VHODNOST RŮZNÝCH DRUHŮ OLEJNIN JAKO PŘEDPLODIN PRO OZIMOU PŠENICI

The suitability of various oilseed plants as preceding crops for winter wheat

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Summary. The suitability of winter oilseed rape, spring oilseed rape, white mustard and Indian mustard as preceding crops for winter wheat was compared in a three-year field experiment conducted in 2005-2009. The analyzed preceding crops significantly differentiated winter wheat yields. Winter oilseed rape induced the greatest increase in winter wheat yields, and Indian mustard was the most effective preceding crop in the group of spring-sown oilseed crops. Oilseed plants as preceding crops contributed to a greater increase in the grain yield of winter wheat than the medium-input production technology. Winter wheat yields were 12% higher in the medium-input than in the low-input production system; however, the medium-input system did not eliminate the negative effects of wheat monocropping.

***Keywords**: preceding crop, production technology, grain yield, yield components*

Souhrn: V tříletém polním pokusu, založeném v letech 2005 – 2009, byla porovnávána vhodnost řepky ozimé, řepky jarní, hořčice bílé a hořčice sareptské jako předplodiny pro ozimou pšenici. Sledované předplodiny významně ovlivnily výnos ozimé pšenice. Řepka ozimá přispěla k nejvyššímu zvýšení výnosu ozimé pšenice a hořčice sareptská byla nejefektivnější předplodina ze skupiny jarních olejnin. Olejniny, jako předplodiny, přispěly k většímu zvýšení výnosu zrna ozimé pšenice než pěstitelská technologie se středními vstupy. Výnosy pšenice byly o 12 % vyšší v produkčním systému se středními vstupy, než v systému s nízkými vstupy. Avšak ani systém se středními vstupy nedokázal eliminovat negativní účinky monokultury pšenice.

***Klíčová slova**: předplodina, technologie pěstování, výnos zrna, výnosotvorné prvky*

Introduction

In the group of winter cereals, winter wheat has the greatest nutritional requirements associated with preceding crops. Winter wheat yields are highest in medium crop rotation systems (50-60% of cereals) (Budzyński 2012). Depending on its duration, monocropping decreases the grain yield of winter wheat by 22-54% relative to crop rotation systems (Budzyński 2012). The yield of winter wheat can be increased in rotation with *Brassica* crops (Wesołowski et al. 2007). Plants of the family *Brassicaceae* are valuable preceding crops due to the high nutritional value of their post-harvest residues, rapid mineralization and the ability to protect crops against take-all disease (Majchrzak et al. 2010, Jankowski 2014, 2015ab). In agricultural practice, high-input treatments effectively counteract the adverse effects of monocropping on grain yields (Woźniak 2006).

The aim of this study was to evaluate the suitability of oilseed plants as preceding crops for winter wheat, and to determine whether the medium-input production technology effectively counteracts the adverse effects of short-term wheat monocropping.

Materials and Methods

The experiment was conducted between 2005 and 2008 at the Agricultural Experiment Station in Bałcyny in northeastern Poland. The station is part of the University of Warmia and Mazury in Olsztyn. The experimental variables were:

(i) - preceding crop: winter oilseed rape, spring oilseed rape, white mustard, Indian mustard, winter wheat

(ii) – production technology of winter wheat as the successive crop:

Cultivation measures/growth stage		Production technology	
		A1 - low-input	**A2 - medium-input**
Top-dressing with nitrogen (kg/ha)	BBCH 29	60	90
	BBCH 32	30	60
Disease control	BBCH 00	seed dressing (triadimenol; imazalil; fuberidazole)	seed dressing (triadimenol; imazalil; fuberidazole)
	BBCH 32	—	picoxystrobin; flusilazole; carbendazim; proquinazid
	BBCH 39	—	picoxystrobin; flusilazole; carbendazim; famoxate

Pre-sowing fertilization was applied at 30 kg N/ha, 17 kg P/ha and 100 kg K/ha. Winter wheat cv. Olivin was sown every year in the second half of September at 450 kernels per 1 m^2. Weeds were controlled in stage BBCH 11 with pendimethalin and isoproturon. In medium-input and low-input production systems, spring treatments involving top-dressing with nitrogen fertilizer and disease control were applied in accordance with the above experimental design (experimental factor II). Each year, winter wheat was harvested in the first ten days of August (once-over harvest).

Results and Discussion

The density of winter wheat spikes (443 spikes per m^2) was lowest in the wheat monoculture. Spike density was 15% higher when winter wheat was grown after oilseed crops. The highest spike density was noted when winter oilseed rape was the preceding crop, and it was 10% higher than when oilseed plants were the preceding crops. The number of spikes per 1 m^2 was approximately 9% higher in the medium-input production system (higher rate of nitrogen fertilizer and antifungal treatments), regardless of the preceding crop (Table 1).

Table 1. Yield components of winter wheat for different production systems and preceding crops.

