scheme

The field experiment was conducted in the years 2020–2022 at the Uhrusk experimental station belonging to the University of Life Sciences in Lublin, located in the central-eastern part of Poland (51°18'N, 23°36'E). The experiment was established in a system of randomized 90 m^2 block, in three replications. The subject of the study was winter wheat of ‘KWS Dakotana’ cultivar, which was sown on plots after: (1) potato,

(2) peas, (3) and winter wheat. The cultivation scheme for winter wheat and the dates of cultivation procedures are shown in Table 1. Potatoes were fertilized with manure (FYM) applied in a dose of 30 t ha^{-1} and plowed in the last week of October as pre-winter ploughing.

Table 1. Types and terms of cultivation measures applied to winter wheat

Previous crop	Previous crop harvest term	Cultivation measures
Potato ('Lord' cultivar)	2nd week of September	(1) cultivator + harrow after potato harvest, (2) cultivation set (cultivator + string roller) before winter wheat sowing
Pea ('Batuta' cultivar)	3rd week of July	(1) cultivator + harrow after pea harvest, (2) pre-sowing ploughing (at a depth of 18 cm) + harrow 10 days before wheat sowing
Winter wheat ('KWS Dakotana' cultivar)	1st week of August	(1) shallow ploughing (at a depth of 10 cm) + harrowing after wheat harvest, (2) pre-sowing ploughing (at a depth of 18 cm) + harrow 10 days before wheat sowing

Winter wheat was sown in the last of week of September, at the sowing density of 380 seeds per m^2. Before sowing, mineral fertilizers were applied in the following doses: N – 20 kg ha^{-1}, P – 35 kg ha^{-1}, and K – 90 kg ha^{-1}. Nitrogen was also applied in the spring in the following doses: (1) 75 kg N ha^{-1} at the tillering stage; (2) 45 kg N ha^{-1} at the shooting stage; and (3) 20 kg N ha^{-1} at the onset of the spike formation stage.

Weeds found on the plots were destroyed mechanically by double-harrowing performed in 7–10-day intervals at the winter wheat tillering stage in the springtime. The following fungicides were applied to protect crops against fungal diseases: (1) Alert 375 SC at the tillering stage in a dose of 1 dm^3 ha^{-1} (a.s. flusilazole + carbendazim), and (2) Tilt Turbo 575 EC at the shooting stage in a dose of 1 dm^3 ha^{-1} (a.s. propiconazole + fenpropidin).

Soil and weather conditions

The experiment was established on soil classified as Rendzic Phaeozem [IUSS Working Group WRB 2015], which in the layer of 0–25 cm has high contents of phosphorus (120 mg P kg^{-1}) and potassium (210 mg K kg^{-1}), an average content of magnesium (60 mg Mg kg^{-1}), as well as pH_{KCl} = 7.1. The total nitrogen content of the soil is 0.90 g N kg^{-1} and that of organic carbon is 11.6 g C kg^{-1}. The clay (<0.002 mm) and dust (0.002–0.05 mm) fractions together account for 48% of the mineral composition of the soil.

The growing season begins at the turn of March and April and lasts 210–220 days. In the study years (2020–2022), the annual precipitation totals ranged from 515 mm to 579 mm, and in the multi-year period (1995–2019) from 411 mm to 822 mm (Fig. 1).

