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EFFECT OF USING COVERS IN EARLY CROP POTATO CULTURE ON THE CONTENT OF PHOSPHPRUS AND MAGNESIUM IN TUBERS

Wanda Wadas, Romualda Jabłońska-Ceglarek, Agnieszka Kurowska

Department of Vegetable Crops
University of Podlasie

Abstract

Potassium is the main mineral component of potato tubers. With a high level of pota to consumption, the crop also supplies the human organism with magnesium and pho sphorus. The content of mineral components in potato tubers may change as an effect of agro technical factors. The aim of the study was to determine the effect of the type of cover (perforated polyethylene film, polypropylene fibre) and date of its removal (2 and 3 weeks after plant emergence) on phosphorus and magnesium in tubers of early potato cultivars (Aksamitka, Cykada). The potatoes were harvested 60 days after planting. Acce lerated plant growth under covering resulted in the phosphorus content in tubers of cv. Aksamitka being 0.088 g kg^{-1} d.m. higher in comparison with thecontrol, but did not affect the content of magnesium. With perforated film used to cover potato plants, an average content of phosphorus in tubers was by 0.217 g kg^{-1} d.m than when polypropylene fibre cover was applied. The content of magnesium in tubers was on average 0.067 g kg^{-1} d.m. higher under polypropylene fibre cover. Duration of the period when potato plants grew under cover did not significantly affect the phosphorus and magnesium accumulation in tu bers.

Key words: early potato, perforated film, polypropylene fibre, phosphorus, magnesium.

prof. dr hab. Wanda Wadas, Department of Vegetable Crops, University of Podlasie, Prusa 14, 08 110 Siedlce, Poland, wwadas@ap.siedlce.pl

WPŁYW STOSOWANIA OSŁON W UPRAWIE ZIEMNIAKA NA WCZESNY ZBIÓR NA ZAWARTOŚĆ FOSFORU I MAGNEZU W BULWACH

Abstrakt

Głównym składnikiem mineralnym bulw ziemniaka jest potas. Spożywanie ziemniaków pokrywa również częściowo zapotrzebowanie organizmu człowieka na fosfor i magnez. Zawartość składników mineralnych w bulwach ziemniaka może ulegać zmianom pod wpływem czynników agrotechnicznych. Celem badań było określenie wpływu rodzaju osłony (folii perforowanej, włókniny polipropylenowej) i terminu jej zdjęcia (2 i 3 tygodnie po wschodach roślin) na zawartość fosforu i magnezu w bulwach wczesnych odmian ziemniaka (Aksamitka, Cykada). Ziemniaki zbierano po 60 dniach od sadzenia. Przyspieszenie wegetacji roślin przez stosowanie osłon spowodowało zwiększenie zawartości fosforu w bulwach odmiany Aksamitka średnio o 0,088 $g \cdot kg^{-1}$ s.m. w porównaniu z uprawą bez osłaniania roślin, ale nie miało wpływu na gromadzenie w bulwach magnezu. W przypadku stosowania folii perforowanej zawartość fosforu w bulwach była większa, średnio o 0,217 $g \cdot kg^{-1}$ s.m., niż przy stosowaniu włókniny. Większą zawartość magnezu, średnio o 0,067 $g \cdot kg^{-1}$ s.m., stwierdzono po zastosowaniu włókniny. Długość okresu okrycia roślin nie miała wpływu na zawartość obu pierwiastków w bulwach ziemniaka.

Słowa kluczowe: ziemniak wczesny, folia perforowana, włóknina polipropylenowa, fosfor, magnez.

INTRODUCTION

Potato tubers contain over 1% mineral compounds, mainly potassium, in fresh mass. With a high potato consumption in some countries, this crop can also supply the human organism with magnesium and phosphorus. Two hundred grams of potatoes provide 8–15% recommended daily amount of magnesium and 8–12% of phosphorus (KOLASA 1993, LESZCZYŃSKI 2000). The content of mineral components in potato tubers depends on the genetic characters of a cultivar, but may change under climatic and agrotechnical factors (CZEKAŁA, GŁADYSIAK 1995, KLIKOCKA 2001, KOŁODZIEJCZYK, SZMIGIEL 2005).