Preceding crop	2006/2007		2007/2008		2008/2009		2006-2009		**Average**
	Production technology								
	A1	A2	A1	A2	A1	A2	A1	A2	
	Number of spikes per 1 m^2								
Winter oilseed rape	599	650	548	587	423	473	523	570	**547**
Spring oilseed rape	585	567	456	516	399	459	480	514	**497**
White mustard	556	608	483	569	387	445	475	541	**508**
Indian mustard	583	552	448	513	407	416	479	494	**487**
Winter wheat	647	528	461	532	328	545	419	468	**443**
Average	**594**	**581**	**479**	**543**	**389**	**428**	**475**	**517**	**496**
Number of kernels per spike									
Winter oilseed rape	48.5	48.3	49.0	47.2	49.6	49.5	49.0	48.3	**48.7**
Spring oilseed rape	46.7	51.6	47.6	44.5	44.5	47.6	46.3	47.9	**47.1**
White mustard	49.6	49.2	45.2	44.4	46.3	46.3	47.0	46.6	**46.8**
Indian mustard	47.2	49.6	47.0	43.2	45.9	48.5	46.7	47.1	**46.9**
Winter wheat	47.7	49.7	48.3	47.0	42.9	47.8	46.3	48.2	**47.2**
Average	**47.9**	**49.7**	**47.4**	**45.3**	**45.8**	**47.9**	**47.1**	**47.6**	**47.3**
1000 kernel weight (g)									
Winter oilseed rape	39.2	39.7	44.9	45.6	34.3	33.3	39.5	39.5	**39.5**
Spring oilseed rape	38.7	39.3	45.6	45.0	33.9	33.4	39.4	39.2	**39.3**
White mustard	39.7	41.1	45.2	45.4	33.9	33.1	39.6	39.9	**39.7**
Indian mustard	34.4	39.5	45.4	45.5	33.3	33.9	37.7	39.6	**38.7**
Winter wheat	36.8	37.7	44.0	44.2	33.5	33.6	38.1	38.3	**38.3**
Average	**37.8**	**39.5**	**45.0**	**45.1**	**33.8**	**33.5**	**38.9**	**39.3**	**39.1**

The highest number of kernels per spike (48.7) was noted when winter wheat was grown after winter oilseed rape. The above parameter was 3-4% lower when winter wheat was grown after spring oilseed crops or in a 2-year monoculture. Higher rates of nitrogen fertilization and complete disease control with fungicides (production technology A2) increased spike density by only around 1% on average (Table 1).

Grain plumpness improved when winter wheat was grown after oilseed crops (regardless of species), and 1000 kernel weight increased by around 3% relative to that noted in the wheat monoculture. Thousand kernel weight increased considerably (by 4-5%) in the medium-input production system only in the first year of the study (2006/2007). In the remaining years of the experiment, the production system had a less pronounced effect on grain plumpness (Table 1).

The lowest grain yield of winter wheat was noted in monoculture (7.42 t/ha). When winter wheat was grown after oilseed crops, grain yield increased by 7% to 25% relative to the 2-year monoculture (Table 2). Preceding crops exerted the smallest influence in the year characterized by the highest winter wheat yield (2007/2008). Preceding crops were more likely to improve winter wheat yields in years characterized by unfavorable weather conditions (2006/2007 and 2008/2009). The average results for the three-year study indicate that grain yield was 14% lower (1.21 t/h in absolute terms) in the wheat monoculture than in treatments where oilseed plants were used as preceding crops. Spring oilseed rape and Indian mustard were less effective preceding crops, and they increased winter wheat yields by 16% relative to the wheat monoculture. The grain yield of winter wheat grown after winter oilseed rape and white mustard increased by 17%. In the experiments conducted by Weber (2000) and Wesołowski et al. (2007), the grain yield of winter wheat increased by 14-30% (around 1 t/h in absolute terms) when grown after winter oilseed rape relative to the wheat monoculture. The increase in yield was smaller at around 0.7 t/ha when winter wheat was grown after spring oilseed crops (Szczebiot and Ojczyk 2002). According to Szczebiot and Ojczyk (2002), the best preceding crop for winter wheat is spring oilseed rape, followed by Indian mustard, white mustard and oilseed radish.

In the medium-input production system where the rate of nitrogen fertilization was increased to 60 kg N/ha and two fungicide treatments were applied, winter wheat yields increased by 11-16% (0.84-1.02 t/h), subject to weather conditions (Table 2). In a study by Szmigiel et al. (2006), the high-input production technology also increased winter wheat yields. In our study, the increase in winter wheat yields induced by the medium-input production technology was 17% lower than the increase induced by oilseed plants as preceding crops. The above implies that increased nitrogen fertilization (by 60 kg N/ha) and two fungicide treatments did not compensate for the adverse effects of short-term wheat monoculture. Grain yield was lower by 160 kg when winter wheat was grown in monoculture in the medium-input production system (A2) than when it was grown after oilseed crops in the low-input production system (A1).

Table 2. Grain yield of winter wheat grown after different preceding crops and in different production systems.

Preceding crop	2006/2007		2007/2008		2008/2009		2006-2009		**Average**
	Production technology								
	A1	A2	A1	A2	A1	A2	A1	A2	
Winter oilseed rape	8.25	9.12	9.82	10.61	6.92	7.76	8.33	9.16	**8.74**
Spring oilseed rape	8.02	8.75	9.54	10.43	6.69	7.72	8.08	8.97	**8.53**
White mustard	7.97	9.05	9.60	10.65	6.98	7.71	8.18	9.14	**8.66**
Indian mustard	8.12	8.92	9.17	10.88	6.71	7.80	8.00	9.20	**8.60**
Winter wheat	6.47	7.19	8.84	10.10	5.24	6.68	8.85	7.99	**7.42**
Average	**7.77**	**8.61**	**9.39**	**10.53**	**6.51**	**7.53**	**7.89**	**8.89**	**-**

Conclusions

- Oilseed plants as preceding crops increased the number of spikes per unit area and 1000 kernel weight in winter wheat.
- Oilseed plants were highly effective preceding crops for winter wheat. Winter oilseed rape induced the greatest increase in winter wheat yields, and Indian mustard was the most effective preceding crop in the group of spring-sown oilseed crops.
- Oilseed plants as preceding crops contributed to a greater increase in winter wheat yields than the medium-input production technology.
- Winter wheat yields were 12% higher in the medium-input than the low-input production system. However, the medium-input system did not eliminate the adverse effects of wheat monocropping.

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