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EFFECT OF BIOELEMENTS (N, K, Mg) AND LONG-TERM STORAGE OF POTATO TUBERS ON QUANTITATIVE AND QUALITATIVE LOSSES PART I. NATURAL LOSSES

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Abstract

Storage is one of the most important and, at the same time, most difficult stages in potato production and potato economy. During long-term storage, potato tubers are affected by processes leading to quantitative changes. The present three-year field experiment (2003-2005) investigated the effect of varied mineral fertilization (N, K and Mg against the fixed P dose) and storage (3 and 6 months) on the occurrence of quantitative potato tuber losses. The research involved mid-early cultivars: Bila and Triada. The samples were stored in a storage chamber for 3 and 6 months (temperature +4°C, relative humidity 95%). The present research shows that natural losses were affected by all the experimental factors. The K and Mg fertilizer doses significantly decreased the amount of fresh weight losses as compared with the control; as for potassium, the most favourable in that respect was the dose of 160 kg K_2O ha^{-1}, and for magnesium – 60 kg MgO ha^{-1}. Nitrogen fertilization, on the other hand, demonstrated a negative effect on the amount of losses throughout the storage period. The highest fresh weight losses occurred after 6 months of storage and for the nitrogen, potassium and magnesium fertilization experiments they reached 8.9, 6.4 and 7.3%, respectively. The best storage life was reported for cv. Triada potato tubers – potassium fertilization and cv. Bila – magnesium fertilization.

Key words: potato tuber, N, K, Mg fertilization, storage, natural losses.

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WPŁYW BIOPIERWIASTKÓW (N, K, Mg) ORAZ DŁUGOTRWAŁEGO PRZECHOWYWANIA BULW ZIEMNIAKA NA STRATY ILOŚCIOWE I JAKOŚCIOWE Cz. I. UBYTKI NATURALNE

Abstrakt

Przechowywanie należy do najważniejszych, a jednocześnie najtrudniejszych etapów w produkcji i gospodarce ziemniakiem. W okresie długotrwałego składowania w bulwach ziemniaka zachodzą procesy prowadzące do zmian ilościowych. W trzyletnim doświadczeniu polowym (2003-2005) badano wpływ zróżnicowanego nawożenia mineralnego (N, K i Mg na tle stałej dawki P) oraz przechowywania (3 i 6 miesięcy) na kształtowanie się strat ilościowych bulw ziemniaka. Do badań wybrano średnio-wczesne odmiany: Bila i Triada. Próby przechowywano w komorze przechowalniczej przez okres 3 i 6 miesięcy (temp. +4°C, wilgotność względna powietrza 95%). Z badań wynika, że na ubytki naturalne miały wpływ wszystkie czynniki doświadczeń. Zastosowane dawki nawozów K i Mg zmniejszały istotnie ilość ubytków świeżej masy w stosunku do obiektu kontrolnego, przy czym dla potasu najkorzystniejsza w tym zakresie okazała się dawka 160 kg K_2O ha^{-1}, a dla magnezu 60 kg MgO ha^{-1}. Natomiast nawożenie azotowe miało negatywny wpływ na wielkość ubytków w całym okresie przechowywania. Największe ubytki świeżej masy wystąpiły po 6 miesiącach przechowywania i wynosiły w doświadczeniach z nawożeniem azotowym, potasowym i magnezowym odpowiednio: 8,9, 6,4 i 7,3%. Stwierdzono, że najlepszą trwałość przechowalniczą miały bulwy ziemniaka odmiany Triada – nawożone potasem oraz odmiany Bila – nawożone magnezem.

Słowa kluczowe: bulwa ziemniaka, nawożenie N, K, Mg, przechowywanie, ubytki naturalne.