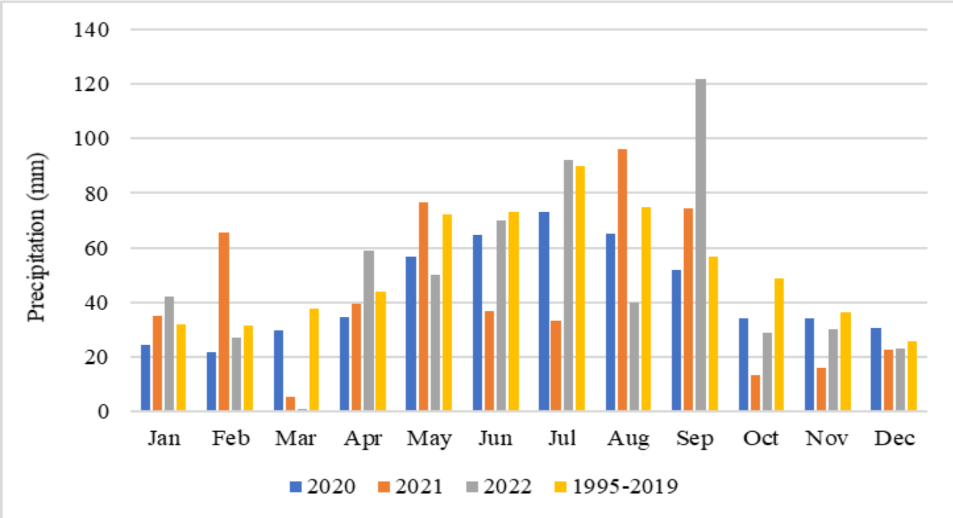


Fig. 1. Average monthly precipitation (mm)

In the spring and summer months (April–September), the sum of precipitation ranged from 346 mm to 433 mm, while in the autumn and winter months (October–March) from 146 mm to 175 mm. The highest air temperatures were recorded in June, July, and August, whereas the lowest ones in December, January, and February (Fig. 2).

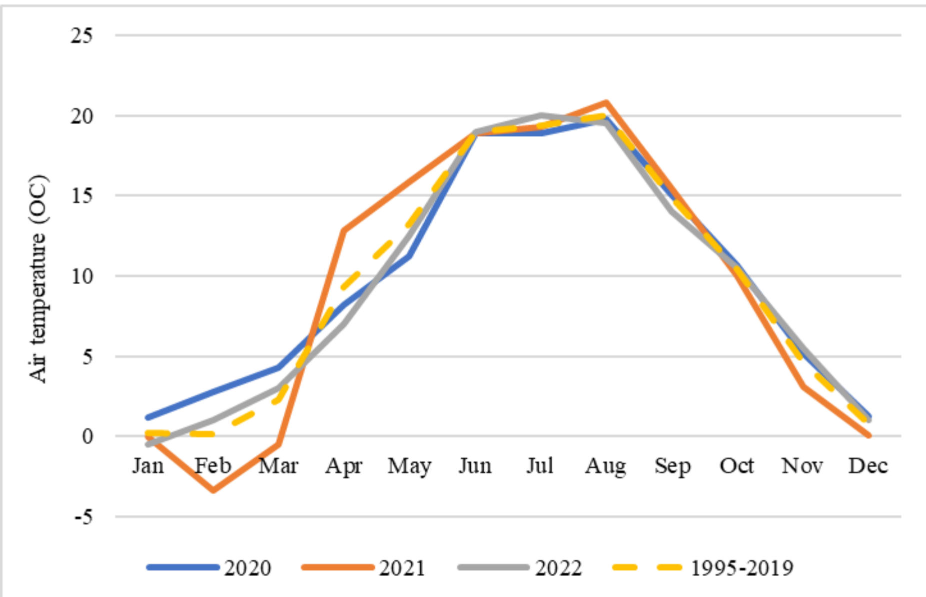


Fig. 2. Average monthly air temperature (°C)

Experimental traits

The experiment aimed to assess: (1) winter wheat grain yield and its components: spike number per 1 m^2, grain weight per spike, 1000 grain weight; (2) grain quality parameters: total protein content, wet gluten content, Zeleny's sedimentation index, and starch content; and (3) weed infestation rates: weed number per 1 m^2, air-dry weight of weeds, and species composition of weeds.

Winter wheat grain was harvested with a field harvester in the first week of August. The number of spikes was calculated on the area of 1 m^2 of each plot, and the grain weight per spike was determined from 40 spikes randomly taken from each plot. The 1000 grain weight was determined by counting and weighing 2 × 500 grains. Total protein content, wet gluten content, Zeleny's sedimentation index, and starch content were determined by NIRS (near infrared reflectance spectroscopy) using the OmegAnalyzer Grain instrument (Bruins Instruments). The weed infestation rates, i.e., the number of weeds, air-dry weight of weeds, and weed species composition were assessed on each plot by the botanical-weight method in the waxy maturity stage of wheat. This method consists in double random determination of the area of 1 m^2 by means of a 1.0 m × 0.5 m frame placed across the rows of wheat, counting the weeds found in the frame, determining their species composition and collecting them for further analytical procedures. The aerial parts of the collected weeds were placed on openwork shelves in a ventilated room and left therein until a constant air-dry weight had been reached.

