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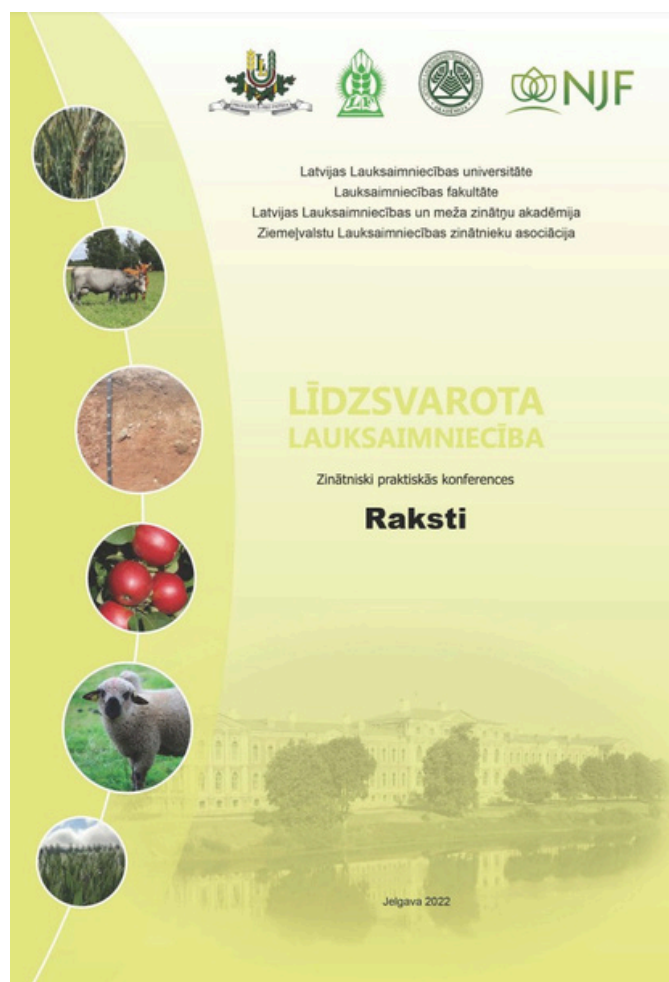


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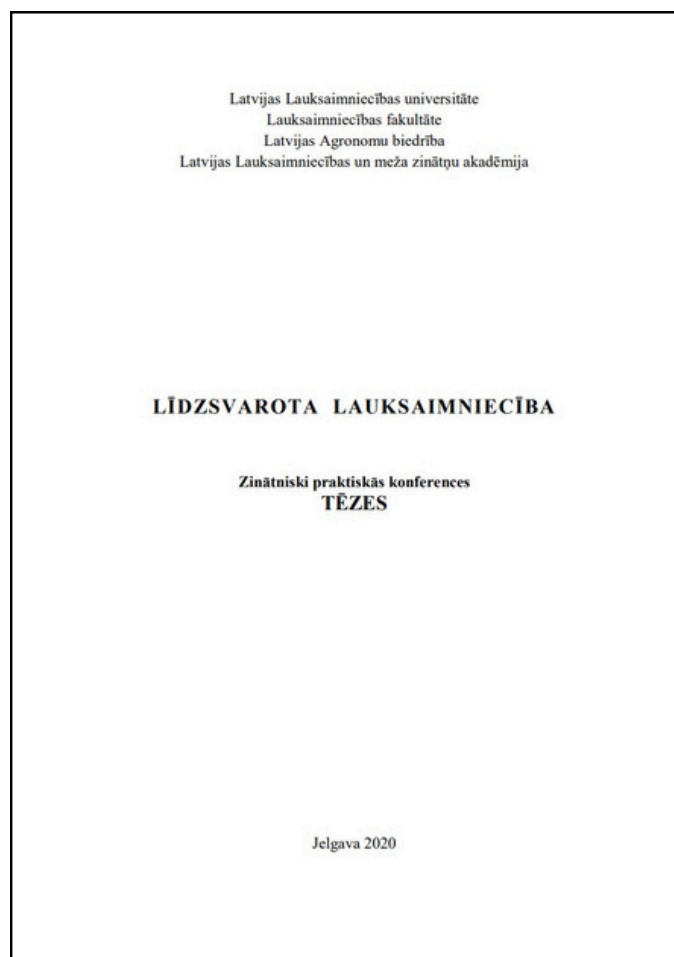
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Exploring the Relationship between Nitrogen Use Efficiency and Protein Concentrations in Potato Genotypes