INTRODUCTION

One of the largest segments of the farm produce market in Poland is the production of edible potato. Its importance is confirmed by the continuing high demand for both fresh potatoes and their products, with the potato processing growing all the time. Of the total potato produce, about 95% of potatoes annually are stored from 1 to 9 months (October through June) for various types of use (GĄSIOROWSKA 2000, LESZCZYŃSKI 2000, 2006 LISIŃSKA, SOWA-NIEDZIAŁKOWSKA 2004a). Storage is one of the most important and yet most difficult stages in the production of potato and potato economy. During long-term storage, potato tubers are affected by processes leading to quantitative changes (GĄSIOROWSKA 2000, LESZCZYŃSKI 2000, SOBOL 2005). The magnitude of these changes depends on a number of factors, cultivar-specific ones, agritechnical practice during the vegetation period (mainly mineral fertilization) and the conditions in a storage room (LESZCZYŃSKI 2000, SOWA-NIEDZIAŁKOWSKA 2002, SOWA-NIEDZIAŁKOWSKA, ZGÓRSKA 2005). The amount of losses is also affected by the handling of potatoes throughout storage preparation, such as the elimination of diseased, damaged and soil-covered tubers (CZERKO 2001) since only mature, healthy and mechanically undamaged tubers demonstrate good suitability for long-term storage (SOWA-NIEDZIAŁKOWSKA 2002).

The aim of this study was to determine the effect of varied N, K, Mg mineral fertilization applied during the growing season and the length of a storage period, 3 and 6 months, on the occurrence of natural losses in the selected cultivars of edible potatoes.

MATERIAL AND METHODS

The research material originated from three independent field experiments conducted at the Experimental Station in Mochełek (2003-2005), owned by the Faculty of Agriculture, the University of Technology and Life Sciences in Bydgoszcz (the Kujawy and Pomorze Province).

The experimental design involved:

I. Nitrogen doses (0, 50 and 100 kg N ha^{-1}) in the form of 34% ammonium nitrate against 120 kg ha^{-1} P_2O_5 and 160 kg K_2O ha^{-1}; edible cultivar – cv. Bila (medium early);
II. Doses (0, 80, 160 and 240 kg K_2O ha^{-1}) in the form of 50% potassium sulphate, against 100 kg N ha^{-1} and 120 kg P_2O_5 ha^{-1}; edible cultivar – cv. Triada (medium early);
III. Magnesium doses (0, 20, 40, 60, 80 and 100 kg MgO ha^{-1}) in the form of 26% magnesium sulphate against 100 kg N ha^{-1}, 120 kg P_2O_5 ha^{-1} and 160 kg K_2O ha^{-1}; edible cultivar – cv. Bila (medium early).

In autumn, each year before planting, manure was used in experiments I and II at the amount of 25 t ha^{-1}. No manure was applied in the magnesium experiment (III) so as to attain a clearer view of the plants' response to the magnesium fertilization. In all the years, cereals were the forecrop for potato. Cultivation, weed-control and plant protection treatments were carried out in accordance with the requirements of the best agritechnical practice, adjusted to the actual weather conditions and potato development stages.

The samples were kept in a storage chamber for 3 and 6 months (temperature +4°C, relative humidity 95%). After storage, the loss of fresh weight, i.e. natural losses, was determined.The results of the 3-year research were statistically verified using the Sigma Stat software (SPSS Inc., Chicago, the U.S.) and Tukey's test to verify the significance of differences.

RESULTS AND DISCUSSION

Reduction in the initial weight of potato tubers, the so-called natural losses, occurs in all storage conditions, and consequently brings about a reduction of marketable yield and economic losses. The loss of weight depends on many factors interacting with one another, both during the growth

of plants (fertilization) and storage (storage time, temperature, relative humidity and air gas composition) (LESZCZYŃSKI 2000, SOWA-NIEDZIAŁKOWSKA, ZGÓRSKA 2005). The present results support these relationships since both the mineral fertilization (N, K, Mg) applied during the growing season and the time of storage had a significant impact on fresh weight losses of the tubers stored (Figures 1,2,3). The longer the storage, the greater the natural losses, and the process is fully justified as resulting from physiological changes characteristic for plant products. The present research demonstrated that the highest fresh weight losses occurred after 6 months of storage, and for the nitrogen, potassium and magnesium fertilization experiments, they accounted for, respectively: 8.9, 6.4, 7.3% (means for the years and fertilization levels). Similar results were reported by GĄSIOROWSKA (2000) who noted that the longer the tuber storage, the higher the losses; and after 9 months the losses were nearly four times higher compared to a period of 3 months.