Statistical analysis

Results obtained were subjected to the analysis of variance (ANOVA), whereas the significance of differences between mean values determined for previous crops (PC), study years (Y), and their interactions (PC × Y) was determined with the Tukey's HSD test, $P < 0.05$.

Coefficients of Pearson's linear correlation between: (1) grain yield and its components, (2) grain quality parameters, and (3) the number and air-dry weight of weeds, were calculated as well.

RESULTS

Grain yield and its components

The grain yield of winter wheat was differentiated by previous crops and study years (Tab. 2). It was higher when winter wheat was grown after potato and pea than after wheat, with the difference reaching 36.1% and 29.2%, respectively. Significantly higher grain yields were also recorded in 2021 and 2022 than in 2020. Similar observations were made for grain yield components. The highest number of spikes per 1 m^2 was determined when winter wheat was grown after pea, whereas the highest grain weight per spike was determined on plots with potatoes as the previous crop. In turn, the highest 1000 grain weight was produced by winter wheat grown after potatoes and pea (Tab. 3). The grain yield components were also significantly affected by study years. A higher spike density per m^2 of winter wheat was determined in 2020 and 2021 than in 2022, and a higher grain weight per spike in 2022 than in the other study years. In turn, the 1000 grain weight was differentiated by the interaction of previous crops and study years, with a significantly higher value of this grain yield component recorded in 2022 on the post-potato plot than in the other study years. The evaluation of the variance analysis components shows that the grain yield and the 1000 winter wheat grain weight were affected to the greatest extent by the previous crops, whereas the number of spikes per m^2 and the grain weight per spike by the study years (Tab. 4).

Table 2. Grain yield of winter wheat (t ha^{-1})

Previous crops (PC)	Years (Y)			Mean
	2020	2021	2022	
Potato	5.34	7.52	7.73	6.86
Pea	5.29	6.79	7.46	6.51
Winter wheat	5.41	4.61	5.11	5.04
Mean	5.35	6.30	6.77	–
$HSD_{0.05}$ for PC = 1.17; Y = 1.17; PC × Y = ns				

ns – not significant, P < 0.05

Table 3. Components of winter wheat grain yield

Previous crops (PC)	Years (Y)			Mean
	2020	2021	2022	
spike number per 1 m^2				
Potato	442	428	394	421
Pea	495	497	414	469
Winter wheat	432	451	353	412
Mean	456	459	387	–
$HSD_{0.05}$ for PC = 40; Y = 40; PC × Y = ns				
grain weight per spike (g)				
Potato	1.21	1.76	1.96	1.64
Pea	1.06	1.37	1.81	1.41
Winter wheat	1.25	1.00	1.47	1.24
Mean	1.17	1.38	1.75	–
$HSD_{0.05}$ for PC = 0.26; Y = 0.26; PC × Y = ns				
1000 grain weight (g)				
Potato	40.8	40.4	43.5	41.6
Pea	42.3	41.4	40.8	41.5
Winter wheat	39.1	39.2	39.1	39.1
Mean	40.7	40.4	41.2	–
$HSD_{0.05}$ for PC = 1.0; Y = ns; PC × Y = 2.3				

Table 4. Effect of previous crops (PC) and study year (Y) on the grain yield and its components

Specification	Value	PC	Y	PC × Y
Grain yield	*F*	8.82	4.97	2.48
	p	**	*	ns
Spike number per 1 m^2	*F*	7.37	13.22	0.76
	p	**	**	ns
Grain weight per spike	*F*	7.59	15.67	2.92
	p	**	**	ns
1000 grain weight	*F*	25.37	2.11	6.52
	p	**	ns	**

ns – not significant, *$p < 0.05$, **$p < 0.01$

Table 5. Pearson's correlation coefficient between grain yield and its components

