

THE ECONOMIC ASSESMENT OF PRODUCTION TECHNOLOGY OF WINTER RYE WITH DIFFERENT INTENSITY LEVEL

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Abstract. The aim of the research was an evaluation of production and economic effects of cultivation of two winter rye cultivars, depending on the applied technology. The paper was based on the results of a field experiment carried out in 2013/2014 and 2014/2015 in the Kępa Agricultural Experimental Station, belonging to the Institute of Soil Science and Plant Cultivation - State Research Institute in Pulawy (Poland). The cultivars tested are: Dankowskie Diament - population cultivar and Palazzo - hybrid cultivar. Rye cultivars were grown under two technologies: intensive and integrated technologies, which differed in terms of the degree of consumption of the means of production. The studies showed a significant influence of the production technology intensity on the yields of winter rye cultivars. In comparison with integrated technology, rye cultivation according to intensive technology, resulted in an increase of grain yields for hybrid cultivar Palazzo by 0.97 t·ha⁻¹, and for population cultivar Dankowskie Diament by 1.26 t·ha⁻¹. This increase of yield resulted from a decrease in direct expenditures related to the use of mineral fertilizers and chemical plant protection agents. Studies have shown that the level of technology intensity calculated by input costs, determined the structure of direct costs and cost-effectiveness of production. Comparable technologies have ensured the profitability of winter rye grain production. The hybrid cultivar Palazzo grown according to the integrated technology, was the most advantageous indicator of direct profitability.

Key words: winter rye, production technology, economic assessment, yield.

JEL code: Q10, Q14

Introduction

Production technology determines the size and quality of agricultural produce (Nowak A., et al., 2013). The final confirmation of the usefulness of a given technology for practical use is its economic evaluation (Harasim A., 2007; Krasowicz S., Nowacki W., 2005). For this purpose, of particular usefulness are calculations that unambiguously indicate that the effectiveness of cereal cultivation depends primarily on the volume of obtained yields, purchase prices and the level of production intensity (Dropka D., 2004; Nasalski et al., 2004). In recent years, issues related to environmental effects have become increasingly important in the development of production technology, which is why intensive technologies, typical especially for farms producing large quantities of grain for sale, have been criticised (Krasowicz S., 2009). An alternative to such technologies is currently considered to be integrated technologies, in which the whole agrotechnology is skilfully connected with a limited consumption of industrial means of production, resulting in an increase in the effectiveness of expenditures incurred and minimizing the negative impact of agriculture on the natural environment (Kus et al., 2007; Podolska G., Sulek A., 2012). In integrated production, the use of pesticides is reduced to the minimum necessary, and mineral fertiliser rates are determined on the basis of soil nutrient abundance and plant nutrition status assessment (Korbas M., Mrowczynski M., 2009). For agricultural producers who produce cereals for the market, the choice of a given technology plays a decisive role in shaping the profitability of farms, as this group of plants usually occupies more than 70 % of the sown area on farms (Nierobca P., et al., 2008).

The research was conducted in two growing seasons 2013/2014 and 2014/2015 in the Agricultural Experimental Station „Kępa” (51 47'49" N, 22 05'32" E) belonging to the Institute of Soil Science and Plant Cultivation - State Research Institute. The experiment was located on pseudobacterial soil, classified as the good wheat complex. They were carried out by means of random blocks in three replications, winter rye being the experimental plant. The first research factor were production technologies of different intensity:

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A - integrated, B - intensive. The second factor were rye cultivars: 1) Dankowskie Diament – a population cultivar, 2) Palazzo – a hybrid cultivar.

The amount of inputs was established on the basis of the actual use of fertilisers, seeds, and plant protection products in the experiment. The costs of the means of production were determined on the basis of purchase prices and the value of winter rye production was determined on the basis of the average purchase price of grain in 2018 (IRGiGZ-PIB, 2018). In the grain production calculations, the selling price of PLN 680 per 1 t of consumer rye grains, was assumed. Only direct costs were taken into account in the economic assessment of the production technology, and the direct surplus was calculated as the difference between the value of the production output and the direct costs incurred. The final stage of the economic calculation was the calculation of the direct profitability index as the ratio of production value to direct costs. For each production technology, balancing the direct costs expressed in terms of grains necessary to cover these costs, has also been calculated.

The aim of this study was to evaluate the production and economic effects of cultivation of two winter rye cultivars depending on the production technology applied.

The results were statistically analysed using a one-way ANOVA, using the Statgraphics Centurion XVI computer program. Significance of differences between means were evaluated using the Tukey test at the level of significance $p=0.05$.

Research results and discussion

Winter rye was cultivated using two production technologies, differing in mineral fertilization and chemical plant protection agents' consumption. The range of differences between production technologies is presented in Tables 1-2. In direct costs, mineral fertilizers in intensive technology accounted for 54.6 - 62.2 %, while in integrated technology 53.8 - 63.9 % (Tab. 3). The share of seed costs ranged from 11.1 - 21.9 % in intensive technology to 15.1-28.5 % in integrated technology. Differences in the level of direct inputs determined the profitability of winter rye production. According to literature, mineral fertilisation is the most energy-intensive and cost-intensive element of agro-technology and may exceed even 60 % of the outlays incurred in cereal production (Dropka D., 2004).