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Abstract

This two-year study assessed nitrogen use efficiency (NUE) and its effect on potato tuber protein concentration, focusing on crude protein concentration (CPC), crude protein yield (CPY), and patatin relative abundance (PRA) across 19 potato genotypes and four nitrogen management treatments (organic with no added fertilizers and three integrated treatments with N rates of 60, 120, and 180 kg ha^{−1}). Nitrogen availability significantly affected CPC, with the highest average CPC across genotypes being 10.7% at 180 kg ha^{−1} and the lowest of 8.15% at 60 kg ha^{−1}. Certain genotypes consistently outperformed others in terms of CPC and/or CPY under varying nitrogen treatments. A significant negative correlation was found between CPC and NUE, and genotypes with higher NUE typically had lower CPC. A positive correlation between CPY and NUE was observed, with the highest CPY of 1.36 t ha^{−1} at 120 kg N ha^{−1} in 2020. This suggests that higher NUE genotypes are more efficient in protein production per unit area. PRA varied significantly among genotypes, ranging from 8.7% to 35.51%. Although the relationship between NUE and PRA was weak, the significant and negative correlation indicates that cultivars with high NUE could have low PRA and vice versa. The findings underscore the importance of genotype variability in the relationship between NUE and protein content in potato tubers.

Keywords: potato tuber quality; protein; patatin; nitrogen use efficiency

1. Introduction

Potato (*Solanum tuberosum* L.) is a key global food crop that provides substantial amounts of carbohydrates, vitamins, and minerals to the diets of the increasing world population. Notably, it is also a source of high-quality protein that contains all the essential amino acids [1,2]. Potato proteins are characterized by high nutritional and functional value and hypoallergenic properties. The high solubility and emulsifying, gelling, and foaming properties of potato protein make it suitable for successful application as a novel product [2].

Potato plants require an abundant nitrogen (N) supply, which is often provided via the application of fertilizers [3]. In many high-intensity agricultural systems, a significant portion of the nitrogen (N) applied to fields, ranging from 50% to 75%, remains unutilized by plants. This excess nitrogen is primarily lost through leaching into soil and aquatic systems and through the release of gaseous emissions into the atmosphere [4,5]. In farming techniques that strive to reduce environmental impacts, advanced nutrient (including N) management practices aim to balance increased yields with minimized environmental contamination risks. NUE efficiency decreases with increasing N input [6]. Moreover, nitrogen-efficient genotypes use nitrogen more effectively, which can enable reduced nitrogen fertilizer application while maintaining or even improving yield [7]. This can contribute to sustainable potato production and minimize the environmental impacts associated with nitrogen fertilizer use [8]. Physiological and molecular mechanisms are involved in N uptake, transport, assimilation, and utilization in potato plants. The efficacy of nitrogen use can vary among different potato cultivars due to genetic differences [9,10]. A complex network of genes is associated with nitrogen use efficiency. Genetic studies have identified candidate genes for improving nitrogen use efficiency (NUE) in potato plants [10,11,12]. The availability of nitrogen affects the expression of genes involved in various processes related to nitrogen metabolism and uptake in different potato cultivars [13]. Despite the identification of candidate genes, the successful development of genotypes with improved NUE has been limited by complex genetic and environmental factors and the various physiological processes involved in the interactions underlying nitrogen utilization in plants [6,14]. Generally, late maturing potato varieties exhibit higher NUE [9,15]; however, this is only valid if the growing season is sufficiently long [6].

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 **Keywords** potato tuber quality; protein; patatin; nitrogen use efficiency