Traits	Yield	Spike number per 1 m^2	Grain weight per spike
Spike number per 1 m^2	0.41	1.00	
Grain weight per spike	0.91[a]	–0.01	1.00
1000 grain weight	0.88[a]	0.50	0.72[a]

[a] significant correlation coefficient

The yield of the winter wheat grain was positively correlated with the grain weight per spike and the 1000 grain weight (Tab. 5). Significant correlations were also found between the grain weight per spike and the 1000 grain weight.

Grain quality

The total protein content of winter wheat grain was differentiated by previous crops, study years and interactions thereof (Tab. 6). A higher protein content was determined in the grain harvested from post-pea and post-potato plots than from post-wheat plots, and in 2021 compared to the other study years. In contrast, the wet gluten content of the grain was influenced only by the study years and previous crops × study years interaction.

Table 6. Quality parameters of winter wheat grain

Previous crops (PC)	Years (Y)			Mean
	2020	2021	2022	
total protein content (%)				
Potato	12.0	14.0	12.5	12.8
Pea	11.8	14.0	12.8	12.9
Winter wheat	11.7	13.5	12.4	12.5
Mean	11.8	13.9	12.6	–
$HSD_{0.05}$ for PC = 0.3; Y = 0.3; PC × Y = 1.1				
wet gluten content (%)				
Potato	22.1	28.9	24.5	25.2
Pea	21.2	29.1	25.3	25.2
Winter wheat	21.0	27.9	24.7	24.5
Mean	21.4	28.6	24.9	–
$HSD_{0.05}$ for PC = ns; Y = 1.5; PC × Y = 3.2				
Zeleny's sedimentation index mL				
Potato	36.5	41.4	33.3	37.1
Pea	36.3	41.4	34.9	37.5
Winter wheat	32.5	37.4	34.7	34.9
Mean	35.1	40.0	34.3	–
$HSD_{0.05}$ for PC = 2.0; Y = 2.0; PC × Y = 3.9				
starch content (%)				
Potato	50.5	50.5	52.1	51.0
Pea	50.6	50.0	52.1	50.9
Winter wheat	51.1	51.3	51.1	51.1
Mean	50.7	50.6	51.7	–
$HSD_{0.05}$ for PC = ns; Y = 0.5; PC × Y = 1.1				

ns – not significant, $p < 0.05$

Its higher value was also determined in the grain harvested in 2021 compared to that from the other study years. More gluten was also found in the grain of winter wheat grown after pea and winter wheat in 2022 than in 2020. In turn, a higher Zeleny's sedimentation index was determined for the grain of winter wheat harvested from post-pea and post-potato plots than from post-winter wheat plot as well as for the grain harvested in 2021 compared to the other study years. In turn, a higher starch content was determined in the grain harvested in 2022 than in 2020 and 2021. The starch content of the grain was also differentiated by the previous crops × study years interaction. The grain harvested from the post-potato and post-pea in 2022 had a higher starch content than the grain harvested from these plots in the other study years.

The evaluation of the variance analysis components shows that the contents of total protein, wet gluten, and starch in winter wheat grain were most influenced by the study years, whereas the value of the sedimentation index by the previous crops (Tab. 7).

Table 7. Effect of previous crops (PC) and study year (Y) on quality parameters of winter wheat grain

Specification	Value	PC	Y	PC × Y
Total protein	*F*	12.18	56.68	10.30
	p	*	**	*
Wet gluten	*F*	0.90	79.33	13.49
	p	ns	**	*
Zeleny's sedimentation index	*F*	21.44	6.95	9.61
	p	**	*	*
Starch content	*F*	0.77	19.78	6.93
	p	ns	**	*

ns – not significant, *$p < 0.05$, **$p < 0.01$

The total protein content of wheat grain was positively correlated with the gluten content of the grain and its sedimentation index (Tab. 8). Positive correlations were also observed between the gluten content of the grain and sedimentation index, while negative correlations between the starch content of the grain and the total protein content, wet gluten and sedimentation index.

