

NEW POTATO CULTIVARS UNDER ORGANIC SYSTEM – EVALUATION OF SUITABILITY

Summary

The study was conducted in 2011-2013 in two places, with different climate and soil conditions. The usefulness of 7 potato cultivars of different groups of earliness for growing under organic farming system was evaluated. It was found that among the analyzed factors affecting the yield of tubers such as cultivar, place of growing and years of research, significant differences concerned only climatic conditions during tested years. The highest yields were obtained in both places in the preferred 2012, and the lowest in 2013 with a very unfavorable weather conditions. The structure of the yield was significantly affected by all the examined factors. On lighter soil, a significant diminution of yield took place. The quality of the crop depended largely on the cultivar and growing location. It was concerned most studied external and internal tuber defects. Taking into account both the yield and the quality of the tested cultivars most useful to organic production were: - on lighter soils: Vineta, Finezja and Gustaw, - on heavier soil: Viviana, Finezja and Medea.

Key words: potato, organic system, yield, quality, cultivar

NOWE ODMIANY ZIEMNIAKA W UPRAWIE EKOLOGICZNEJ – OCENA PRZYDATNOŚCI

Streszczenie

Badania przeprowadzono w latach 2011-2013 w dwóch miejscowościach, o zróżnicowanych warunkach klimatyczno-glebowych. Oceniano przydatność 7 odmian ziemniaka z różnych grup wczesności do uprawy w systemie ekologicznym. Stwierdzono, że spośród badanych czynników wpływających na wielkość plonu bulw takich jak odmiana, miejsce uprawy i lata badań istotność zróżnicowania dotyczyła jedynie lat badań. Największe plony uzyskano w obu miejscowościach w korzystnym 2012 roku, najniższe zaś w roku 2013 o bardzo niesprzyjających warunkach atmosferycznych. Na strukturę plonu istotny wpływ miały wszystkie badane czynniki. Na glebie lżejszej stwierdzono znaczne zdrobnienie plonu. Jakość plonu zależała w dużej mierze od odmiany i miejsca uprawy. Dotyczyło to większości badanych wad zewnętrznych i wewnętrznych bulw. Biorąc pod uwagę zarówno wielkość plonu, jak i jego jakość, spośród badanych odmian za najbardziej j przydatne do produkcji ekologicznej uznano: – na gleby lżejsze: Vineta, Finezja i Gustaw- na gleby cięższe: Viviana Finezja i Medea.

Słowa kluczowe: ziemniak, system ekologiczny, plon, jakość, odmiana

1. Introduction

The development of organic farming in Poland in recent years is very dynamic. We are at the forefront of European countries in terms of the number of farms and acreage. This increase, however, is not the same and does not apply equally to all plants. One of the crop, which share in organic farming is small is potato, though, that it is still basic of diet a large number of Poles. This is due to the difficulty of cultivation of this species, mainly protection against pathogens, specially *Phytophthora infestans* and Colorado beetle. An important role also plays an appropriate choice of cultivars. The significance of cultivars in organic potato production has been undertaken in a lot of publication [1, 10, 11, 13, 15]. We know what attributes should have a cultivar most suitable for this type of production. Agronomic requirements, however, do not always go hand in hand with the requirements of consumers who expect mostly good quality product. Therefore, in addition to features that facilitate the cultivation, ie high resistance to pathogens, low requirements of soil and fertilizer, we should also take into account the quality of the yield, ie the share of external and internal defects of tubers. The aim of this study was to evaluate the usefulness some new potato cultivars for culti-

vation in the organic system under different soil and climatic conditions.

2. Material and methods

Material for the study came from field experiments conducted at two places ie experimental station of the Institute of Soil Science - Osiny (South-Eastern Poland) on the soil of very good rye complex and the Institute of Plant Breeding and Acclimatization - Jadwisin (central Poland) on weak rye complex. The factors of the experiment were place of growing and cultivar. Experiment was conducted without replications during three years: 2011, 2012, 2013. Tuber yield and its structure was assessed in 3 replications. In the organic system no mineral fertilizers was used. The exception was allowed in organic farming potassium sulphate in Osiny. No pesticides were also used with the exception of copper against potato late blight and Novodor (bacterial fungicide) against the Colorado potato beetle. Compost (Osiny) or manure (Jadwisin) at a dose of 250 dt · ha⁻¹ was applied. Weed control was carried out in a mechanical way.