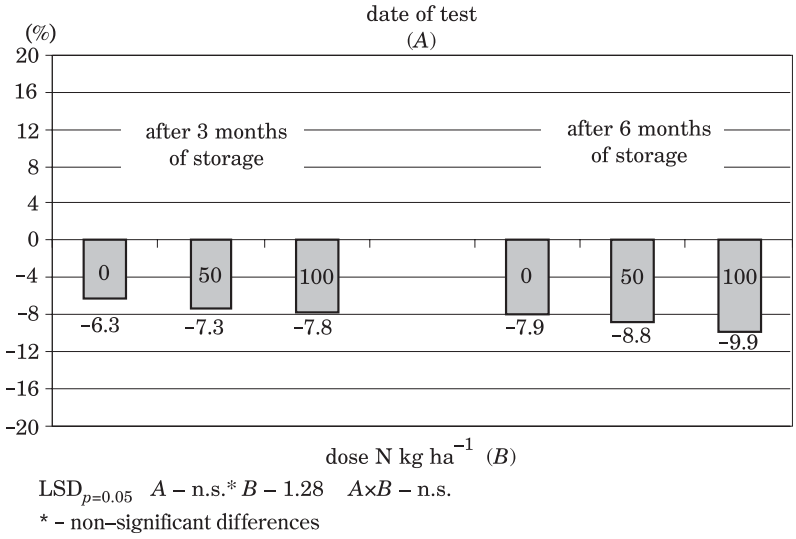
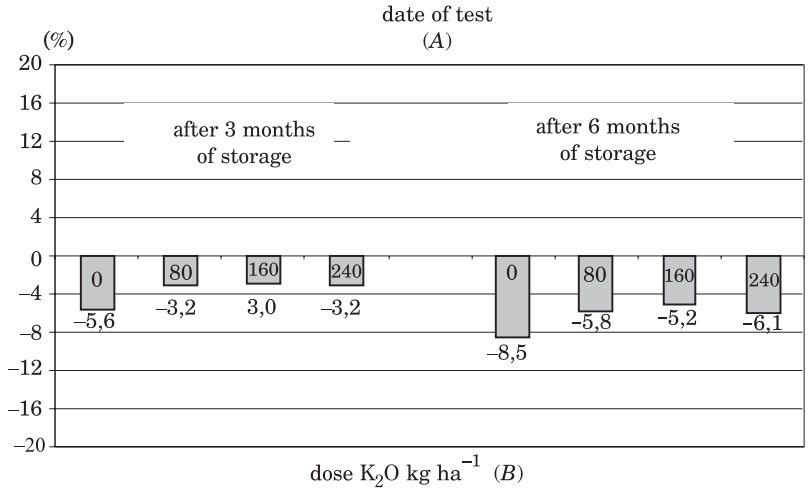


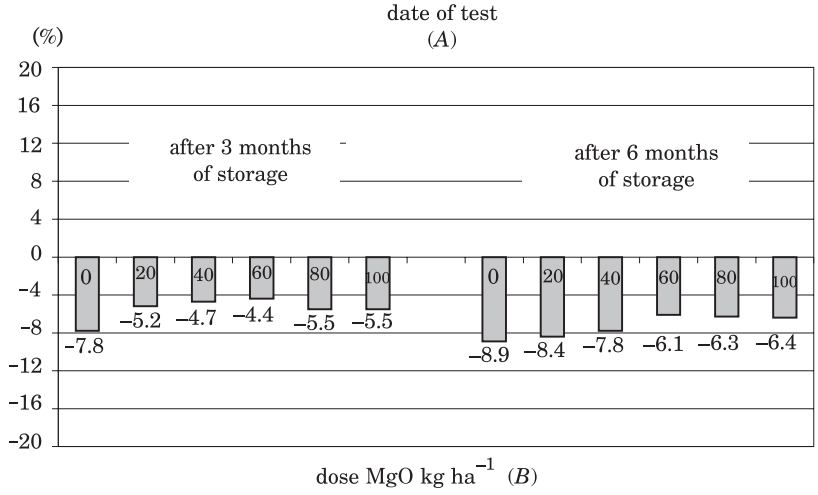
Fig. 1. Loss of fresh weight (%) of cv. Bila potatoes, depending on nitrogen fertilization and date of test (mean from 3 years)