Table 8. Pearson's correlation coefficient between grain quality parameters

Traits	Total protein	Wet gluten	Zeleny's sedimentation index
Wet gluten	0.89[a]	1.00	–
Zeleny's sedimentation index	0.82[a]	0.73[a]	1.00
Starch content	–0.80[a]	–0.86[a]	–0.86[a]

a significant correlation coefficient

Weed infestation of winter wheat crop

A higher number of weeds (by more than 63%) was recorded on the plots of winter wheat grown after itself than after potatoes and peas (Tab. 9). Also, greater weed infestation was recorded in 2020 than in 2021 and 2022. A similar observation was made for the air-dry weight of weeds, which was higher on post-winter wheat plots than on post-potato and post-pea plots by 62.4% and 53.9%, respectively, as well as in 2020 than in the other study years. The evaluation of the variance analysis components indicates that the number and air-dry weight of weeds were affected to a greater extent by the study years than by the previous crops (Tab. 10). In turn, the values of Pearson correlation coefficients showed a positive correlation between the number of weeds and the air-dry weight produced by the weeds (Tab. 11). In contrast, the values of these weed infestation rates were negatively correlated with grain yield, number of spikes per 1 m^2, grain weight per spike, 1000 grain weight, total protein content of the grain, and the value of Zeleny's sedimentation index. Negative correlations were also found between the number of weeds and wet gluten content of the grain.

Table 9. Number and air-dry weight of weeds in winter wheat crop

Previous crops (PC)	Years (Y)			Mean
	2020	2021	2022	
number of weeds per 1 m^2				
Potato	42.4	18.8	19.6	26.9
Pea	35.0	23.4	21.9	26.8
Winter wheat	61.4	37.2	33.1	43.9
Mean	46.2	26.5	24.9	–
$HSD_{0.05}$ for PC = 4.2; Y = 4.2; PC × Y = 9.7				
air–dry weight of weeds (g m^{-2})				
Potato	34.3	15.2	15.7	21.8
Pea	31.3	19.0	18.8	23.0
Winter wheat	49.7	30.1	26.5	35.4
Mean	38.5	21.4	20.3	–
$HSD_{0.05}$ for PC = 2.3; Y = 2.3; PC × Y = 5.7				

Table 10. Effect of previous crops (PC) and study year (Y) on the number and air-dry weight of weeds

Specification	Value	PC	Y	PC × Y
Number of weeds	*F*	72.08	105.34	4.77
	p	**	**	*
Air-dry weight of weeds	*F*	144.56	260.37	7.03
	p	**	**	*

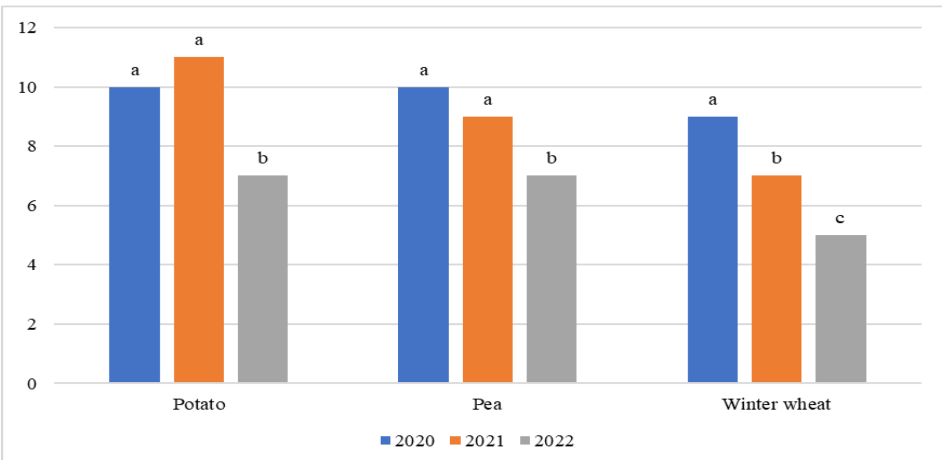
*$p < 0.05$, **$p < 0.01$

Table 11. Pearson's correlation coefficient between the number and air-dry weight of weeds and the yield and grain quality parameters