The Efficiency of Using Alternative Fertilizers in Potato Plantations

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Abstract. Field trials with the two potato variety were carried out in sod stagnogley soil. Soil agrochemical parameters: pH_{KCl} 6.7 organic matter (OV) content in soil 2.3%, phosphorus (P_2O_5) content - 149 mg kg^{-1} and potassium (K_2O) content - 200 mg kg^{-1} in soil. Potato plantations were created using different variants of fertilizer mix with pig (from SIA "Latvi Dan Agro") and cattle (from SIA "Ziedi JP") manure digestate and wood ash (from SIA "Gren Jelgava") in different ratio (digestate : wood ash ratio used: 4:1 and 3:1). The rates of innovative mixed fertilizer for pig and cattle manure digestates for potatoes were 15 and 30 t ha^{-1} . Both norms for digestate manure from pure pigs and cattle were used as control options. The potato production norm was 3.0 t ha^{-1} . The placement of the variants in the trial was randomized, in triplicate. In the study, the two types of fertilizer had different effects on potato tuber yield. Using mixtures of pig manure digestate and wood ash in different ratios, the average yield was 34.2 t ha^{-1} , but using mixtures of cattle manure digestate and wood ash, the average yield was 27.8 t ha^{-1} . In the studied variants, its content in potato dry matter varied in the range of 9.15-11.42%. The amount of dry matter affects the culinary properties of the tubers. The application of fertilizer mixtures increased the dry matter content by an average of 1.7-2.7%. Fertilizer variants with higher tuber yield or higher starch content provided the highest starch yield. In general, the use of mixtures of wood ash and biogas digestate to fertilize crops and improve soil fertility can be an efficient way to process both products and can be an environmentally friendly alternative to fertilizers. The objective of the research was to study the influence of digestate and wood ash mixtures fertilizer rates on potato productivity and quality.

Keywords: digestate, fertilizer mix, potatoes, wood ash.

1. INTRODUCTION

Potatoes are one of the most important agricultural crops and are rightly called the second bread. In the world,

in terms of cultivated areas, they occupy one of the first places along with rice, wheat and corn.

According to the literature, potato tubers contain on average 76-78% water and 13 to 36% dry matter, with 12-15% starch, 1-3% protein and about 1% minerals. Potato protein has a very high biological value because it contains an essential amino acid complex that is not synthesized in humans and animals and must be obtained from food or feed.

As a result of the operation of biogas and biomass cogeneration plants, production by-products are obtained - digestate and ash. It is a good source of plant nutrients because it contains many trace elements and macroelements important for plant growth, so digestate can be used as an effective fertilizer for crops [1], [2]. The physical and chemical properties of ash can vary significantly depending on the plant species, plant growth conditions, parts of the plant used for combustion, parameters of the combustion process and storage conditions [3]. Ash contains a variety of minerals that make it a valuable source of plant nutrients. They contain various macronutrients and microelements important for plant growth and development, with the exception of nitrogen, which is released into the atmosphere by flue gases during combustion [4], [5].

Studies have shown a positive effect of ash on soil properties, structure and water regime in the soil [3]. Ash fertilizer increased the amount of phosphorus, potassium, calcium and magnesium used in plants in the soil [5]. A decrease in nitrogen concentration in the upper soil layers and an increase in soil pH after ash application have been observed. They can be used to improve soil fertility, crop yields and crop quality. However, the use of both products separately can cause certain environmental problems. To prevent this, at least in part, the idea arose to mix digestate

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Potatoes as wheat flour substitute in gluten-free pastry cream

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Abstract. Pastry cream contains wheat flour, which is not suitable for celiac patients who require a gluten-free diet. Potatoes are known as a good source of starch, minerals and vitamins. They also contain protein, dietary fibre and various phytochemicals. Their addition to pastry cream can both serve as a texturising agent and enrich the nutritional value of the final product. This study aimed to evaluate the suitability of potatoes as a replacement for wheat flour in pastry cream. For study purposes, the physicochemical attributes of eleven potato varieties were evaluated. Among other varieties, the boiled potato variety Gala exhibited higher fibre, fat, phosphorus and potassium content; however, significantly higher protein (12.48 ± 0.08 g 100 g⁻¹ DW) and iron (3.12 ± 0.02 g 100 g⁻¹ DW) content. Higher antiradical activity (18.72 ± 0.74 mM TE 100⁻¹ g DW) was detected in potatoes of the variety Blue Congo. After preliminary investigation, wheat flour was replaced with mashed potatoes, making up 30% of the cream weight, and its impact on the pastry cream was studied. It was established that potatoes had a significant effect on pastry cream colour and texture. American Rose, Imanta, Rigonda and Viviana were selected as the most suitable from the eleven varieties tested. The addition of potatoes in pastry cream doubled its fibre and potassium content, whereas, other changes in nutritional value of the creams were variety dependent.

Key words: potato variety, cream textural properties, nutritional value, phenolic compounds, antioxidant activity.