In the potassium and magnesium fertilization experiments, the highest fresh tuber weight losses were observed for control treatments both after 3 and after 6 months of storage (Figures 2,3). The fertilizer doses applied significantly decreased the amount of fresh weight losses compared with the control; as for potassium, the most favourable in that respect was the dose of 160 kg K_2O ha^{-1}, and for magnesium it was 60 kg MgO ha^{-1}. Reduction in the losses both after 3 and 6 months of storage, versus the control, by applying the above most favourable doses, accounted for 2.6 and 3.3% for potassium and 3.4 and 2.8% for magnesium, respectively. A positive effect



$LSD_{p=0.5}$ A – 1.26, B – 0.67, $A \times B$ – 0.95

Fig. 2. Loss of fresh weight (%) of cv. Triada potatoes, depending on potassium fertilization and date of analysis (mean from 3 years)



$LSD_{p=0.5}$ A – 42, B – 1.08, $A \times B$ – 1.53

Fig. 3. Loss of fresh weight (%) of cv. Bila potatoes, depending on magnesium fertilization and date of test (mean from 3 years)

of magnesium on limiting natural losses was also reported by CIEĆKO et al. (2001) or ROGOZIŃSKA and JAWORSKI (2001), who noted that it was the dose of 40 kg MgO ha^{-1} which appeared significantly favourable.

A positive effect of potassium on limiting the quantitative losses, which coincides with the results of the present research, is reported by e.g. JABŁOŃSKI (2000, 2001), ROGOZIŃSKA, JAWORSKI (2001). CIEĆKO et al. (2001), on the other hand, when testing the same potassium doses as in the present research but different potato cultivar and storage conditions, did not identify any significant effect of that factor on the amount of storage losses.

In the experiment where varied nitrogen fertilization was applied, an opposite effect was recorded (Figure 1), since each of the doses increased the losses during storage as compared with the control. Irrespective of the storage time, maximum losses were reported at the dose of 100 kg N ha^{-1}. A negative effect of nitrogen fertilisation on the storage life of tubers was also demonstrated in other research (GĄSIOROWSKA 2000, JABŁOŃSKI 2006a,b, ROGOZIŃSKA et al. 2002); it has been unanimously stated that nitrogen can lead to specific difficulties when storing potatoes, mainly delayed tuber ripening over the vegetation period and their increased susceptibility to storage diseases. Different results were reported by JABŁOŃSKI (2006a,b), who demonstrated that levels of nitrogen fertilization (60 and 90 kg N ha^{-1}) did not have any significant effect on natural losses after 6 months of tuber storage in a storage room (under optimal conditions); the average amount of losses reported did not exceed 7% irrespective of the cultivar and was almost the same as in the present research.

According to SOWA-NIEDZIAŁKOWSKA (2004b) and JABŁOŃSKI (2004, 2006a,b), the cultivars in which the losses after a long-term storage period, irrespective of the affecting factors, do not exceed 12% are considered to be the material of good storage life, while the fresh weight losses exceeding 10 % deteriorate the quality and result in an excessive loss of tuber turgor. The selection of cultivars is very important since, under the same conditions, much more commercial 'produce' of higher quality with lower financial outlays can be obtained from cultivars well surviving storage. The cultivars selected for the present research, Triada and Bila, demonstrated good storage life since fresh weight losses for those cultivars, irrespective of the factors analyzed, did not exceed 12% (Figures 1,2,3). SOWA-NIEDZIAŁKOWSKA (2004b) stresses that each increase in natural losses, even by a single per cent, results not only in financial losses for the producer but also in worse quality of the tubers stored, and good quality is what the customer (the consumer, food industry) is interested in.

CONCLUSIONS

1. Magnesium (60 kg MgO ha^{-1}) and potassium (160 kg K_2O ha^{-1}) fertilization applied to potato growing limits the losses of fresh weight of potato tubers during storage, contrary to nitrogen fertilisation.

2. The best storage life was demonstrated for cv. Triada potato tubers, fertilized with potassium, and cv. Bila – fertilized with magnesium.

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