In each place suitable for soil conditions rotation was used:

Jadwisin: potato → oat + field peas → rye with undersaw serradela → lupine + white mustard as catch crop + buck-wheat

Osiny: potato → spring barley with red clover → red clover with grasses (2 years) → winter wheat+ catch crop.

After harvesting, the total yield, tuber size distribution and quality of tubers was evaluated. Assessing the quality of the yield the share of external defects such as : common scab, black scurf, tuber deformations, damages by pests, green tubers and the share of internal defects: rust spot and hollow hearts have been taken into account.

7 potato cultivars belonging to different groups of earliness were assessed. The cultivars have been chosen according to the highest resistance to *Phytophthora infestans*. List of cultivars and their basic characteristics are given in table 1.

Table 1. Characteristics of tested cultivars
Tab. 1. Charakterystyka badanych odmian

Cultivar	Origin	Maturity group	Resistance to <i>Phytophthora infestans</i> *
Flaming	Polish	very early	2
Viviana	German	very early	2
Eugenia	Polish	early	3
Vineta	German	early	2
Finezja	Polish	mid early	4,5
Gustaw	Polish	mid late	5,0
Medea	Polish	late	6,5

*- 1- means no resistance, 9- the highest resistance

Weather conditions during the vegetative period in each growing season in both places are shown in the table 2.

The weather conditions during growing seasons in the years of the study were very different. The most favorable year for potato yields in both places was the year 2012 when the air temperature, and the amount and distribution of rainfall during the growing season were the best. The worst conditions were in 2013 when it was cold and very wet spring (especially in Jadwisin) but in full vegetation (June) the drought occurred.

3. Results

3.1. Yield and tuber size distribution

Varied weather conditions prevailing during the growing season reflected in the tuber yield. Particularly big decrease of yield was recorded in 2013 on lighter soil in Jadwisin. Such large differences in yield between years in both places has contributed to overcoming the differences between cultivars. There were no significant differences for both the yield of cultivars as well as the place of cultivation (table 3).

Table 2. Mean temperature and sum of rainfalls in months of vegetation for 2 places and 3 years of investigations

Tab. 2. Średnia temperatura powietrza i suma opadów w poszczególnych miesiącach wegetacji dla 2 miejscowości i 3 lat badań (Jadwisin, Osiny 2011-2013)

Month		May		June		July		August		September	
Year	Place	Rain fall (R)	Tem (T)	(R)	(T)	(R)	(T)	(R)	(T)	(R)	(T)
2011	Jadwisin	33,1	13,2	44,8	17,5	278,1	17,0	57,1	17,5	18,5	13,7
	Osiny	60,5	14,8	54,4	19,4	250,1	18,5	36,2	18,7	3,1	14,4
2012	Jadwisin	52,4	13,9	96,6	15,6	92,2	18,8	87,2	17,4	26,9	12,8
	Osiny	35,3	15,6	68,9	17,7	114,3	21,4	93,9	19,0	19,4	15,0
2013	Jadwisin	130,0	15,7	105,4	17,2	17,1	18,7	97,7	18,2	94,0	10,9
	Osiny	85,4	15,6	37,4	19,7	30,3	19,8	7,1	19,8	47,6	12,1

There also has not been proven interaction between cultivars and years of investigation. Significant differences were observed only between the years and their interaction with place of growing. Despite the lack of significance of cultivar yielding, however slightly different reaction of cultivars on climate and soil conditions was noticed. Most cultivars yielded higher on heavier soil. The highest differences was observed for the varieties Medea, Finezja and Viviana. Among earlier cultivars smaller differences between type of soil were noticed.

An important feature in assessing the suitability of varieties for organic production is yield stability. Analyzing the data in table 4 should be noted that the cultivars Finezja and Gustaw had the most stable yields in individual years. The greatest differences were recorded for cultivars: Medea, Vineta and Viviana.

It has been proven the statistical differences in tuber size distribution depending both on the cultivar and growing location. Potatoes grown on lighter soil in Jadwisin characterized by a more diminutive tubers compared to the yield obtained from Osiny. The share of small tubers i.e. less than 35 mm for Jadwisin was over 10%, while for Osiny only 3.5%. Significantly lower was also share of large tubers i.e. with a diameter above 60 mm. However, share of marketable sized tuber (35-60mm) was smaller. The biggest diminutive of tubers characterized by a cultivar Flaming and the smallest by cultivar Vineta. Exact opposite situation took place in relation to the large tubers (table 5). There was no interaction between the cultivars and place of growing, although the differences were not the same. The greatest diversity concerned the share of large tubers (>60 mm) for the variety Vineta. In Jadwisin the share of this tubers was only 3,9% in Osiny up 37,2%.

