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THE INFLUENCE OF EDIBLE POTATO CULTIVAR ON YIELD SIZE AND QUALITY

The study material included five cultivars of edible potato (Jurek, Laskara, Satina, Tajfun, Jelly) cultivated between 2018–2020 in a commercial farm in Żywnów (49°49' N, 21°50' E), in soil with valuation class IVb, defective wheat complex, and slightly acidic pH. The planting material included class O – Original potatoes purchased in the Seed Centre. Potatoes were planted manually in the third decade of April with 75 × 33 cm spacing and harvested in the third decade of September. During harvest, the study focused on the general yield of tubers, yield structure, the share of tubers with external defects in the yield, starch content, dry mass in tubers and flesh browning in raw tubers after 1 h and 2 h from cutting. Individual cultivars of edible potato differed in terms of general yield size. The percentage of commercial tubers in individual cultivars was at a similar level. The highest value was observed in the Satina cultivar, followed by the Tajfun and Jelly cultivars, whereas the Laskara cultivar demonstrated the smallest percentage of commercial tubers. The tuber fraction mass in general yield of the 5 potato cultivars was differentiated. The studies revealed a small percentage of deformed, mechanically damaged, diseased or rotting tubers. The individual cultivars under study differed significantly in terms of

the content of dry mass and starch in tubers. The highest starch content was noted in the Tajfun cultivar, and the lowest in Jurek. After 1 h from cutting, the most browning was found in the Satina cultivar, and after 2 h from cutting – in the Jelly cultivar.

Key words: *potato, cultivar, yield, quality, starch, darkening.*

Дослідний матеріал включав п'ять культурних сортів їстівної картоплі (Юрек, Ласкара, Сатіна, Тайфун, Желе), вирощених у період 2018–2020 рр. у комерційному господарстві у Żyżnów (49° 49' пн.ш., 21° 50' с.д.), у ґрунті з класом оцінювання IVb, дефектний пшеничний комплекс і слабокислий рН. Посадковий матеріал включав клас О – Оригінальна картопля, придбана в насінневому центрі. Картоплю садили вручну в третій декаді квітня з інтервалом 75 × 33 см і збирали в третій декаді вересня. Під час збирання врожаю дослідження зосереджувалося на загальній урожайності бульб, структурі врожаю, частці бульб із зовнішніми дефектами, вмісті крохмалю, сухої маси в бульбах та підрум'яненні м'якоти у сирих бульбах через 1 год. та 2 год. від зрізання. Окремі сорти їстівної картоплі відрізнялися за загальним розміром врожаю. Відсоток товарних бульб в окремих сортах був на аналогічному рівні. Найвище значення спостерігалось у сорту Сатіна, за ним – сорти Тайфун та Желе, тоді як у сорту Ласкара найменший відсоток товарних бульб. Маса бульбової фракції в загальному врожаї 5 сортів картоплі була диференційованою. Дослідження виявили невеликий відсоток деформованих, механічно пошкоджених, хворих чи таких, що гниють, бульб. Окремі досліджувані сорти значно відрізнялися за вмістом сухої маси та крохмалю в бульбах. Найвищий вміст крохмалю відзначено у сорту Тайфун, а найнижчий – у Юреку. Через 1 год. від зрізання найбільше коричневого кольору виявлено у сорту Сатіна, а через 2 год. – у сорту Желе.

Ключові слова: *картопля, сорт, урожай, якість, крохмаль, потемніння.*

Introduction

Like wheat, corn and rice, potato (*Solanum tuberosum* L.) is the most popular source of food for people all over the world. Potatoes have become most popular in North America and Europe and are now becoming more and more widespread in Africa and Asia (Nowacki 2015). Potato tubers are a source of various vitamins necessary for humans. They contain high amounts of vitamin C and many other valuable nutrients (Wroniak 2006, Leszczyński 2012). Presently, Poland is among the largest potato producers in the European Union (Nowacki 2015). The average potato yield in Poland is generally considered very low, mostly due to agrotechnical errors. The cause of low yield of potato is also poor-quality seeding material. In Poland, the consumption of this species per capita is high and amounts to over 130 kg per annum (Dzwonkowski 2011, Zarzyńska and Goliszewski 2016). For potato producers, the most important aspect is the commercial yield, which largely determines the profitability of production, whereas for consumers, the most important aspect is quality, i.e. consumer, technological and nutritious value. Potato yield size and its quality depend on the agrotechnology and genetic properties of the cultivar, therefore, the aim of this study was to determine the influence of potato cultivars on the yield size and tuber quality cultivated in south-eastern Poland.

