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ECONOMIC ASPECTS OF *ROSA MULTIFLORA* THUNB. BIOMASS PRODUCTION

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ABSTRACT

The objective of the paper was to determine the elements of economic assessment of multiflora rose cultivation as an energy plant. A one - factor field experiment carried out in Mydlniki near Krakow in the years 2009-2013 was the object of the research. The impact of two doses of irradiation with laser beams of seedlings on the economic efficiency of multiflora rose cultivation was investigated. As a result of the research, it was stated that extensive cultivation of multiflora rose is economically profitable. The cost of seedlings (57.5%) constituted the highest share in costs of setting a plantation. A gross margin with a direct payment for one year long plantation was similar to the analogous value calculated for energy willow. Cultivation of multiflora rose may be an alternative for cultivation of energy willow especially on poor sandy soils.

Introduction

According to the forecasts even 4.3 million of hectares will be allotted for cultivation of energy plants in our country in 2020 (Faber et al., 2009). In mainly concerns soils of poor rye complexes, the surface area of which covers almost 63% of agricultural land, i.e. approximately 10 million of hectares (Mocek, 2014). Thus, searching for energy plants, cultivation of which in these conditions will be profitable, is justified. Multiflora rose may be such a plant, because due to low soil demands it is particularly predisposed, even without fertilization, to be cultivated on low quality soils as an energy plant (Klima et al. 2014a). The research, which has been carried so far, shows that multiflora rose does not react with a significant decrease of yield in extensive cultivation on light soil (Kieć et al., 2011). Mineral and organic fertilization is the condition of cultivation on light soils of other energy plants species (Kitczak and Czyż, 2014).

Research on the production and economic aspects of cultivation of this plant is justified since in 2021 participation of electric energy consumption from renewable sources should be 20% (Directive 2009/28). Relevance and the need to carry out research on the economic aspects of multiflora rose cultivation also follows from the fact that on the present stage of transformation in agriculture, the factor of economic effectiveness influences the most the selection of plants for cultivation and agrotechnology (Klima et al., 2014b).

The objective, scope and methods

The objective of the paper was to determine the elements of economic assessment of multiflora rose cultivation as an energy plant.

A one-factor field experiment carried out in 2009-2013 in the Experimental Station of the Department of Agrotechnology and Agricultural Ecology of the University of Agriculture in Kracow located in Mydlniki next to Krakow (50°05` N, 19°51` E) was the object of the research. The impact of two doses of irradiation of multiflora rose seedlings of Jantar cultivar with laser beams on the yield and economic effectiveness of cultivation of this plant was assessed. The seedlings were radiated in 2009. Medical Laser D 68-1 emitting red light with the waves length of λ 672 nm and the power of 20 mW was applied. Two times of interrupted exposition a) 3x3 seconds and b) 3x 9 seconds were applied. The experiment was set with the split-plot method in four iterations. Each field was 10 m^2. The soil of the experimental field was determined as brown leached formed from fluvioglacial formations with a granulometric composition of loamy sands, soil formation - VI rye weak. The content of available forms of phosphorus and potassium was low, slight acid reaction (pH in KCl 5.93). No mineral, organic or natural fertilization or chemical plant protection was applied in order to decrease the production costs. Details concerning the method of setting up an experiment and the obtained results are presented in the publication by Klima et al. (2014a). Harvesting was carried out in winter 2013 for 4-year growth. Directly after the harvest the yield of fresh mass, the content of dry mass, the heat of combustion and the calorific value were determined. The calorific value of biomass was determined according to a standard descriptive method set forth in PN 81/G 04513 according to DIN 51731 in a calorimetric bomb AC-350.

In the said publication, results of economic analysis of biomass production were presented. Plant density was 18,000 $pcs \cdot ha^{-1}$, and harvesting was carried out in a 4-year cycle. The size of expenditures on the production means were determined based on the technology applied in the field experiment and real consumption of planting material, pesticides (at field preparation for planting), amounts of which were calculated in relation to the area of 1 ha. Costs of the provided production means were taken from the Market Analyses prepared in the Market Research Department of the Institute of Agricultural and Food Economics (Zalewski, 2013) and the Calculation of agricultural production developed by the Department of Economics and Entreprenuership of the Małopolska Region of Agricultural Advisory (Bednarz et al., 2013). Assumed prices and costs concern 2013. The size of manual work inputs on cultivation treatments was assumed after Klikocka et al., (2011), costs of the treatments were determined with the use of the method applied by Muzalewski (2009). Spraying with Roundup 360 SL herbicide was applied in the dose of 5 $l \cdot ha^{-1}$ in order to kill weeds on the site for cultivation of multiflora rose. After a month from the applied spraying, a deep fall ploughing was carried out. In Spring 2009, an aggregate comprising a cultivator + a harrow and then rows were determined and planting was carried out. The harvesting was carried out with a field straw cutter Class Jaguar 830 According to Klepacki's and Gołębiowski's (2002) methodology transport of cuttings from the field was included in the costs of harvesting.

