Journal of Ecological Engineering
Volume 16, Issue 4, Oct. 2015, pages 176–179
DOI: 10.12911/22998993/59367 *Research Article*

INFLUENCE OF PRECIPITATION AND THERMAL CONDITIONS ON STARCH CONTENT IN POTATO TUBERS FROM MEDIUM-EARLY CULTIVARS GROUP

Katarzyna Rymuza[1], Elżbieta Radzka[1], Tomasz Lenartowicz[2]

[1] University of Natural Sciences and Humanities in Siedlce, Prusa 14, 08-110 Siedlce, Poland, e-mail: katarzyna.rymuza@uph.edu.pl

[2] The Research Centre for Cultivar Testing in Słupia Wielka, 63-022 Słupia Wielka, Poland

Received: 2015.05.15
Accepted: 2015.08.31
Published: 2015.10.01

ABSTRACT
The basis of this elaboration constituted data concerning mean starch content in nine medium-early cultivars of potato grown in six experimental stations belonging to COBORU (Research Centre for Cultivar Testing) in years 2010–2013. Using stepwise regression analysis the influence of thermal and precipitation conditions on starch content in potato cultivars was examined. Such analysis was performed for locations, years and particular cultivars. The analysis showed that starch content in tubers of medium-early potato cultivars depends more on precipitation than on thermal conditions. The relationship between starch content in tubers and precipitation and thermal conditions varied in different stations. In four stations (Karżniczka, Sulejów, Uhnin, Węgrzce) it depended on precipitation noted in August, in two (Uhnin and Słupia) – in July and in other two (Naroczyce and Słupia) – in June. Positive influence of temperature on starch content was noted only in August in Karżniczka. Starch content in tubers of Ametyst and Gawin cultivars depended on precipitation sum in August, Satina cultivar – in July, Oberon cultivar – in June and July, and Cekin, Finezja, Jurek, Stasia and Tajfun cultivars – on precipitation in July and August.

Keywords: medium-early cultivars, potato, precipitation, temperature, starch content.

INTRODUCTION

Chemical composition and value of potato tubers are mainly determined by cultivars features which are modified under the influence of agrotechnology and climate and soil conditions. According to Sawicka et. al. [2011] starch content results most of all from cultivars features. The contrary opinion presents Bombik et. al. [2007] as they claim that starch content to the greatest extent depends on vegetation conditions in particular years. These conditions are formed mainly by temperature and precipitation. Excessive amount of precipitation during the growing season of potato has a negative influence on starch accumulating in tubers [Puła and Sokwera 2004], while drought results in increase of dry matter content as well as decrease in starch content in some cultivars [Boguszewska 2007]. However Zarzecka et. al. [2004] claim that content of this polysaccharide is determined by cultivars and years of study and there is a significant relationship between these two factors.

The aim of this study was to define the influence of precipitation and thermal conditions on starch content formation in medium-early cultivars of potato grown in six different locations in a period of four years.

MATERIALS AND METHODS

Material constituted the results of long-term filed trials (2010–2013) as well as meteorological observations derived from six COBORU stations (Karżniczka, Naroczyce, Słupia, Sulejów, Uhnin and Węgrzce). The experiments were performed in incomplete blocks system. Potatoes were planted in the third decade of April with a spacing of 75 cm and distance between furrows in a

row of 33 cm. They were collected in a period of full maturity. Fertilization was used according to principles of COBORU methodology. During the experiments full plants protection against potato blight, Colorado potato beetle and against weeds was used. Mean starch content in Ametyst, Cekin, Finezja, Gawin, Jurek, Oberon, Satina, Stasia and Tajfun cultivars were obtained as a result of cumulative trial (total from repetitions) collected in each location in subsequent years.

In order to define the influence of precipitation and thermal conditions on starch content in potato tubers grown in the analyzed years, the stepwise regression analysis was calculated. The dependent variable was respectively: locations, years and cultivars, while the independent variables were precipitation and mean air temperature in particular months: X_1 – June temperature, X_2 – July temperature, X_3 – August temperature, X_4– June precipitation, X_5 – July precipitation, X_6 – August precipitation. As a measurement of model fit coefficient of determination was taken. All calculations were performed using STATISTICA 10.0 where $p \leq 0,05$.