Study material and methods

The study material included five cultivars of edible potato (Jurek, Laskara, Satina, Tajfun, Jelly) cultivated between 2018–2020 in a commercial farm in Żyżnów (49°49' N, 21°50' E), in soil consisting of flysch sediments, with the mechanical composition of loam, valuation class IVb, defective wheat complex, with slightly acidic pH. The

planting material included class O – Original potatoes purchased in the Seed Centre. The pre-crops for potato were Fabaceae plants. The plantation preparation consisted in the following tillage works: coarse mulch disc tilling, aggregate cultivation (harrow+roller), secondary crop mulching, pre-winter ploughing, aggregate cultivation (cultivator+roller), fertiliser sowing, Roton aggregate cultivation. The following mineral fertilisation dose was applied: 60 kg·ha⁻¹ P₂O₅, Polifoska 6, K₂O – 180 kg·ha⁻¹ Polifoska 6, 90 – potassium sulphate and N – 120 kg·ha⁻¹ Polifoska 6. In all experiment years, potatoes were planted in the third decade of April. Weeding of emerged potatoes was carried out twice with the use of a ridging plough with chains. Directly prior to emergence, after the final earthing-up, Afalon 450 SC was applied, and after potato emergence – Titus 23 WG. During vegetation, plant protection procedures were employed: 5 times against phytophthora infestans and 2–3 times against Colorado potato beetle. Potatoes were planted manually in the third decade of April with 75 × 33 cm spacing and harvested in the third decade of September. One crop plot contained 30 plants. During harvest, the general tuber yield from each crop plot was determined and two 5-kg samples were collected in order to determine the yield structure (the mass of tuber fractions below 35 mm, from 35 to 50 mm, from 50 to 60 mm and above 60 mm), the share of tubers with external defects in the yield (percentage of deformed, green or scabby tubers) and the content of starch and dry mass in tubers. The size of commercial yield was determined after the removal of tuber fractions with a diameter of less than 35 mm and defective tubers from general yield. The starch content was measured based on the Ewers polarimetric method (starch was hydrolysed in a bath of boiling water and then protein was precipitated with wolfram phosphoric acid) with readings from the automatic polarimeter Polamat S. Dry mass was determined in a heating chamber by drying ground samples at 60°C and then post-drying at 105°C. In order to determine raw tuber browning, 10 average-sized tubers of each cultivar were collected, washed and dried up. Each tuber was cut in two with a sharp knife along the stolon end axis. The cut halves were placed on a white background of tissue paper, flat side up. Browning assessment was carried out after 1 h and 2 h from cutting according to a 9-point scale, where 9 means unaltered colour and 1 means the most darkened colour (Roztropowicz 1999).

Findings and discussion

The research shows that the average general yield size in all potato cultivars under study grown in defective wheat complex soil amounted to 53.44 t·ha⁻¹ (Table 1). A similar general yield size was determined in a research by Dzieżyc et al. (2012), with general yield size of 49 t·ha⁻¹.

Table 1

General yield and commercial yield of 5 potato cultivars

No.	Cultivar	General yield (t·ha ⁻¹)	Commercial yield (t·ha ⁻¹)	Commercial tuber share (%)
1.	Jurek	52.13	51.50	98.80
2.	Laskara	47.86	47.48	99.20
3.	Satina	58.11	57.88	99.60
4.	Tajfun	57.02	56.80	99.60
5.	Jelly	52.08	51.87	99.60
	Average	53.44	53.10	99.36

Source: own study.