Until now, studies on the effect of covers used in early crop potato culture on the chemical composition of tubers have focused mostly on organic compounds (LACHMAN et al. 2003, WADAS et al. 2003, 2007, DVOŘÁK et al. 2006). The aim of the present study was to determine the effect of potato plants being covered, for various lengths of time, on phosphorus and magnesium in immature potato tubers.

MATERIAL AND METHODS

The effect of the type of cover (perforated polyethylene foil, polypropylene fibre) and the date of its removal (I – 2 weeks after plant emergence, II

– 3 weeks after plant emergence) on phosphorus and magnesium in tubers of early potato cultivars (Aksamitka, Cykada) was investigated.

The study was carried out in the years 2002–2004 at the Department of Vegetable Crops, University of Podlasie in Siedlce. The field experiment was established in a split-block split-plot design with the control object not covered, on soil characterised by a low to moderate content of available potassium and moderate to high content of phosphorus and magnesium, pH_{KCl} 6.1–6.7. In each year of the study spring triticale was grown as a potato forecrop. Farmyard manure was applied in autumn, at a rate of 30 t ha^{-1}. Mineral fertilizers were applied in spring at the recommended rates of 60 kg N (ammonium nitrate 34%), 26 kg P (60 kg P_2O_5, granular superphosphate 19%) and 75 kg K (90 kg K_2O, potassium sulphate 60%) per 1 ha. In the successive years 8-week pre-sprouted seed potatoes were planted on 9, 16 and 13 April. The potatoes were harvested 60 days after planting. The content of phosphorus with vanadium-molibdenum colorimetric method and magnesium with atomic absorption spectrometry (AAS) method were determined. The analysis of the results was conducted using the orthogonal contrast to compare the control with the test objects.

The most favourable weather conditions for early crop potatoes were in a very warm and wet vegetation period of 2002 (Table 1). The year 2003 was warm but with the whole potato growth season was marked by seasonal drought. In contrast, the year 2004 was the coldest one with the least rainfall from mid-May to mid-June.

Table 1

Mean air temperature and precipitation sums in the vegetation period of potato

Years	Temperature (°C)			Precipitation (mm)		
	April	May	June	April	May	June
2002	9.0	17.0	17.2	12.9	51.3	61.1
2003	7.1	15.6	18.4	13.6	37.2	26.6
2004	8.0	11.7	15.4	35.9	97.0	52.8
Mean 1981–2000	8.1	11.2	16.7	49.6	48.2	67.7

RESULTS AND DISCUSSION

The content of phosphorus in potato tubers ranged from 2.730 to 3.733 g kg^{-1} d.m.; that of magnesium varied from 1.267 to 1.670 g kg^{-1} d.m. (Tables 2 and 3). Irrespective of the potato culture method, most phosphorus and magnesium was accumulated by potato tubers in 2003 and 2004, when drought occurred in the period of tuber formation and growth, which was in contrast to a very warm and wet year 2002. According to CZEKAŁA and

Table 2

Phosphorus content in potato tubers ($g \cdot kg^{-1}$ d.m.)

Years	Cultivar	Control object no covering	Kind and date of cover removal						Mean for covers
			perforated film			polypropylene fibre			
			I	II	mean	I	II	mean	
2002	Aksamitka	2.967	2.967	3.000	2.983	2.767	2.933	2.850	2.917
	Cykada	3.033	2.767	3.100	2.933	2.767	2.730	2.750	2.842
	mean	3.000	2.867	3.050	2.958	2.767	2.832	2.800	2.879
2003	Aksamitka	3.067	3.133	3.300	3.217	2.900	2.867	2.883	3.050
	Cykada	3.100	3.267	3.130	3.200	2.833	2.870	2.850	3.025
	mean	3.083	3.200	3.215	3.208	2.867	2.868	2.867	3.038
2004	Aksamitka	3.133	3.400	3.733	3.567	3.333	3.400	3.367	3.467
	Cykada	3.267	3.633	3.267	3.450	3.467	3.230	3.350	3.400
	mean	3.200	3.516	3.500	3.508	3.400	3.320	3.358	3.433
Mean		3.094	3.194	3.255	3.225	3.011	3.010	3.008	3.117

$LSD_{0.05}$:
years = 0.146
comparison the control object with remaining (contrast) = n.s.
contrast x cultivar = 0.068
kind of cover = 0.159
date of cover removal = n.s.