RESULTS AND DISCUSSION

Table 1 presents mean monthly air temperature and monthly precipitation sum in each of the locations in years 2010–2013. In the analyzed years mean monthly air temperature in all stations was similar to mean long-term values (1967–2013). Whereas monthly precipitation sums, especially in June and July, in all stations analyzed in years 2010–2013 were significantly higher than sums from multi-year (1967–2013). In all the years in each of the stations, there were noted months with precipitation sum over 100 mm higher than the multi-year sum. It can be said that second part of the growing seasons in the analyzed years was characterized by excessive moisture. Monthly precipitation sums were to a large extent higher than precipitation demands of medium-early cultivars of potato.

On the basis of multiple regression analysis it was stated that in the analyzed stations starch content in tubers of medium-early cultivars of potato depended on different elements according to the station location (Table 2). In Sulejów

Table 1. Mean monthly air temperature and monthly atmospheric precipitation sum at the analyzed stations in 2010–2013

Station	Year	Temperature			Precipitation		
		VI	VII	VIII	VI	VII	VIII
Karżniczka	2010	15.0	19.7	9.7	16	142	173
	2011	16.5	17.7	12.5	75	100	114
	2012	14.7	18	13.3	124	172	84
	2013	15.9	18.2	13.7	52	77	108
Naroczyce	2010	17.0	21.1	18.3	12	41	24
	2011	18.5	17.9	18.7	82	49	122
	2012	16.2	19.5	19	37	107	165
	2013	17.0	20.1	18.6	182	140	59
Słupia	2010	16.9	20.6	18.5	78	169	155
	2011	18.1	17.6	18.3	27	170	71
	2012	17.0	20.5	18.8	100	81	55
	2013	17.3	19.4	18.3	133	86	44
Sulejów	2010	16.9	20.6	18.5	58	87	131
	2011	18.1	17.6	18.3	53	176	85
	2012	17.0	20.5	18.8	69	60	54
	2013	17.3	19.4	18.3	172	35	39
Uhnin	2010	18.2	21.9	20	64	63	141
	2011	18.4	18.7	18.1	117	170	43
	2012	17.5	21.8	18.7	101	53	70
	2013	18.8	19.4	18.8	98	54	7
Węgrzce	2010	17.5	21.1	19.2	167	141	148
	2011	18.3	17.9	19.4	48.9	176.3	60.4
	2012	17.8	20.3	19.1	128	47	33
	2013	18.0	20.3	19.7	229	36	16

and Węgrzce regression equation covered only August precipitation, while in Naroczyce – June precipitation. In Słupia starch content in tubers was determined by June and July precipitation, while in Uhnin – Julu and August. In Karżniczka regression equation covered August temperature and precipitation. Zarzecka et. al. [2004] pointed that dry mass and starch content depends on cultivar and weather conditions, and mutual interaction of these factors can be observed.

Table 3 presents relationship between precipitation and thermal conditions and starch content in tubers of potato grown in particular years. In the year 2010 regression equation covered monthly precipitation sum in July, in 2011 – in June, and in years 2012–2013 August precipitation. Increase in monthly precipitation sum in June of 10 mm caused increase in starch content in tubers of the analyzed cultivars in 2011 of approximately 0,5%. In other years regression coefficient had negative values. According to Roztropowicz [1989]) and Leszczyński [2000] opinion during the years with large amount of precipitation, tubers contain less starch.

Table 2. Multiple regression equations describing relationship between mean temperature and monthly precipitation sums and starch content in tubers of potato grown in particular locations

Location	Multiple regression equation	Coefficient of determination (R^2)
Karżniczka	$y = 16.55+4.3X_3 – 0.04X_6$	0.326
Naroczyce	$y = 11.51+0.03X_4$	0.439
Słupia	$y = 16.54+0.04X_4 -0.05 X_5$	0.817
Sulejów	$y = 18.47 - 0.04X_6$	0.438
Uhnin	$y = 19.80 - 0.02X_5 - 0.03X_6$	0.447
Węgrzce	$y = 18.29 - 0.03X_6$	0.476

Table 3. Multiple regression equations describing relationship between mean temperature and monthly precipitation sums and starch content in tubers of potato grown in particular years

Year	Multiple regression equation	Coefficient of determination (R^2)
2010	$y = 17.32 - 0.04X_5$	0.384
2011	$y = 10.65+0.05X_4$	0.606
2012	$y = 18.45 - 0.04X_6$	0.432
2013	$y = 18.75 - 0.03X_6$	0.384

