THE IMPACT OF PRECIPITATION CONDITIONS ON MEDIUM-EARLY CULTIVARS OF POTATO YIELDING

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ABSTRACT

This elaboration was based on yields of nine medium-early cultivars of potato grown in Karżniczka station belonging to COBORU(Research Centre for Cultivar Testing) and on monthly precipitation sums during the growing season (April – August). For each of the cultivars separately in subsequent years and for precipitation sums in particular months of the growing season (IV–VII) polynomial regression models of precipitation – cultivar's yield – were calculated. At the beginning of the growing season the yield of medium-early cultivars of potato was negatively correlated with monthly precipitation sums, while in the final stage of vegetation – this correlation was positive. The lowest yield of Stasia cultivar was noted with monthly precipitation sum of 34–38 mm in April, Tajfun cultivar with May precipitation from 100 to 120 mm, Finezja and Jurek cultivars with monthly June precipitation of 120 mm. Whereas maximum yield of Cekin and Jurek cultivars was noted with August precipitation of about 100 mm.

Keywords: medium-early cultivars, yield, potato, precipitation.

INTRODUCTION

Root crops have high water demands due to long growing season, large amount of biomass produced and weaker root system than in other plants [Dzieżyc et. al. 1987; Nowak 2006a, 2006b; Rębarz and Borówczak 2006; Trawczyński 2009]. The highest impact on potato growth, development and yielding has agronomic treatment as well as the weather, especially the amount and distribution of precipitation [Nowak 2006]. Periods of evident sensitivity to water deficiency for early potato cultivars fall in June and early July [Głuska 2000 and 2004], while for medium-late and late cultivars – in July and first decade of August [Biniak et. al. 2007, Kalbarczyk 2005]. Early cultivars are particularly sensitive to water deficiency due to intensive growth of aerial parts and rapid increase in tuber [Sawicka and Krochmal-Marczak 2005, Dzieżyc et. al. 2012]. The list of cultivars of agricultural plants includes many po-tato cultivars in particular earliness groups. They differ not only in rhythm of development, length of the growing season, but most of all, in utility features. This creates a possibility of their widespread use in practice. Many cultivars in natural way fall out of the register. Their place is taken by the new ones. Both the new and already existing cultivars show different reactions to variable growing conditions [Dmowski et. al. 2004].

The aim of this study was to define the impact of monthly precipitation sums during the growing season on yield of medium-early potato cultivars.

MATERIALS AND METHODS

Material constituted the results of long-term field trials (2010–2013) and meteorological observations coming from Cultivars Assessment Station Karżniczka belonging to CO-BORU. Experiments with medium-early potato

cultivars were performed in incomplete blocks system on the soil of good wheat complex. The surface of the plots was 15 m². 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.

Cultivars selected for the analysis were tested in experiments in all four years of the studies (2010–2013). For each cultivar separately based on yields received from repetitions (plots) in subsequent years and on precipitation sum in particular months of the growing season (IV – VIII) polynomial regression models precipitation – cultivar's yield were calculated. This study includes only these models which in significant way (when p≤0,05) described the above mentioned relations. All the calculations were performed using STATISTICA 10.0.

RESULTS AND DISCUSSION

Yield of medium-early potato cultivars was negatively correlated with monthly precipitation sums at the beginning of the growing season and positively – in the second part of vegetation (Table 1). Yielding of Stasia cultivar was significantly dependent on April precipitation, Satina and Tajfun cultivars – on May precipitation, Finezja and Jurek cultivars – on June precipitation. Increase in monthly precipitation sums in July significantly influenced the increase in yield of Ametyst, Oberon and Stasia cultivars. Whereas increase in yielding of Jurek and Cekin cultivars occurred together with increasing precipitation in August. In the first stages of development, potato plants use water supplies of winter in the soil, therefore, high precipitation in the period from March to May can have negative influence on quality and quantity of the yields. The period of setting the flower budsuntil the end of flowering is a period of increased sensitivity of the plant to water factor [Jakubowski 2007]. It was stated that in May and June there is an excess of precipitation in comparison to water demands of potato across the whole country in the multi-year on average. Mean multi-year precipitation sum in these months in Poland is respectively higher of 15 and 11 mm than the optimal value [Kalbarczyk and Kalbarczyk 2009].

Polynomial regression analysis describing the relationship between monthly precipitation sums and the yield of the analyzed cultivars revealed that yielding of seven out of nine of the analyzed cultivars depended on precipitation during the growing season (Table 2). Regression equations for Ametyst and Oberon cultivars covered only precipitation sums in July, for Satina and Tajfun cultivars – in May and for Finezja – in June. Only for Jurek and Stasia cultivars the equations describing their yielding relationship with precipitation covered precipitation sums of two months. For Jurek cultivar it was June and August precipitation, while for Stasia – April and July.

The lowest yield of Stasia cultivar about 450 dt·ha^{-1} was observed with monthly precipitation sum in April around the level of 34–38 mm (Figure 1). More unfavorable in this month could be the excess of water because it may result in rotting of tubers [Rolbiecki et al. 2009].