3.2. Quality of tubers

The place of growing, statistically differed such disorders as: green tubers, share of tubers with rust spot and hollow hearts. More green tubers and tubers with rust spot were noticed in Osiny. Higher share of tuber with hollow hearts was in tubers grown in Jadwisin. In the case of the rest of disorders there were no statistical differences although higher infection of common scab, black scurf and pest damages was observed on tubers from lighter soil (table 6). The cultivars, statistically varied of share a following disorders: common scab, deformations, rust spot and hollow hearts. For most disorders the interaction between cultivars and place of growing has been proven. The highest common scab infection was observed on cultivar Viviana (specially on lighter soil), Medea and Flaming.

Table 3. Total yield depending on cultivars and place of growing (dt·ha⁻¹)

Tab. 3. Plon ogólny bulw (t·ha⁻¹) w zależności od odmiany i miejsca uprawy

Cultivar	Place	Yield (dt·ha ⁻¹)	LSD for cultivars
Eugenia	Jadwisin	209	-
	Osiny	216	
	Średnio	213	
Finezja	Jadwisin	235	
	Osiny	279	
	Średnio	257	
Flaming	Jadwisin	225	
	Osiny	226	
	Średnio	225	
Gustaw	Jadwisin	201	
	Osiny	222	
	Średnio	212	
Medea	Jadwisin	169	
	Osiny	274	
	Średnio	223	
Vineta	Jadwisin	251	
	Osiny	226	
	Średnio	239	
Viviana	Jadwisin	186	
	Osiny	206	
	Średnio	196	
	Mean for Jadwisin	211	
	Mean for Osiny	236	
	LSD for place	-	

Table 4. Yielding of cultivars in years of investigations (mean for 2 places) (dt·ha⁻¹)

Tab. 4. Plonowanie odmian w poszczególnych latach badań (średnio dla dwóch miejscowości) (dt·ha⁻¹)

Cultivar/ Years	2011	2012	2013
Eugenia	199	300	166
Finezja	251	358	246
Flaming	242	305	154
Gustaw	244	289	178
Medea	226	314	154
Vineta	317	300	163
Viviana	238	290	123
Mean	245	308	190
LSD	45		

Source: Own work / Źródło: opracowanie własne

Table 5. Tuber size distribution (%) depending on cultivar and place of growing

Tab. 5. Struktura plonu bulw w zależności od odmiany i miejsca uprawy

Cultivar	Place of growing	Share of small tubers (<35 mm)	LSD	Share of medium tubers (35-60mm)	LSD	Share of big tubers (>60 mm)	LSD
Eugenia	Jadwisin	8,4	5,8	83,8	5,8	8,0	11,6
	Osiny	3,7		74,6		21,7	
	Mean	6,0		79,4		14,9	
Finezja	Jadwisin	7,8		86,0		8,0	
	Osiny	2,4		75,8		21,7	
	Mean	5,1		80,9		14,9	
Flaming	Jadwisin	17,2		82,5		0,3	
	Osiny	7,5		88,7		3,8	
	Mean	12,4		85,6		2,1	
Gustaw	Jadwisin	10,1		88,8		1,1	
	Osiny	3,7		89,2		7,0	
	Mean	6,9		89,0		4,0	
Medea	Jadwisin	15,0		84,8		0,3	
	Osiny	4,4		79,5		16,2	
	Mean	9,7		82,2		8,3	
Vineta	Jadwisin	7,3		88,8		3,9	
	Osiny	1,3		61,6		37,2	
	Mean	4,3		75,2		22,7	
Viviana	Jadwisin	11,0		89,0		0	
	Osiny	2,5		84,1		13,4	
	Mean	6,7		86,6		6,7	
	Mean for Jadwisin	10,9	86,3	2,8			
	Mean for Osiny	3,5	79,3	17,2			
	LSD	2,9	5,8	5,9			

Table 6. Tuber quality depending on cultivar and place of growing
 Tab. 6. Jakość bulw w zależności od odmiany i miejsca uprawy (Jadwisin, Osiny 2011-2013)