Table 1

Mean of seeds and fertilizers applied in particular technologies of winter rye

Production technology	Cultivar	Seeds kg·ha ⁻¹	Fertilization kg·ha ⁻¹		
			N	P ₂ O ₅	K ₂ O
Integrated	Dankowskie Diament	102	82	60	90
	Palazzo	78	82	60	90
Intensive	Dankowskie Diament	102	124	70	110
	Palazzo	78	124	70	110

(own study)

Table 2

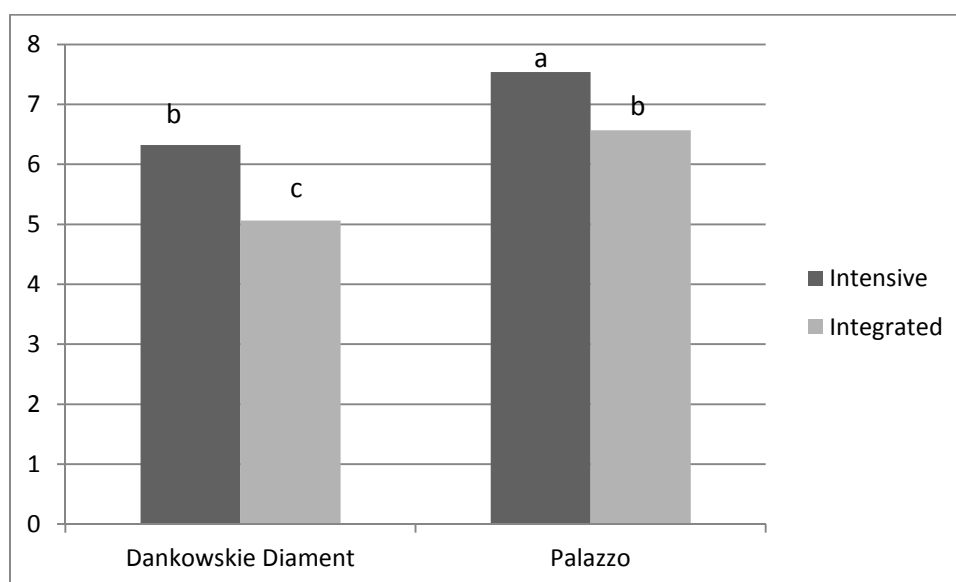
Consumption of plant protection products in particular technologies of winter rye

Production technology	Herbicides	Fungicides	Retardants	Insecticides
Integrated	Alister Grande 1.0 l·ha ⁻¹	Falcon 460EC 0.6 l·ha ⁻¹	-	Fury 100 EW 0.1 l·ha ⁻¹
Intensive	Alister Grande 1.0 l·ha ⁻¹	Saligor 425EC 0.8 l·ha ⁻¹ Falcon 460EC 0.6 l·ha ⁻¹	Moddus 250EC 0,3 l·ha ⁻¹	Fury 100 EW 0.1 l·ha ⁻¹

(own study)

Winter rye, regardless of cultivar, produced significantly higher grain yield under intensive production technology (Fig. 1). Comparing the studied cultivars, it should be stated that a higher grain yield was obtained for the hybrid cultivar - Palazzo. In the case of Dankowskie Diament, the increase in grain yield was 1.26 t·ha⁻¹, while in the case of Palazzo 0.97 t·ha⁻¹, as compared to that obtained in the integrated technology (Tab. 4). Hybrid cultivars of rye have a high yield potential and a higher tillage area in comparison to population rye (Haffke S., et al., 2014; Piechota T., et al., 2017). They also are highly resistant to disease and make effective use of minerals (Miedaner T., et al., 2012).

The increase in the yields of both cultivars resulted from increased outlays on mineral fertilizers and plant protection products. Other research results (Nierobca P., et al., 2008) also indicate that under intensive technology conditions cereal grain yields (triticale) were the highest. According to Jaskiewicz's B. research (2015; 2017), intensive technology also results in higher grain yields. In the study by Jaskiewicz B. and Sulek A. (2018), the lower yield of triticale grain in the economical technology resulted from lower direct outlays related to the use of seeds, mineral fertilizers and chemical plant protection agents. Studies conducted with winter wheat (Sulek A., et al., 2016) indicate that under the conditions of intensive technology of grain production, grain yields were higher by 13 % and 18 %, respectively, compared to those obtained in the integrated and economical technology.



(own study)

a, b, c mean value followed by the letters differ significantly at $p = 0.05$

Fig. 1 Grain yields (t·ha⁻¹) of winter rye depending on the production technology (average from 2014 and 2015).