Introduction

Potatoes (*Solanum tuberosum* L.) were introduced to Europe in the 16th century, and since then they have been bred to produce heat- and cold-tolerant potatoes and increase the content of biologically active compounds (Skrabule & Bebre, 2013). Nowadays, the potato is the fourth most widely consumed crop in the world after rice, wheat and maize, with a biodiversity of around 5,000 varieties (Burlingame *et al.*, 2009; Zhou *et al.*, 2019). It has been reported that potatoes are an important source of various nutrients, such as starch, proteins, dietary fibre, minerals and vitamins. After cooking, the starch becomes more rapidly digestible and is quickly absorbed in the human body, which can be explained by its hydrolyses (Singh *et al.*, 2020). In addition, potatoes contain phenolic compounds and other phytochemicals possessing antioxidant activity. According to Yang *et al.* (2016), the total content of phenols, including pigments, may decrease, remain the same or even increase in potatoes

upon processing. Some phenolic compounds may be degraded by heating or extracted into cooking water (Fang *et al.*, 2022a).

Potato components have been reported to have various health benefits (Tian *et al.*, 2016). Therefore, potatoes are used in preparation of various dishes through boiling and frying (Dong *et al.*, 2021), used as colorants in the drinks industry (Sampaio *et al.*, 2021), for food packaging (Wang *et al.*, 2022), and as an additive to enrich other foods such as steamed bread (Cao *et al.*, 2020). Nevertheless, some adverse effects should be noted. Rapidly digested starch of cooked potatoes may cause increased glucose levels, presence of glycoalkaloids and allergy causing proteins that are deemed unfavourable for human health (Tian *et al.*, 2016).

Traditionally, pastry cream is an oil-in-water emulsion. Liquids (water, milk) form the continuous phase. Sweeteners (sugar), fats, gelling agents and other ingredients are also used in the formulation of

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Keywords

potato variety, cream textural properties, nutritional value, phenolic compounds, antioxidant activity

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The effect of nitrogen use efficiency on significant traits of potato starch production

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Abstract

The improvement of nitrogen use efficiency (NUE) in potato (*Solanum tuberosum* L.) can reduce the required N input. As a result, economic benefits will increase, and environmental pollution will decrease due to N loss. The aim of the study was to determine the NUE of potato genotypes and to evaluate the relationship of NUE with the tuber yield, starch yield, and starch content at different N fertiliser rates. During a two-year experiment, the performance of 19 potato genotypes was evaluated by different farming practices involving the varying levels of N fertiliser rates. These practices included the integrated farming (IF) system with three different N fertiliser rates and the organic farming (OF) system without N fertilisation. The N fertilisation in both farming systems was stated as plant-available N in soil and as N added with a fertiliser. A significant effect of the genotype and the farming system on the tested traits was determined. The potato genotype tuber yield correlation with NUE was high or moderate in the farming system with different N fertiliser rates in both years. The tuber yield of potato grown in the farming system with a comparatively higher N fertilisation usually did not increase significantly; therefore, a decrease in genotype NUE was detected. The correlation between starch yield and NUE was high and strong in both farming systems, although high and moderately strong correlation was determined between tuber yield and starch yield. NUE had a weak correlation with the starch content in potato tubers, so genotype characteristics and growing conditions had the greatest influence on this trait. An increase in N fertilisation did not lead to an increase in starch yield due to a decrease in starch content and a slight insignificant increase in tuber yield. However, genotypes with higher NUE produced a higher tuber yield and starch yield than genotypes with relatively lower NUE, even in the farming systems with different N fertiliser rates in both experimental years.

Keywords: *Solanum tuberosum*, nitrogen use efficiency, starch content in tubers, starch yield, tuber yield.

Introduction

Potato (*Solanum tuberosum* L.) is known as the third most important food crop in the world according to Q. Dongyu, Director-General of the Food and Agriculture Organization of the United Nations (FAO) at the World Potato Congress 2022 (WPC, 2022). Potato tubers are rich in antioxidants, vitamins, essential amino acids, and important minerals in addition to a high amount of carbohydrates such as starch and sugars (Van Dingenen et al., 2019).

Potato requires a large amount of nitrogen (N) during the formation of yield, and there are several sources of N: soil organic matter, plant residues from previous years, atmospheric depositions, N accumulated

by fixing bacteria, and synthetic N fertilisers (Haverkort et al., 2003). High N fertilisation combined with a shallow potato root system can lead to leaching of nitrates and contamination of the surrounding environment (Milburn et al., 1990; Sharifi, Zebarth, 2006).