A gross margin was calculated as a difference between the value of the obtained production and direct costs. The direct profitability index (relation of the production value to direct costs) was calculated according to Klepacki's and Gołebiowski's method (2002).

Moreover, the expense of 2075 PLN·ha^{-1} on liquidation of the plantation was included in the production costs structure (Stolarski et al., 2008). Since there is no data in literature concerning multiflora rose, the amount allotted for liquidation of shrubby willow was assumed. It was assumed that the duration of multiflora rose plantation will be 25 years.

For evaluation of the manual work costs it was assumed after Stolarski et al., (2013) that a person employed full time in agriculture works 22 days in a month 8 hours a day, namely 176 hours. According to the data of the Main Statistical Office (2014) an average monthly remuneration in agriculture was PLN 3939.33 in 2013. Taking those data into consideration, the cost of manual work was determined on the level of PLN 22.38 for one hour. The value of fresh multiflora rose cuttings at the price of 20 PLN·GJ^{-1} (Stolarski et al., 2013) was determined at the level of 185.30 PLN·t^{-1}.

A uniform single area payment, which in 2013 was 830.30 PLN·ha^{-1}, was included into economic evaluation.

Results and discussion

Laser beam irradiation resulted in a tendency to a higher yield at a higher dose of irradiation (table 1).

Table 1
The fresh biomass yield and calorific value of multiflora rose

Specification	Control	Laser beam irradiation	
		3 x 3 seconds	3 x 9 seconds
Yield (t·ha^{-1}) of fresh cuttings of multiflora rose			
Multiflora rose	38.51	38.96	40.11
NIR/LSD $_{\alpha=0.05}$		r.n. /n.s	
Calorific value (kJ·kg^{-1}) of dry cuttings of multiflora rose			
Multiflora rose	16367	16879	17988
NIR/LSD $_{\alpha=0.05}$		r.n. /n.s	

NIR / LSD – Least significant difference; r.n. /n.s – non significant differences

The obtained yield of cuttings was at the average by 47% lower than the yield of willow cuttings harvested every 3 years (Stolarski et al., 2013). However, in the quoted research, willow was fertilized and pesticides were applied, and multiflora rose in the said research was extensively used without fertilization or pesticides. Statistical analysis did not show significant differences for the calorific value (table 1). The yield of dry mass was 20.52 t·ha^{-1} (control), 21.18 t·ha^{-1} (irradiation 3x3 seconds) and 22.60 t·ha^{-1} (irradiation 3x9 seconds).

The costs of setting up the plantation were 4692.2 PLN·ha^{-1}, (tab. 2). The highest participation in the costs of setting up was in case of seedlings (57.5%) and the manual work costs (25.4%). Kwaśniewski (2011) found out a similar high participation in the structure of biomass production costs from a three-year energy willow. The costs of setting up (4692.2 PLN·ha^{-1}) and costs of liquidation (2075 PLN·ha^{-1}) were in total 6767.2 PLN ·ha^{-1}. Assuming that the plantation will be utilised 25 years an average annual cost of setting up and liquidation of a plantation was 270.6 PLN·ha^{-1}. The obtained result is almost two times lower than the analogical value calculated for the energy willow (Stolarski et al., 2012). A fundamental reason is a shorter, namely only 20-year period of the use of the energy willow plantation and the use of pesticides and soil enrichment. Direct costs calculated for the 4-year multiflroa rose plantation were 5628.3 PLN·ha^{-1}, (tab. 3).