Traits	Number of weeds	Air-dry weight of weeds
Air-dry weight of weeds	0.98[a]	1.00
Grain yield	–0.88[a]	–0.87[a]
Spike number per 1 m^2	–0.54[a]	–0.51[a]
Grain weight per spike	–0.68[a]	–0.69[a]
1000 grain weight	–0.94[a]	–0.93[a]
Total protein	–0.73[a]	–0.69[a]
Wet gluten	–0.54[a]	–0.44
Zeleny's sedimentation index	–0.62[a]	–0.63[a]
Starch content	0.44	0.36

[a] significant correlation coefficient

Previous crops and study years also differentiated the species composition of weeds. In 2020 and 2022, crops grown on post-potato plots were infested by 7 to 11 weed species, those grown on post-pea plots by 7 to 10 species, and those cultivated on post-winter wheat plots by 5 to 9 species (Fig. 3). In 2020, the most abundant weeds identified on the post-potato plots included: *Chenopodium album*, *Avena fatua*, *Lamium purpureum*, and *Fallopia convolvulus*; whereas those found on the post-pea plots included: *Capsella bursa-pastoris*, *Galium aparine*, *Thlaspi arvense*, and *Lamium amplexicaule*; and those on the post-wheat plots included: *Apera spica-venti*, *Papaver rhoeas*, *Matricaria perforata*, and *A. fatua* (Fig. 4). In 2021, the weed community found on the post-potato plot was predominated by: *C. album*, *G. aparine*, *Elymus repens*, and *P. rhoeas*; that found on the post-pea plot by: *C. album*, *A. fatua*, *M. perforata*, and *Sonchus oleraceus*; and that identified on the post-wheat plot by: *A. fatua*, *P. rhoeas*, *A. spica-venti*, and *G. aparine* (Fig. 5).



a, b, c – means denoted with the same letters do not differ significantly, $p < 0.05$

Fig. 3. Number of weed species in winter wheat after previous crops

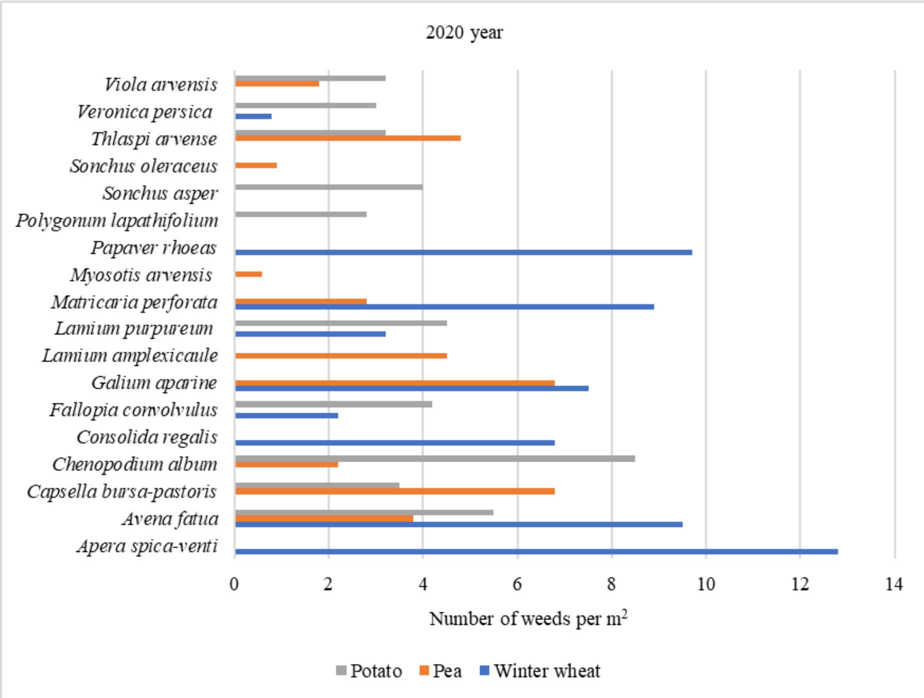


Fig. 4. Species composition of weeds in a canopy of winter wheat depending on the previous crops (2020 year)