The fundamental goal of crop production is to optimise high nutrient efficiency in crops. One way to limit N usage is the breeding of N use-efficient potato cultivars. Improvement of nitrogen use efficiency (NUE) in potato genotypes can reduce the N requirements. As a result, economic benefits will be increased, and environmental pollution due to nitrate loss will be reduced (Getahun et al., 2020; Stefaniak et al., 2021). One of the important

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Solanum tuberosum, nitrogen use efficiency, starch content in tubers, starch yield, tuber yield

THE IMPACTS OF NITROGEN USE EFFICIENCY OF POTATO GENOTYPES ON ENVIRONMENTALLY FRIENDLY RAW MATERIAL PRODUCTION FOR STARCH PROCESSING

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Potato starch production in Latvia is increasing as demand for this product is growing due to the outstanding properties of potato starch, such as superior water binding capacity, good clarity and neutral flavour. The production of raw material using varieties with improved nitrogen use efficiency (NUE) is essential for optimal farming systems to reduce environmental pollution. The aim of this study was to detect the NUE of genotypes and to evaluate the impact of NUE on starch content in tubers (SC), tuber yield (TY) and starch yield (SY). The production of potato was evaluated in organic and integrated farming with three different nitrogen supplies over two years. The NUE of genotypes was estimated as the tuber dry matter yield per available nitrogen. The genotype impact on TY as partitioning of variance components (PVC) was 24 and 34% in all environments in 2020 and 2021, respectively. SC was mostly determined by genotype and PVC was 83 and 84% in 2020 and 2021, respectively. The impact of genotype on NUE was only 29 and 20% (PVC in 2020 and 2021), respectively. The relationship between TY and SC was not significant ($p>0.05$) in both years, and NUE and SC correlated insignificantly ($p>0.05$), with some exceptions. The correlation of SC and SY was significant ($p<0.5$) and positive. NUE correlated positively and significantly with TY and SY. In conclusion, the raw material for potato starch processing was determined by TY, and SY was determined by SC. The higher NUE provided an increase in TY and SY but did not influence SC.

Keywords: potato, nitrogen use efficiency, starch content, starch yield, tuber yield

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Keywords potato, nitrogen use efficiency, starch content, starch yield, tuber yield

**POTATO CULTIVARS WITH ELEVATED PROTEIN CONTENT –
PROMISING SOURCE OF NOVEL FOOD**

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Potato proteins are considered to be one of the most valuable plant origin foods for human consumption. One of the largest groups of potato proteins is patatine, which has high potential to be used in the food industry as a novel food with foaming and emulsifying properties and good health benefits. Since patatine content is strongly dependent on cultivar, it could be used in potato breeding programmes to create potato cultivars with elevated content to develop new products. Potato genotypes were evaluated by pure protein and patatine content in four management systems with different nitrogen (N) supplies for two years.

The results of this study showed that crude protein in tubers of different genotypes varied from 4.69 to 16.17% D. Pure protein varied from 3.5% to 8.31% DW. Patatin relative abundance (PTA) ranged from 1.65% to 50.8% of the pure protein. The highest PTA was found for cultivars 'Verdi' (36.9–50.8%), 'Rigonda' (21.9–23%), 'Lenora' (19.3–27.4%), 'Brasla' (19.1–27.6%), and 'Imanta' (22.5–30.2%). The PTA of these cultivars exceeded the average of the tested (19) genotypes in both years of the study, although the difference between the harvest years was significant ($p < 0.05$). The plant available nitrogen amount in soil did not affect PRA significantly ($p > 0.05$).

Keywords: protein, patatine, health benefits, potato genotypes

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Sterna V., Sokolova E., Taskova I., Skrabule I., Dimante I. **Potato cultivars with elevated protein content – promising source of novel food.** In: *FoodBalt 2023: 16th Baltic conference on Food Science and Technology "Traditional Meets Non-Traditional in Future Food"*: abstract book, Jelgava, Latvia, May 11-12, 2023. Latvia University of Life Sciences and Technologies. Faculty of Food Technology. Jelgava, 2023, p. 95.