Table 3

**The cost of seeds, mineral fertilizers and plant protection agents
 (prices as in 2018)**

Production technology	Cultivar	Seeds		Mineral fertilizers NPK		Plant protection agents	
		PLN ·ha ⁻¹	% of direct cost	PLN ·ha ⁻¹	% of direct cost	PLN ·ha ⁻¹	% of direct cost
Intensive	Dankowskie Diament	187	11.1	1048	62.2	451	26.7
	Palazzo	420	21.9	1048	54.6	451	23.5
Integrated	Dankowskie Diament	187	15.1	793	63.9	261	21.0
	Palazzo	420	28.5	793	53.8	261	17.7

(own study)

The effectiveness of mineral fertilization depended on the applied production technology. Productivity expressed in kg of rye grain converted into 1 kg of nitrogen applied in mineral fertilizers (on average for cultivars) was higher under integrated technology conditions (Tab. 4). When all fertiliser components are taken into account, the difference between intensive and integrated technology in terms of productivity of 1 kg NPK was 27 %. The direct surplus being the difference between the value of yield and direct production costs calculated for particular production technologies showed significant differences (Tab. 4). The lowest direct costs were incurred under integrated technology with cultivar Dankowskie Diament, while the highest under the intensive technology with the hybrid cultivar Palazzo. The difference in direct costs between production technologies, resulted primarily from a reduction of rates of mineral fertilizers and reduction of plant protection treatments under the integrated technology in comparison to those used intensive technology. The highest direct surplus from 1 ha of winter rye cultivation was obtained under intensive technology. In the cultivation of the Palazzo cultivar, it amounted to PLN 3209, and in the case of the Dankowskie Diament cultivar - PLN 2612. Compared to the integrated technology, these surpluses were higher by 9.3 and 8.4 %, respectively. The economic evaluation carried out for other cereal species (Sulek A., 2017; Jaskiewicz B., Sulek A., 2018) also indicates that the highest direct surplus per 1 ha was obtained by growing wheat and triticale under intensive technology. In research of Nierobca P., et al. (2008), the level of the direct surplus was not proportional to the level of yields of winter triticale. The biggest direct surplus was obtained by using economical technology, while the smallest by using intensive production technology. The reason for such a situation was high grain yields obtained in the economical technology with low consumption of means of production, while the increase in grain yield in the intensive technology did not compensate for the increase in the expenditures incurred. Our research indicates that the value of harvested grain significantly exceeded the direct costs of its production (Tab. 4). In intensive technology, more grains (2.6 t) than economical grains (2.0 t) had to be used to cover direct costs.

An important element of technology assessment is the cost-effectiveness of production, which is the relation between the value of production and direct costs. High profitability of winter rye production in both technologies and for both cultivars was obtained in our own research. The hybrid cultivar Palazzo was characterized by higher profitability of production in comparison to the population cultivar Dankowskie Diament. In other studies (Podolska G., et al., 1996), the highest profitability of wheat production was obtained in low-input technology without the use of chemical plant protection. Grabinski J., et al. (2015) indicate that the cost-effectiveness of integrated technology is higher than in intensive technology, despite similar wheat yields.

Table 4

Yields and chosen and indicators of economic efficiency of winter rye cultivars production

Specification	Production technology			
	Integrated		Intensive	
	Cultivar			
	Dankowskie Diament	Palazzo	Dankowskie Diament	Palazzo
Yield of grain [t·ha ⁻¹]	5.06	6.57	6.32	7.54
Productivity of N [kg grain · kg ⁻¹ N]	61.7	80.1	51.0	60.8
Productivity of NPK [kg grain · kg ⁻¹ NPK]	21.6	28.3	20.8	24.8
The value of production [PLN · ha ⁻¹]	3441	4468	4298	5127
Direct costs [PLN · ha ⁻¹]	1241	1474	1686	1919
Direct surplus without direct payment [PLN · ha ⁻¹]	2200	2994	2612	3209
Crop balancing direct costs [t]	1.8	2.2	2.5	2.8
Indicator of direct profitability without direct payment [%]	277	303	255	267

(own study)

Conclusions, proposals, recommendations

- 1) Winter rye cultivation under intensive technology, in comparison with the integrated technology, caused an increase in grain yield for the hybrid cultivar Palazzo by 0.97 t·ha⁻¹, and for the population cultivar Dankowskie Diament by 1.26 t·ha⁻¹.
- 2) The level of technology intensity determined by expenditures on means of production determined the structure of direct costs, in which mineral fertilisers accounted for the largest share, amounting to in intensive technology 54.6 - 62.2 %, while in integrated technology 53.8 - 63.9 %.
- 3) Integrated technology without growth retardant and with limited fungicide protection and low level of mineral fertilization turned out to be more cost-effective, and at the same time more profitable than the intensive technology. The indicator of direct profitability without direct payment was higher in integrated technology (277-303 %) compared to intensive technology (255-267 %).
- 4) The hybrid cultivar Palazzo grown according to the integrated technology was characterized by the most advantageous indicator of direct profitability.

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