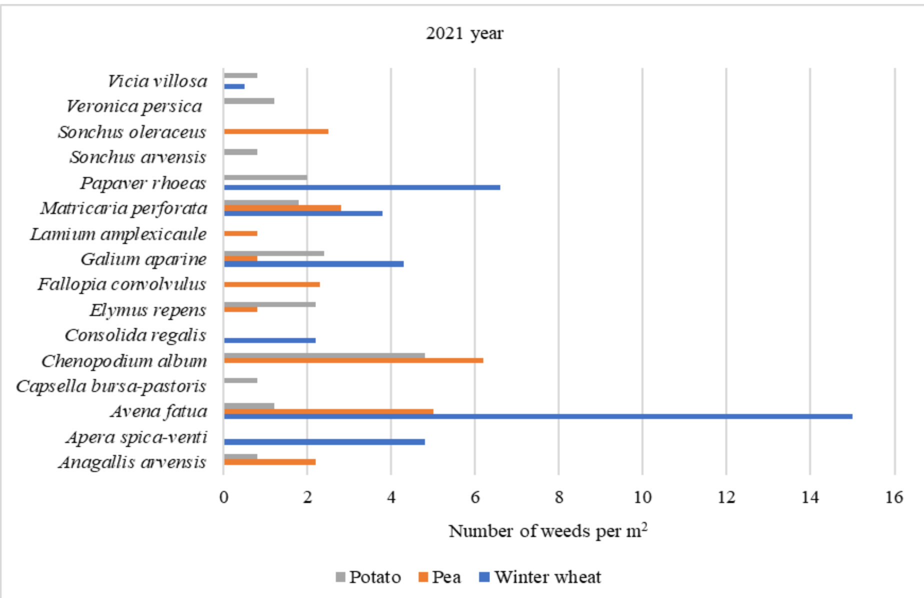


Fig. 5. Species composition of weeds in a canopy of winter wheat depending on the previous crops (2021 year)

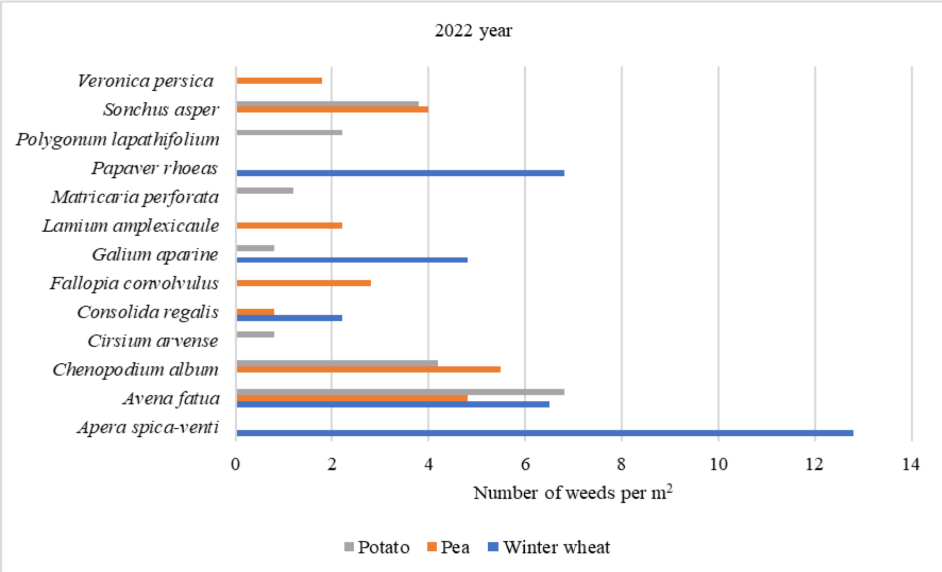


Fig. 6. Species composition of weeds in a canopy of winter wheat depending on the previous crops (2022 year)

In 2022, winter wheat crops grown after potatoes were most heavily infested by: *A. spica-venti*, *P. rhoeas*, *A. fatua*, and *G. aparine*; those cultivated after pea by: *C. album*, *A. fatua*, *Sonchus asper*, and *F. convolvulus*; and those grown after wheat by: *A. spica-venti*, *P. rhoeas*, *A. fatua*, and *G. aparine* (Fig. 6).