Keywords protein, patatine, health benefits, potato genotypes

THE EFFECTS OF AN INNOVATIVE DIGESTATE AND WOOD ASH MIXTURE FERTILIZER ON POTATO YIELD QUALITY

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Abstract

Field trials with the potato variety ‘Rigonda’ were carried out in a sod stagnogley soil. Soil agrochemical parameters were: pH_{KCl} 5.9, organic matter content – 2.3%, phosphorus (P₂O₅) content – 149 mg kg⁻¹, and potassium (K₂O) content – 200 mg kg⁻¹. Potato plots were established using different treatments of a fertilizer mixture consisting of pig and cattle manure digestate and woodchip ash in different ratios (digestate to wood ash = 4:1 and 3:1). The doses of the innovative mixed fertilizer for potato were 15 and 30 t ha⁻¹. Both norms of the digestate from pure pig and cattle manure were used as control options. The experimental design was an RCB with three replications. Crude protein content in potato dry matter varied from 8.28% to 10.94%. The application of fertilizer mixtures increased the dry matter content by 1.4–2.0%, reaching an average of 21%. Fertilizer treatments which produced higher tuber yields or higher starch contents gave also higher starch yields. In our studies, the average starch content in potato tubers dry matter was 73.3% and 15.3% in a fresh potato tuber, but the average starch yield reached 3.55 t ha⁻¹. The objective of the research was to study the influence of the rates of the digestate and wood ash mixture fertilizer on the quality of potato yield.

Keywords: *digestate, wood ash, fertilizer, potato, yield quality.*

Introduction

Potato is one of the most important agricultural crops and is rightly called “the second bread”. In the world, in terms of cultivated areas, the potato crop occupies one of the first places along with rice, wheat and corn (reference). According to the literature, potato tubers contain on average 76–78% water, 13–36% dry matter, 12–15% starch, 1–3% protein, and approximately 1% minerals (reference). Potato protein has a very high biological value, because it contains an essential amino acid complex which is not synthesized in humans and animals and should be obtained from food or feed. As a result of the operation of biogas and biomass cogeneration plants, the production by-products digestate and ash are obtained. They are a good source of plant nutrients as they contain many trace elements and macroelements important for plant growth; therefore, digestate and ash can be used as an effective fertilizer for crops (Koszel and Lorencowicz, 2015; Risberg, *et al.*, 2017). The physical and chemical properties of ash can vary significantly depending on plant species, plant growth conditions, parts of the plant used for combustion, parameters of the combustion process, and storage conditions (Demeyer, Nkana, Verloo, 2001). Ash contains a variety of minerals that make it a valuable source of plant nutrients. Also, they contain various macronutrients and microelements important for plant growth and development, with the exception of nitrogen which is released into the atmosphere by flue gases during combustion (Patterson *et al.*, 2004; Fuzesi *et al.*, 2015).

Adamovičs A., Antipova L. The effects of an innovative digestate and wood ash mixture fertilizer on potato yield quality. In: *XIII International Scientific Agricultural Symposium "Agrosym 2022"*: virtual conferences book of proceedings, Jahorina, Bosnia and Herzegovina, 6-9 October, 2022. University of East Sarajevo, Faculty of Agriculture. Jahorina, 2022, p. 250-255.

 **Keywords** digestate, wood ash, fertilizer, potato, yield quality

INVESTIGATION OF ENERGY AND PERFORMANCE INDICATORS OF POTATO DIGGER WORK WITH EXPERIMENTAL DIGGING-SEPARATING OPERATING PART

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Abstract. Potato harvesting is the most labor-intensive technological process in the potato production, which accounts for 45...60% of the total labor costs. When working in difficult conditions, the potato harvesters have insufficiently high quality indicators, low reliability and high energy performance. The purpose of this work is to determine the energy and performance indicators of a two-row potato digger-loader KKN-2 with an experimental V-shaped heap distributor. The test conditions were typical for heavy soils, the soil hardness in the tuber layer was up to 3.0 MPa. The performance indicators were determined at operating speeds of 3.2...4.8 km·h⁻¹. The obtained dependences of the traction resistance upon the forward speed of the potato harvester for the basic and the modernized machines show that at the speeds above 3.55 km·h⁻¹ the resistance of the modernized machine is lower. This can be explained by a better separation of the heap and, as a result, a decrease in its total mass, which is in the cleaning system. The use of the proposed combined digging-separating operating part in the technological scheme of the potato harvester provides higher operational and energy performance: it increases the productivity by 0.16 ha·h⁻¹ and reduces the specific fuel consumption by 4.1 kg·ha⁻¹.