Table 2

The structure of the cost of production of multiflora rose

Direct costs	4692.2 (PLN·ha^{-1})	100.0 (%)
Treatments, including:	1839.2	
Glyphosate	41.7	0.9
Ploughing	216.0	4.6
Cultivator + harrow	153.4	3.2
Signing	41.7	0.9
Two-times mechanical weeding	200.3	4.3
Manual work (including planting)	1186.1	25.4
Means of productions including:	2853.0	
Plantings	2700.0	57.5
Herbicide treatment	153.0	3.2

Table 3

The structure of the costs calculated for 4-year plantation (harvested every 4 years)

Direct costs, including:	5628.3
Mean yearly cost of setting up and liquidation of the plantation	1082.4
Harvest + transport	4545.9

A gross margin without direct payments in case of plantings irradiated with laser beam was only 12% higher than the plantings irradiated for 3 seconds. (tab. 4). No explicit difference resulted, inter alia, from the fact that only tendency to higher yield of plants which grew from plantings irradiated for 9 seconds was determined. (tab. 1). A gross margin without direct payments divided by 4, namely calculated for 1 year, was 3-4 times lower for a gross margin of production of shrubby willow cuttings (Stolarski et al., 2013). The cited authors did not include subsidies. In the said research, a gross margin with a subsidy was similar to the calculated one (without subsidies) by Stolarski et al., (2013) for one year of production of shrubby willow cuttings. It means that the use of subsidies in case of multiflora rose is entirely justified.

In the research a positive profitability index was obtained (table 4). One of the reasons was a satisfactory sale price of cuttings, that is 185.30 PLN·t^{-1}. The obtained result is confirmed by Kwaśniewski (2011), who, inter alia, stated that a positive value of the profitability index is usually obtained at the sale prices which are higher than 170 PLN·t^{-1}.

Table 4
Indicators of the economic efficiency of the production of multiflora rose for different years of plantation

Specification	laser beam irradiation	
	seconds	3 x 9 seconds
The value of production (PLN·ha^{-1} for 4 years)	7219.2	7432.3
Direct payments (PLN·ha^{-1} for 4 years)	3321.2	3321.2
The value of the production with direct paymennts (PLN·ha^{-1} for 4 years)	10540.4	10753.5
Direct costs (PLN·ha^{-1} for 4 years)	5628.3	5628.3
Gross margin without direct payments (PLN·ha^{-1} for 4 years)	1590.9	1804.0
Gross margin without direct payments (PLN·ha^{-1} for 1 year)	397.7	451.0
Gross margin with direct payments (PLN·ha^{-1} for 4 years)	4912.1	5125.2
The share of direct payments in gross margin (%) (for 4 years)	68.6	64.8
Gross margin with direct payments (PLN·ha^{-1} for 1 year)	1228.0	1281.3
Indicator of the direct profitability		
Without direct payments	1.28	1.32
With direct payments	1.87	1.91

When comparing the results obtained in this paper with the results of similar research carried out in foreign scientific centres, it may be stated that the gross margin without direct payments was at the average three times lower than in case of Melin's and Larson's (2005) research as well as in case of research carried out by Styles et al., (2008). The basic reason was the yield of multiflora rose cuttings which was at the average half times lower.

The obtained results allow determination that cultivation of multiflora rose may be an alternative for energy willow. Extensive production of multiflora rose cuttings despite low yield proved to be profitable. Possibility of obtaining direct payments increases the value of the gross margin by three times.

Conclusions

1. An average yield of multiflroa rose cuttings is half lower than the yield of energy willow cuttings.
2. The cost of plantings (57.5%) constitutes the highest participation in costs of setting up the multiflora rose plantation. The costs of manual work (25.4%) is half lower than the cost of plantings.
3. An extensive cultivation of multiflora rose is economically profitable.
4. Cultivation of multiflora rose is an alternative for cultivation of energy willow especially on poor sandy soils.

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ASPEKTY EKONOMICZNE PRODUKCJI BIOMASY RÓŻY WIELOKWIATOWEJ

Streszczenie. Cel pracy obejmował określenie elementów oceny ekonomicznej uprawy róży wielokwiatowej jako rośliny energetycznej. W latach 2009-2013 przeprowadzono jednoczynnikowe doświadczenie polowe w Mydlnikach k. Krakowa. Badano wpływ dwóch dawek naświetlania promieniami lasera sadzonek róży wielokwiatowej na plon, wartość energetyczną i efektywność ekonomiczną róży wielokwiatowej. W wyniku badań stwierdzono, iż ekstensywna uprawa róży wielokwiatowej jest opłacalna. Największy udział w kosztach założenia plantacji stanowił koszt sadzonek. Nadwyżka bezpośrednia z dopłatą wliczona dla jednego roku trwania plantacji była zbliżona do analogicznej wartości wyliczonej dla wierzby energetycznej. Uprawa róży wielokwiatowej może być alternatywą dla uprawy wierzby energetycznej, zwłaszcza na glebach piaszczystych kompleksów żytnich.

Słowa kluczowe: nadwyżka bezpośrednia, struktura kosztów produkcji, rośliny energetyczne