DISCUSSION

Many authors have discussed the importance of agricultural practice and habitat factors in affecting cereal grain yield and its quality [Rachoń et al. 2015, Dziki et al. 2017, Zhang et al. 2017, Bobryk-Mamczarz et al. 2022]. Soil and weather conditions have been shown to be the main drivers of differences in grain yield, protein content of the grain, and grain mineral composition [Gomez-Becerra et al. 2010, Mohammadi et al. 2020, Rachoń et al. 2022]. Also the present study results demonstrate that the winter wheat cultivation years had a stronger effect on the grain quality, including in particular protein, gluten and starch contents, compared to the previous crops. In turn, in the study conducted by Rachoń et al. [2022], weather conditions caused greater differences in the grain yields of spring wheat than winter wheat. They also differentiated the protein, carbohydrate, fiber, and ash contents as well as mineral composition of wheat grain [Rachoń et al. 2015]. These differences were due to the shortage of precipitation for spring wheat in the springtime. In turn, in the same period, winter wheat had a well-developed root system and made good use of autumn-winter water reserves accumulated in the soil.

A study conducted by Alijošius et al. [2016] has demonstrated significant correlations between individual elements of the chemical composition of the grain, i.e., a negative correlation between the protein content and starch content of the grain. Similarly, in the present study, the starch content of the grain was negatively correlated with protein content, wet gluten content, and sedimentation index value. In addition, the study results showed that the chemical composition of wheat grain was also significantly affected by previous crops. The grain harvested from post-pea and post-potato plots contained more protein and had a higher value of Zeleny's sedimentation index than the grain of winter wheat grown after itself. Certain studies [Herridge et al. 2008, Peoples et al. 2009, Siddique et al. 2012] have indicated that the inclusion of legumes in the crop rotation improves the availability of nutrients in the soil and, consequently, increases grain yield. Meena and Lal [2018] and Woźniak [2022] have also reported that legumes are known for their many pre-harvest benefits including, among others, their contribution to increasing soil fertility and competitiveness to weeds. In the present study, potatoes and peas increased the yield of winter wheat grain compared to winter wheat used as the previous crop. Ample studies have shown that wheat grown after itself or other cereals is exposed to foot and root rot [Gutteridge and Hornby 2003, Kirkegaard et al. 2004, Gutteridge et al. 2006, Gosme et al. 2007] and compensation of troublesome weed species in the crop stand [Woźniak and Soroka 2018]. Also in the present research, weeds were the most abundant on the plots where winter wheat was grown after itself. The quantitative predominance of *A. spica-venti*, *A. fatua*, and *P. rhoeas* negatively affected the winter wheat grain yield and its quality, including especially the total protein content, wet gluten content, and Zeleny's sedimentation index.

CONCLUSIONS

Higher grain yields of winter wheat were obtained on post-potato and post-pea plots than on post-winter wheat plots. In addition, the grain harvested from the post-potato and post-pea plots had a higher total protein content and a higher sedimentation index value than the grain harvested from the post-winter wheat plots. However, the study years affected the protein, gluten and starch contents of winter wheat grain to a greater extent than the previous crops did.

Greater weed infestation of winter wheat, expressed by the number of weeds per 1 m^2 and their air-dry weight, was recorded on the post-winter wheat plots than on the post-potato and post-pea plots. These plots were quantitatively predominated *by Apera spica-venti*, *Avena fatua*, and *Papaver rhoeas*. The weeds infesting the winter wheat stand reduced grain yield and its quality parameters, as evidenced by the negative values of Pearson's correlation coefficients.

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