Individual edible potato cultivars differed in terms of general yield size. The most yielding cultivar was Satina and the smallest yield was observed in the Laskara cultivar. A similar differentiation of general yield size in individual potato cultivars was arrived at in a research by Zarzyńska and Goliszewski (2016). They believe that morphological and physiological differentiation of cultivars has a significant influence on yield size.

The research showed that the average commercial yield size in all potato cultivars under study amounted to 53.10 t·ha⁻¹ (Table 1). Similar commercial yield was obtained in a research by Lenartowicz (2009), with the commercial yield size of 51.20 t·ha⁻¹. The individual potato cultivars under study differed in terms of commercial yield size. The highest value was observed in the Satina cultivar, and the lowest in the Laskara cultivar. Similar sizes of general yield in individual potato cultivars were determined in a research by Zarzecka et al. (2004).

The share of commercial tubers of individual cultivars was slightly different. The highest value was observed in the Satina cultivar, followed by the Tajfun and Jelly cultivars, whereas the Laskara cultivar demonstrated the smallest percentage of commercial tubers (Table 1). According to Lenartowicz (2009), the environmental factors that have a significant influence on potato plant growth and dry mass transport from leaves to tubers are air temperature and photosynthetically active radiation. Air temperature above the cultivar optimal level shortens the subsequent stages of potato tuber growth, which leads to earlier tuberisation (Zarzyńska and Goliszewski 2016). Low air temperatures decrease photosynthesis, whereas high temperatures increased transpiration. Both processes influence the size of commercial tubers (Trawczyński and Prokop 2016).

Table 2

Tuber fraction mass of 5 potato cultivars

		Mass of tuber fraction (mm)			
No.	Cultivar	up to 35	35–50	50–60	>60
1.	Jurek	0.50	3.20	20.90	25.40
2.	Laskara	0.40	7.80	14.70	27.10
3.	Satina	0.20	4.30	10.40	35.10
4.	Tajfun	0.20	12.00	13.60	24.20
5.	Jelly	0.20	4.40	13.40	32.00
Average		0.30	6.34	14.60	28.76

Source: own study.

The tuber fraction mass in general yield was different in the 5 potato cultivars (Table 2). Regardless of the cultivar, potato tubers with a diameter of above 60 mm had the largest share in the general yield, whereas tubers with a diameter of below 35 mm – the smallest share. Potato tubers with a diameter of 50–60 mm also had a large share. It was determined that tuber mass of the fraction up to 35 mm was the largest in the Jurek cultivar and the smallest in the Satina, Tajfun and Jelly cultivars. The largest share of tuber mass fraction above 60 mm was observed in the Satina cultivar. According to Lenartowicz (2009), genetic properties of potato cultivar have the greatest influence on tuber fraction size. It has been confirmed by our own studies.

Table 3

The mass of cracked and deformed tubers of 5 potato cultivars

No.	Cultivar	Mass of cracked and deformed tubers (kg)	Fraction of cracked and deformed tubers (%)	Mass of diseased and rotting tubers (kg)	Fraction of diseased and rotting tubers (%)
1.	Jurek	0	0	0.1	0.2
2.	Laskara	0	0	0	0
3.	Satina	0	0	0	0
4.	Tajfun	0	0	0	0
5.	Jelly	0	0	0	0
Total		0	0	0.1	0.2

Source: own study.

The conducted research showed a small percentage of deformed, mechanically damaged, diseased or rotting tubers, tubers affected by internal rust spot and a small amount of tubers affected by hollow heart (Table 3).

Table 4

Number of tuber defects caused by physiological disorders

No.	Cultivar	Number of tubers affected by internal rust spot	Internal rust spot (%)	Number of tubers affected by hollow heart	Hollow heart (%)
1.	Jurek	0	0	0	0
2.	Laskara	3	6	0	0
3.	Satina	0	0	0	0
4.	Tajfun	1	2	0	0
5.	Jelly	0	0	0	0
Total		4	8	0	0

Source: own study.