Table 1. Correlation coefficients values between monthly precipitation sums and the yield of the analyzed cultivars

Cultivar	Month				
	April	May	June	July	August
Ametyst	-0.109	-0.130	-0.340	0.910*	0.264
Cekin	-0.133	0.164	-0.525	0.502	0.648*
Finezja	-0.381	-0.232	-0.620*	0.348	0.429
Gawin	-0.291	0.111	-0.373	0.321	0.476
Jurek	-0.506	0.0128	-0.596*	0.255	0.595*
Oberon	-0.566	-0.167	-0.362	0.908*	0.253
Satina	0.526	-0.635*	-0.111	0.516	0.244
Stasia	-0.707*	-0.098	0.105	0.637*	-0.115
Tajfun	0.477	-0.889*	-0.367	0.371	-0.345

* correlation significant when p≤0,05.

Table 2. Polynomial regression equations describing the relationship between monthly precipitation sums and yield of the analyzed cultivars

Cultivar	Month	Polynomial regression equation
Ametyst	July	$y = 0{,}01x^2 – 1{,}69x + 635{,}21$
Finezja	June	$y = 0{,}1047x^2 – 25{,}38x + 1713{,}68$
Jurek	June	$y = 0{,}09x^2 – 23{,}56x + 1655{,}8$
	August	$y = –0{,}05x^2 – 11{,}14x + 123{,}52$
Oberon	July	$y = 0{,}01x^2 – 1{,}69x + 635{,}21$
Stasia	April	$y = 1{,}14x^2 – 80{,}92x + 1895{,}60$
	July	$y = 0{,}02x^2 – 4{,}25x + 739{,}96$
Satina	May	$y = 806{,}76 – 3{,}98x$
Tajfun	May	$y = 730{,}09 – 0{,}87x – 0{,}001x^2$

Figure 1. Dependency graph between yielding of Stasia cultivar and mean precipitation sum in April

Yield of Satina cultivar decreased linearly along with an increase in monthly precipitation sums in May (Figure 2). Whereas the lowest yield (about 600 dt·ha^{-1}) of Tajfun cultivar was observed with May precipitation ranging from 100 to 200 mm.

Minimum yield of Finezja and Jurek cultivars (respectively: about 180 dt·ha^{-1} and 250 dt·ha^{-1}) was obtained with monthly precipitation sum in June of 120 mm (Figure 3). When precipitation sums in this month were higher, yield of both cultivars increased.

Low precipitation sums in July: till about 80 mm for Ametyst and Oberon cultivars, and about 100 mm for Stasia cultivar shaped their yielding at a low level (Figure 4). An increase in precipitation sum in this month resulted in gradual increase in yielding of all three cultivars. It was stated that potato responds strongly to moisture conditions improvement [Mazurczyk et. al. 2009, Rolbiecki et. al. 2009, Rzekanowski et. al. 2004, Żarski 2011]. High precipitation demands of potato in July wasestimated from 78 to 120 mm, as observed by Dzieżyc et. al. [1987], Głuska [2004] and Kalbarczyk [2005].

Increase in precipitation sum in August resulted in yielding increase of Cekin and Jurek cultivars (Figure 5). Maximum yield of both cultivars (respectively: about 650 dt·ha^{-1} and 670 dt·ha^{-1}) was noted with precipitation of about 100 mm. Further increase in precipitation resulted in yielding decrease of the analyzed potato cultivars. According to Lutomirska [2005], the final stage of the growing season which is the period of drying of haulm and collecting of tubers is characterized by lower water requirements.
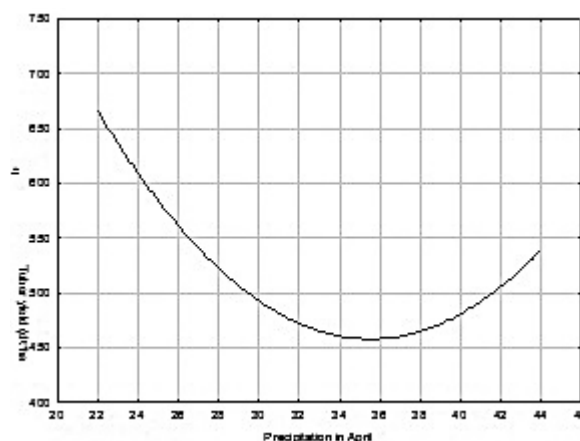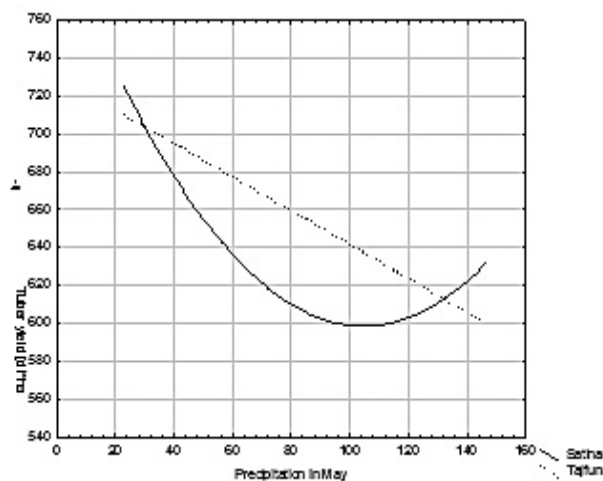