Cultivar	Place	Common scab (%)	Black curf (%)	Green tubers (%)	Pest damages (%)	Deformations (%)	Internal disorders (nb/ 20 tubers)	
							Rust spot	Hallow heart
Eugenia	Jadwisin	2,6	30,7	4,7	0,2	6,5	0,5	1,5
	Osiny	2,1	7,8	8,9	1,2	15,9	6,5	0
Finezja	Jadwisin	2,7	10,5	1,9	2,1	9,2	0,2	1,6
	Osiny	3,3	3,7	17,0	0,8	10,9	0	0
Flaming	Jadwisin	7,2	22,5	0,3	0,3	10,4	0	0
	Osiny	20,9	7,9	0,7	1,2	9,7	0	0
Gustaw	Jadwisin	13,7	11,5	0,9	0,7	4,5	0,7	1,0
	Osiny	7,6	9,9	9,5	0,4	5,1	0	0
Medea	Jadwisin	19,1	8,2	1,1	3,7	10,8	0,7	0
	Osiny	12,0	1,2	3,8	0,5	9,8	0	0
Vineta	Jadwisin	10,1	0,6	0,9	1,6	2,9	0	0
	Osiny	3,6	5,6	2,6	0,2	7,5	0	0
Viviana	Jadwisin	70,7	3,1	3,2	1,8	1,9	0,3	0
	Osiny	21,3	7,3	2,7	0,8	3,2	0,6	0
Średnio	Jadwisin	18,0	12,5	1,8	1,5	6,6	0,3	0,6
	Osiny	10,1	6,2	6,5	0,7	8,9	1,0	0
NIR		nu	nu	3,4	nu	nu	2,5	0,4

Cultivar differences : common scab, ++ , rust spot -, green tubers -, pest damages -, deformation ++ , rust spot ++ , hallow heart ++ , Where - no significant, ++ significant for $\alpha \leq 0,05$

Source: Own work / Źródło: opracowanie własne

The biggest share of deformed tubers was noticed for cultivars Eugenia and Finezja in Osiny and Flaming and Medea in Jadwisin. The rust spot occurred mainly on cultivar Eugenia grown in Osiny.

Analyzing both the yield and the quality of the tested cultivars most suitable for organic production on lighter soils are : among early cultivars - Vineta, among later cultivars Finezja and Gustaw. On heavier soils respectively - Viviana, Finezja and Medea.

4. Discussion

With the development of organic farming in the world is ongoing breeding work aimed at obtaining the greatest number of cultivars suitable for this type of production [1, 15]. In Poland we have a very large number of potato cultivars from which you can choose the most suitable to the required standard [5]. The main features of determining the suitability of cultivars for organic production include high resistance to disease, the rapid rate of growth in the early stages of development, the rapid rate of accumulation yield, low soil and fertilizer requirements [10]. However, one of the basic characteristics is resistance to late blight [2, 4, 6]. The fact that one of the priorities of the Polish potato breeding was resistant to the diseases, so we have number of cultivars with increased resistance to *Phytophthora isfestans* [3]. Select from these cultivars, however, should take into account other characteristics, mainly the yield and quality of tubers. As is well known variation in the level of the yield of each cultivar is very large [7, 8]. Therefore, our results of a three-year research are somewhat surprising. There was no significant cultivar differences, although the comparison concerned of cultivars from different groups of earliness, which generally differentiates the most the level of yield. In previous studies of other cultivars, these differences were always significant [14]. Surprising is also no differences between the place of growing i.e soil-climatic conditions in which potatoes were cultivated. The explana-

tion for this may be extremely different weather conditions in years of research in both places, which erased the differences. So, it is difficult to assess the suitability for specific conditions only on the yielding of cultivars. You could take into a count a stability of yielding but also in this case it is difficult to talk about stability, mainly due to the very unfavorable weather conditions in 2013, which resulted in a very large decrease in yields, especially on lighter soil. Clearly highlighted the differences in the quality of the crop. For most of the defects both tuber differences between the cultivars, as well as between the place of cultivation were found. Such differentiation is confirmed by previous work [9, 12]. Looking more closely at the reaction of individual cultivars on the soil and climatic conditions we can select more or less suitable for specific conditions. Like the previous years, it should be noted varied reaction of cultivars belonging to different groups of earliness to grow in different environment.

5. Conclusions

1. Tuber yield differed significantly only between the years. The highest yields were obtained in both places in the 2012, and the lowest in 2013 in very unfavorable weather conditions.
2. In contrast to the total yield, its structure was significantly affected by all the examined factors. On lighter soil, a significant diminution of tuber yield was proved.
3. The share of external and internal tuber defects determining the quality of the crop depended mostly on the variety and growing location. This concerned the most of studied disorders.
4. Taking into account both the yield and the quality of the tested varieties most suitable for organic production should be considered:
 - on lighter soils: Vineta, Finezja and Gustaw,
 - on heavier soils: Viviana, Finezja and Medea.

6. References

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