A small mass of diseased and rotting tubers was observed in the Jurek cultivar. Other defects, such as internal rust spot, were present in the Laskara and Tajfun cultivars (Table 4). According to Trawczyński and Prokop (2016), the presence of internal rust spot was significantly decreased by potato irrigation at times of draught and by using cultivars less susceptible to internal rust spot. According to Nowacki (2013), potato cultivars differ a lot in terms of resilience to diseases occurring in the entire vegetation period and are prone to external defects and internal flesh defects. Cultivars with a very high yield potential often tend to be affected by tuber deformation.

Table 5

The content of dry mass and starch in 5 potato cultivars

No.	Cultivar	Dry mass	Starch
1.	Jurek	19.1	11.6
2.	Laskara	15.5	13.8
3.	Satina	19.0	12.6
4.	Tajfun	22.1	14.4
5.	Jelly	17.3	13.0
Average		18.60	13.08

Source: own study.

The individual cultivars under study differed significantly in terms of the dry mass content (Table 5). The highest amount was observed in the Tajfun cultivar and the lowest in Laskara. According to Wierzbicka (2012), the right selection of cultivar has a significant influence on the content of dry mass. According to Nowacki (2013), dry mass content in potato tubers depends on starch content.

The edible potato cultivars under study differed in terms of starch content in tubers (Table 4). The highest starch content was noted in the Tajfun cultivar, and the lowest in Jurek. A research conducted by Zarzyńska and Goliszewski (2016) confirmed that the cultivar property of potatoes was the most important factor determining starch content.

Another important property influencing the quality of potato tubers is flesh browning. It is one of the crucial quality properties, often significantly affecting the consumer acceptance of the cultivar (Boguszewska (2007, Bienia et al. 2019). According to Kołodziejczyk (2014) and Sawicka et al. (2006), tuber flesh browning is a quality that largely depends on the cultivar genotype and environmental conditions. Our own research corroborates this conclusion, as it was noted that flesh browning was cultivar-dependent. The potato cultivars under study were characterised by little browning in raw tubers both after 1 h and after 2 h from cutting (Table 5).

Table 6

Raw tuber flesh browning after 1 h and 2 h

No.	Cultivar	Raw tuber flesh browning after 1 h	Raw tuber flesh browning after 2 h
1.	Jurek	8.90	8.80
2.	Laskara	8.70	8.60
3.	Satina	8.600	8.40
4.	Tajfun	8.80	8.60
5.	Jelly	8.90	8.10
Average		8.78	8.50

Source: own study.

After 1 h from cutting, the most browning was found in the Satina cultivar, and after 2 h from cutting – in the Jelly cultivar (Table 6). Farmers pay special attention to using potato tubers with the least tendency for flesh browning (Grudzińska and Zgórska 2006). According to Kołodziejczyk (2014), Grudzińska and Zgórska (2006), and Wszelaczyńska et al. (2017), the content of bioactive ingredients in tubers of individual potato cultivars, which determine the processes of enzymatic browning, depend e.g. on the cultivar genotype, weather conditions and storage.

Conclusions

1. Individual cultivars of edible potato differed in terms of general yield size. The most yielding cultivar was Satina and the smallest yield was observed in the Laskara cultivar.

2. The percentage of commercial tubers in individual cultivars was at a similar level. The highest value was observed in the Satina cultivar, followed by the Tajfun and Jelly cultivars, whereas the Laskara cultivar demonstrated the smallest percentage of commercial tubers.

3. The tuber fraction mass in general yield of the 5 potato cultivars was differentiated. Regardless of the cultivar, potato tubers with a diameter of above 60 mm had the largest share in the general yield, whereas tubers with a diameter of below 35 mm – the smallest share.

4. The studies revealed a small percentage of deformed, mechanically damaged, diseased or rotting tubers. A small mass of diseased and rotting tubers was observed in the Jurek cultivar. Other defects, such as internal rust spot, were present in the Laskara and Tajfun cultivars.

5. The individual cultivars under study differed significantly in terms of dry mass content. The highest amount was observed in the Tajfun cultivar and the lowest in Laskara.

6. The edible potato cultivars under study differed in terms of starch content in tubers. The highest starch content was noted in the Tajfun cultivar, and the lowest in Jurek.

7. After 1 h from cutting, the most browning was found in the Satina cultivar, and after 2 h from cutting – in the Jelly cultivar.