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PRODUCTION VALUE OF EDIBLE POTATOES DEPENDING ON THE TYPE OF BIOSTIMULATORS USED

WARTOŚĆ PRODUKCJI ZIEMNIAKÓW JADALNYCH W ZALEŻNOŚCI OD RODZAJU STOSOWANYCH BIOSTYMULATORÓW

Key words: potatoes, direct costs of production, gross margin

Słowa kluczowe: ziemniaki, bezpośrednie koszty produkcji, nadwyżka bezpośrednia

JEL codes: Q1, Q14

Abstract. The aim of the study was to determine the effect of biostimulators on the yield and profitability of edible potato cultivation in comparison with the control. The field experiment was carried out in 2015-2017 with the use of biostimulators on an individual farm in a triplicate, split-plot system. The factors were: I – three varieties of edible potato: Honorata, Jelly and Tajfun; II – four types of biostimulators: the control (without using biostimulators), biostimulator Kelpak SL®, Titanit®, GreenOk® and BrunatneBio Złoto®. The biostimulators used in the experiment influenced the yield increase (on average by 1.80 t/ha) as compared to the control plot without foliar feeding. The value of production, direct production costs and direct surplus were calculated. The biostimulators used were the element differentiating the direct production costs. Studies have shown that the highest yield was obtained on the site where BrunatneBio Złoto Cytokinin was applied.

Introduction

In recent years, yield has increased to around 24-27 t/ha [Nowacki 2015]. In order to obtain high and good quality crops next to chemical plant protection products, qualified preparations referred to as plant development regulators or biostimulators [Trawczyński 2014, Maciejewski et al. 2007], extracts from algae [Dobrzański et al. 2008], bacterial vaccines [Emitazi et al. 2004] or immune stimulators [Koziara et al. 2006] are used. The task of biostimulators is to control and accelerate life processes, protect plants against stress and facilitate regeneration after stress and stimulate the development of roots, stems and leaves to more efficiently use environmental conditions [Kozak 2009, Słowiński 2004]. According to Barbara Sawicka and Barbara Krochmal-Marczak [2009b], foliar fertilization is an intervention and is assigned the role of preventing the reduction of crop yield. The profitability of potato cultivation depends on the yield amount obtained, the level of prices and means of production [Chotkowski 2000, Mystkowska et al. 2016, Nowacki 2009, Rembeza, Chotkowski 1995]. The aim of the study was to determine the effect of biostimulators on the yield and profitability of edible potato cultivation in comparison with the control.

Material and methodology of research

Field research was carried out in 2015-2017 on an individual farm. The experiment was established in three replications using the random split-plot method on soil found in a very good rye complex, IVA bonitation class. In individual years of research, soil differed in the content of organic matter and digestible macro elements. In 2015 and 2016, the soil was characterized by a slightly acidic reaction, and in the last year of research – alkaline. The content of organic

matter ranged from 15.0 to 18.7 g/kg. The content of absorbable phosphorus (P) ranged from high to very high, potassium (K) from medium to very high, and magnesium (Mg) – high. The first factor was three varieties of edible potato: Honorata, Jelly and Tajfun, and the second – four types of biostimulators used in three periods (the beginning of flowering, fully flowering and after flowering of plants):

1. Control object – without the use of biostimulator sprayed with distilled water.
2. Biostimulator Kelpak®SL (active substance – Extract from algae *Ecklonia maxima*,), containing plant hormones: auxins – 11 mg/l and cytokines – 0.031 mg/l, at a dose of 0.20 l/ha,
3. Biostimulator Tytanit® (active substance – titanium) at a dose of 0.20 l/ha,
4. Biostimulator GreenOk® (active substances – humus substances 20 g/l) at a dose of 0.20 l/ha.
5. Biostimulator BrunatneBio Złoto (active substances – plant hormones: auxins – 0.06 mg/l and cytokines – 12 mg/l,) at a dose of 0.20 l/ha.

Winter wheat was the forecrop for potato in particular years of research. Potatoes were planted in the third week of April, and collected in the first week of September, during harvest, the total yield was determined. Potatoes collected in field experiment were packaged and sold separately from each object. The economic assessment was made at average prices for the years 2015-2017. The production value was calculated as the product of tuber yield and its price. The direct costs included: seed potatoes, mineral and natural fertilizers (manure 50%), biostimulators, plant protection products, cost of specialist work. Direct surplus constituted the difference between the value of production and direct production costs, without area subsidies [Skarżyńska, ed. 2008].

Research results and discussion

When analyzing the impact of the methods of biostimulator use on the total yield of potato tubers, it was found that the largest mass of tubers was collected from object 5, where the biostimulator BrunatneBio Złoto was used and averaged 45.8 t/ha. In other variants (1-4), tuber yields were smaller. The varieties grown differed in terms of the level of yields. Variety Jelly produced the highest yield an average of 51.05 t/ha and the highest yields were obtained in 2017 weather conditions compared to other years of research (tab. 1). The increase in potato yield under the influence of biostimulators was ranged on average from 1.3 to 2.5 t/ha, in relation to the yield collection from the contro (tab. 2). Renata Czeczko and Maria Mikos-Bielak [2004] also observed the beneficial effect of the biostimulator Asahi SL on potato yield. The studies by Tomasz Erlichowski [2005], T. Erlichowski and Maria Pawińska [2003] as well as Kinga Matysiak and Kazimierz Adamczewski [2010] found an increase in potato yield after using the Kelpak SL growth regulator.