GŁADYSIAK (1995), phosphorus in potato tubers was negatively correlated with the air temperature prevailing from plant emergence to flowering, while magnesium was reversely correlated with the field water capacity from flowering to the early canopy drying time, the finding which was confirmed in the present study. According to other authors, potato tubers harvested in a wet year contain more magnesium, whereas the accumulation of phosphorus does not depend on meteorological conditions (KOŁODZIEJCZYK, SZMIGIEL 2005).

Stimulating plant growth by using plant covers resulted in increased phosphorus content in tubers of cv. Aksamitka (by 0.088 $g \cdot kg^{-1}$ d.m., on average) in a three-year period in comparison with the cultivation without plant covering, but did not significantly affect the content of this element in tubers of cv. Cykada. The use of covers in the early crop potato culture slightly affected the accumulation of magnesium in tubers. The present study showed a significant affect of the type of cover on phosphorus and magnesium content in tubers. Phosphorus content was higher by an average of 0.217 $g \cdot kg^{-1}$ d.m. over a three-year period when perforated film cover was applied. The content of magnesium content rose by 0.067 $g \cdot kg^{-1}$ d.m. when polypropylene fibre cover was used. Polypropylene fibre plant cover proved to be most effective in enhancing magnesium concentration in tu-

Table 3

Magnesium content in potato tubers ($g \cdot kg^{-1}$ d.m.)

Years	Cultivar	Control object no covering	Kind and date of cover removal						Mean for covers
			perforated film			polypropylene fibre			
			I	II	mean	I	II	mean	
2002	Aksamitka	1.267	1.300	1.167	1.233	1.367	1.367	1.367	1.300
	Cykada	1.333	1.267	1.170	1.217	1.333	1.300	1.317	1.267
	mean	1.300	1.283	1.168	1.225	1.350	1.334	1,342	1.283
2003	Aksamitka	1.533	1.600	1.567	1.583	1.633	1.600	1.617	1.600
	Cykada	1.567	1.567	1.500	1.533	1.533	1.670	1.600	1.567
	mean	1.550	1.583	1.534	1.558	1.583	1.635	1.608	1.583
2004	Aksamitka	1.500	1.500	1.500	1.500	1.500	1.533	1.517	1.508
	Cykada	1.500	1.533	1.400	1.467	1.467	1.570	1.517	1.492
	mean	1.500	1.517	1.450	1.483	1.483	1.552	1.517	1.500
Mean		1.450	1.461	1.384	1.422	1.472	1.507	1.489	1.456

$LSD_{0.05}$:
years = 0.081
comparison the control object with remaining (contrast) = n.s.
kind of cover = 0.028
years x kind of covers = 0.048
date of cover removal = n.s.

bers in the warm and moderately wet vegetation period of the year 2002. With this type of cover, the average magnesium content in tubers was higher by 0.117 $g \cdot kg^{-1}$ d.m. compared to that in tubers grown under perforated film. Polypropylene fibre plant cover also created more favourable conditions for potassium accumulation in tubers (WADAS et al. 2007).

The length of time when potato plants were covered did not significantly affect phosphorus and magnesium accumulation in tubers (Tables 2, 3). Prolongation of the perforated film cover period to 3 weeks after plant emergence raised the phosphorus concentration in tubers but depressed their magnesium content. However, the interaction between the type of cover material and the date when the cover was removed was not statistically confirmed.

The content of phosphorus and magnesium in tubers of very early potato cultivars Aksamitka and Cykada was similar.

CONCLUSIONS

1. Phosphorus and magnesium content in tubers was higher in years with less rainfall in the potato growth season.

2. Plant vegetation being accelerated by application of covering resulted in higher phosphorus content in the tubers of cv. Aksamitka, but had only very weak effect on magnesium.

3. Phosphorus content was higher when perforated film cover was applied; magnesium accumulated best under polypropylene fibre cover.

4. Duration of the period when potato plants grew under cover did not significantly affect the phosphorus and magnesium accumulation in tubers.

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