Figure 2. Dependency graph between yielding of Satina and Tajfun cultivars and mean precipitation sum in May
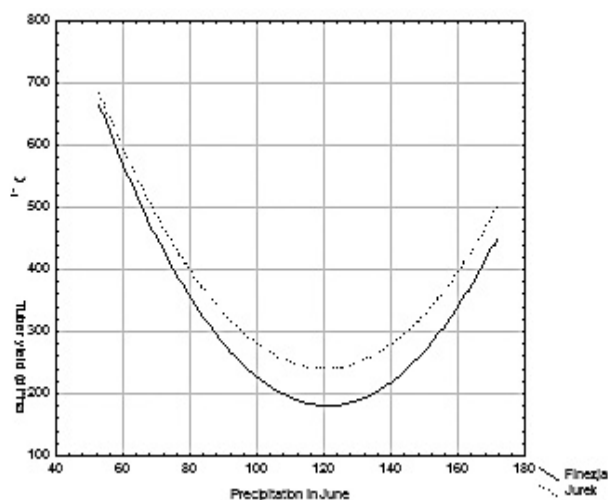

Figure 3. Dependency graph between yielding of Finezja and Jurek cultivars and mean precipitation sum in June
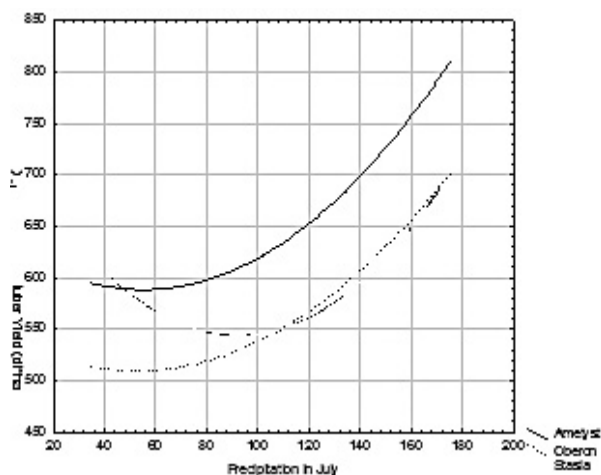
Figure 4. Dependency graph between yielding of Ametyst, Oberon and Stasia cultivars and mean precipitation sum in July
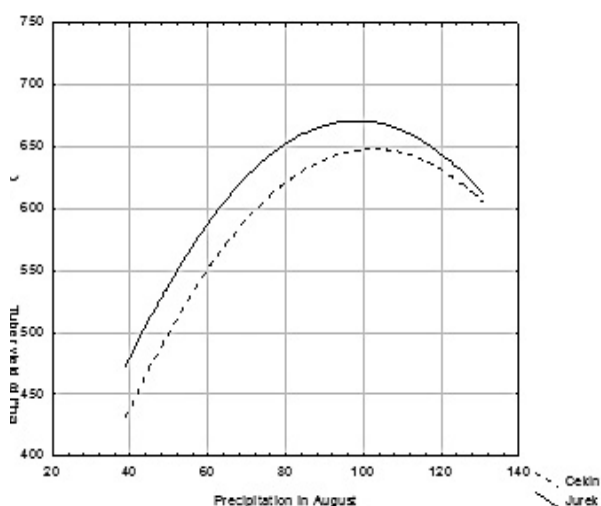

Figure 5..Dependency graph between yielding of Cekin and Jurek cultivars and mean precipitation sum in August

CONCLUSIONS

1. Yield of medium-early potato cultivars was negatively correlated with monthly precipitation sums at the beginning of the growing season, and positively correlated – in the final stage of vegetation.

2. Yielding of Satina and Tajfun cultivars was correlated with May precipitation, of Ametyst and Oberon cultivars – July, and of Jurek and Satina cultivars respectively – June, August and April, July.

3. The lowest yield of Stasia cultivar (about 450 dt·ha⁻¹) was noted with monthly precipitation sum in April of 34–38 mm, Tajfun cultivar

(about 600 dt·ha⁻¹) with May precipitation ranging from 100 to 120 mm, and Finezja and Jurek cultivars (respectively: about 180 dt·ha⁻¹ and 250 dt·ha⁻¹) with monthly precipitation sum in June of 120 mm. Maximum yield of Cekin and Jurek cultivars (respectively: about 650 dt·ha⁻¹ and 670 dt·ha⁻¹) was observed with August precipitation of about 100 mm.

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