Table 4. Multiple regression equations describing relationship between mean temperature and monthly precipitation sums and starch content in tubers of potato grown in particular cultivars

Cultivar	Multiple regression equation	Coefficient of determination (R^2)
Ametyst	$y = 18.15 – 0.04X_6$	0.410
Cekin	$y = 20.04 – 0.03X_5 – 0.02X_6$	0.587
Finezja	$y = 20.95 – 0.03X_5 – 0.02X_6$	0.538
Gawin	$y = 19.82 – 0.04X_6$	0.382
Jurek	$y = 17.94 – 0.02X_5 – 0.02X_6$	0.529
Oberon	$y = 13.63 + 0.03X_4 – 0.02X_5$	0.628
Satina	$y = 16.10 – 0.03X_5$	0.302
Stasia	$y = 19.00 – 0.02X_5 – 0.03X_6$	0.623
Tajfun	$y = 20.04 – 0.01X_5 – 0.02X_6$	0.496

Multiple regression analysis describing relationship between monthly precipitation sums and starch content in the analyzed cultivars showed that in all of the analyzed cultivars starch content depended on precipitation during the growing season (Table 4). For Ametyst and Gawin cultivars, regression equations covered only precipitation sums in August, for Satina – in July. Starch content in Oberon cultivar depended on monthly precipitation sum in June and July, while in Cekin, Finezja, Jurek, Stasia and Tajfun cultivars on precipitation in July and August. Kołodziejczyk [2014] proved diverse reaction of cultivars on weather conditions in particular growing seasons in the field of starch gathering.

CONCLUSIONS

1. The analysis performed showed that starch content in tubers of medium-early cultivars of potato depended more on precipitation than thermal conditions.
2. Relationship between starch content in tubers and precipitation and thermal conditions varied in different stations. In four stations (Karżniczka, Sulejów, Uhnin, Węgrzce) it depended on precipitation noted in August, in two (Uhnin and Słupia) – in July, and in other two (Naroczyce i Słupia) in June. Positive influence of temperature on starch content was noted only in August in Karżniczka.
3. In 2010 regression equation covered monthly precipitation sum in July, in 2011 – in June, and in years 2012–2013 – precipitation in August.
4. Starch content in tubers of Ametyst and Gawin cultivars depended on precipitation sum in August, Satina cultivar – in July, Oberon cultivar – in June and July, while Cekin, Finezja, Jurek, Stasia and Tajfun cultivars – on precipitation in July and August.

REFERENCES

1. Boguszewska D., 2007. Wpływ niedoboru wody na zawartość wybranych składników chemicznychw bulwach ziemniaka. Żywn. Nauka Technol. Jakość 5(54), 93–101.
2. Bombik A., Rymuza K., Markowska M., Stankiewicz C., 2007. Variability analysis of selected quantitative characteristics in edible potato varieties. Acta Sci. Pol., Agricultura 6(3), 5–15.
3. Kołodziejczyk M., 2014. Wpływ warunków opadowo-termicznych na skład chemiczny oraz wybrane parametry, jakości bulw średnio późnych i późnych odmian ziemniaka jadalnego. Annales UMCS, sec. E., 3, 1–10.
4. Leszczyński W., 2000. Jakość ziemniaka konsumpcyjnego. Żywność, Nauka, Technol., Jakość., 4(25), 5–27.
5. Puła J., Skowera B., 2004. Zmienność cech jakościowych bulw ziemniaka odmiany Mila uprawianego na glebie lekkiej w zależności od warunków pogodowych. Acta Agrophys. 3(2), 359–366.
6. Roztropowicz S., 1989. Środowiskowe, odmianowe i nawozowe źródła zmienności składu chemicznego bulw ziemniaka. Fragm. Agron., 1(21), 33–75.
7. Sawicka B., Michałek W., Pszczółkowski P., 2011. Uwarunkowania potencjału plonowania średnio późnych i późnych odmian ziemniaka w warunkach środkowo-wschodniej Polski. Biul. IHAR 259, 219–228.
8. Zarzecka K., Antolak M., Pszczółkowski P., 2004. Plonowanie dziesięciu średnio wczesnych odmian ziemniaka w warunkach Podlasia. Zesz Nauk AP, Rol. Siedlce, 65, 59–63.