Table 1. Total yield of potato tubers

Objects	Yield [t/ha]						
	cultivars			years			mean [t/ha]
	Honorata	Jelly	Tajfun	2015	2016	2017	
Control object	39.4	50.1	41.4	43.1	43.2	44.6	43.6
Kelpak SL	40.7	50.8	42.3	44.7	44.0	45.1	44.6
Tytanit	40.8	51.1	43.0	44.7	44.5	45.7	45.0
GreenOk	41.2	51.4	42.9	44.7	44.7	46.0	45.2
BrunatneBio Złoto	42.3	51.8	43.3	45.2	45.8	46.5	45.8
Mean	40.9	51.1	42.6	44.5	44.4	45.6	44.8

$LSD_{0.05}$: cultivars – 0.39, objects – 0.2, years – 0.39; interaction: objects x years – 0.36, cultivars x years – 0.52, cultivars x objects – 0.305, cultivars x objects x years – 0.53

Source: own study

The production value was different on the examined objects where biostimulators were used (tab. 2). The highest production value was obtained on object 2, where the Kelpak SL biostimulator was applied. The value of production on other facilities was higher than on the control without the use of biostimulators. According to Jacek Chotkowski [2000] and Wojciech Nowacki [2009], the value of production is determined by the yield, market price and expenditure incurred on production. Sales prices varied and depended on the objects from which the potatoes were harvested. The average prices of edible potatoes in the years 2015-1017 for individual varieties were 402-557 PLN/t. In the economic assessment of edible potato, the level of direct surplus is important, calculated as the difference between the value of production and direct production costs [Augustyńska-Grzymek et al. 2000]. The level of direct surplus recorded on the facilities where biostimulators were used was higher than the surplus on the control on which biostimulators were not used. The highest direct surplus was recorded on the object fertilized with the biostimulator Kelpak SL in a foliar manner.

Seed potato and mineral fertilizers costs accounted for the greatest proportion of the total costs. The cost of biostimulants administered was between 7.1 to 7.84% direct costs (tab. 4).

Table 2. Total yield of fresh mass of potato tubers (means from 2015-2017)

Objects	Total yield [t/ha]	The difference of yield in comparison with control [t/ha]
The Control	43.6	0.0
Kelpak SL	44.6	+ 1.0
Tytanit	45.0	+ 1.7
GreenOK	45.2	+ 1.9
BrunatneBio Złoto	45.8	+ 2.5
$LSD_{0,05}$ /$NIR_{0,05}$	0.2	-

Source: own study

Table 3. Results of economic evaluation of potato foliar fertilization with biostimulators according to average prices for the years 2015-2017

Objects	Economic value [PLN/ha]		
	production value	direct costs of production	gross margin
The Control	17,517.9	10,254.0	7,263.9
Kelpak SL	24,856.0	11,125.2	13,730.8
Tytanit	23,234.2	11,035.4	12,198.8
GreenOK	23,800.4	11,104.3	12,696.1
BrunatneBio Złoto	24,832.7	11,120.7	13,712.0
Mean	22,848.2	10,927.9	11,920.3

Source: own study

Table 4. The direct costs structure in potato cultivation

Specication	The control	Kelpak SL	Tytanit	Green Ok	Brunatne BioZ
Share [%]					
Seed potato	55.1	50.78	51.2	50.88	50.8
Manure (50%)	15.21	14.02	14.13	14.04	14.03
Mineral fertilizers	16.87	15.55	15.67	15.58	15.55
Plant protection agents	8.18	7.54	7.6	7.55	7.54
Foliar biostimulators	-	7.84	7.1	7.68	7.81
Specialized costs	4.63	4.27	4.3	4.27	4.27
Total	100,0	100,0	100,0	100,0	100,0

Source: own study

Summary

The research showed that the highest yield was obtained on the object where the biostimulator BrunatneBio Złoto Cytokinin was used in a foliar manner. The highest value of potato production was obtained on object 2, where the Kelpak SL biostimulator was used. The most profitable was the cultivation of edible potatoes fertilized with the biostimulator Kelpak SL and BrunatneBio Złoto in a foliar manner.

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Streszczenie

Celem badań było określenie wpływu stosowania biostymulatorów na plonowanie i opłacalność uprawy ziemniaków jadalnych w porównaniu do obiektu kontrolnego. Doświadczenie polowe przeprowadzono w latach 2015-2017, z zastosowaniem biostymulatorów w gospodarstwie indywidualnym w układzie split-plot w trzech powtórzeniach. Badanymi czynnikami były: I – trzy odmiany ziemniaka jadalnego: Honorata, Jelly, Tajfun, a II – cztery rodzaje stosowania biostymulatorów: obiekt kontrolny (bez stosowania biostymulatorów), biostymulator Kelpak SL®, Titanit®, GreenOk®, BrunatneBio Złoto®. Zastosowane w doświadczeniu biostymulatory wpływały na zwiększenie plonu (średnio o 1,80 t/ha) w porównaniu do poletka kontrolnego bez dolistnego dokarmiania. Obliczono wartość produkcji, bezpośrednie koszty produkcji i nadwyżkę bezpośrednią. Stosowane biostymulatory stanowiły element różnicujący bezpośrednie koszty produkcji. Badania wykazały, że największe plony otrzymano na obiekcie, gdzie zastosowano dolistnie biostymulator BrunatneBio Złoto Cytokinin.

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