Key words: potatoes, harvesting, separation, resistance, tubers.

Introduction

Potatoes are an important agricultural crop that is widely distributed in many countries [1-2]. The peculiarity of potatoes, used for food purposes, is the relatively high possibility to damage the tubers during harvesting. On the other hand, the need for long-term storage (six months or more) requires that the damage to the tubers should be minimal [3-4].

Analysis of the labor costs in the technological process of the potato production shows that harvesting accounts for 45-60% of the total costs [5]. The significant labour intensity of harvesting potatoes is due to the fact that the tubers are in the soil layer and therefore can be harvested most reliably and completely only when using the harvesting principle, which is based on digging a potato bed with the subsequent separation of tubers from the soil impurities. This determines the complexity and high energy intensity of the process since, when digging a potato bed, into the potato harvester every second about 100 kg of the tuberous mass (1-1.5 thousand tons per each hectare) come from one linear meter of the bed. In this mass, the tubers make only 2-3%. However, the difficulty of obtaining tubers clean without the impurities of soil in the container is determined not only by the need to sift a significant amount of soil but also by some of its unfavorable properties that appear during harvesting.

The main indicators that characterize the quality of combine harvesters are damage to the tubers, the completeness of harvesting and the cleanliness of the tubers in the bunker (container) [6]. According to agricultural requirements [3] a modern potato harvester must collect at least 97% of the potato crop into the bunker, the losses of all kinds should not exceed 3% (but not more than 6 centn·ha⁻¹). The purity of the tubers in the bunker (container) must be at least 80%. Damage to the tubers due to the operation of the combine harvester on light, medium and stone-contaminated soils should not exceed 10%, and on waterlogged heavy soils – up to 5%. The efficiency of the modern potato harvesters should be at least 0.15 ha·h⁻¹ per one row of the crop [7].

Separation of a layer of the dug-up heap is the main operation of the technological process of harvesting [5]. High-performance and high-quality operation of potato harvesters depends mainly on the solution of the problem how to increase the efficiency of the heap separation [1, 8]. Experimental studies [9] have shown that the intensification of the separation process utilizing uniform distribution of the heap across the width of the elevator web can improve the quality of the results seen in the use of the

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Keywords potatoes, harvesting, separation, resistance, tubers

EXPERIMENTAL RESEARCH OF QUALITY INDICATORS OF OPERATION OF NEW POTATO HARVESTER

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Abstract. Potato harvesting is a labor-intensive and energy-intensive operation in the production of this crop. Therefore, the development of new and improvement of the existing potato harvesters, which will have higher quality harvesting indicators, is an important task for agricultural production. We have developed a new 2-row potato harvester with an improved cleaning system from soil and vegetable admixtures. The purpose of this research was to determine a rational design and technological parameters of the potato harvester that ensure high quality indicators of potato harvesting. To determine rational parameters of the distributor, the influence of the parameters of the distributor upon the content of impurities in the potato heap with soil impurities was studied. The criterion for evaluating the impact of these parameters upon the quality of the machine was taken as the indicator of contamination of tubers with the soil and plant impurities, which is defined as the ratio of the mass of soil elements in the heap to the total mass of the heap at the outlet of the potato harvester. The established graphic dependencies also made it possible to choose rational design parameters of the V-shaped potato heap distributor. On the basis of experimental investigations a mathematical model of the influence of the design parameters of the distributor upon contamination of the tubers with the soil admixtures was obtained, and the area of rational values of the parameters of the distributor, which were determined theoretically, was confirmed. These parameters of the distributor reduce contamination of the heap on the sorting table of the potato harvester to 11.41%.

Key words: potatoes, harvesting, experiment, cleaning, quality.

Introduction

Potato is an important agricultural crop, used for food and industrial purposes. Harvesting potatoes is one of the most labor-intensive and energy-intensive operations in the technology of growing this valuable agricultural crop [1]. A lot of research has been devoted to the improvement of potato harvesters, but this topic is still relevant. This is because of different soil and climatic conditions for the cultivation of potatoes, different sizes of areas in farms, financial opportunities, etc.[2-4]. Despite the availability of perfect kinds of machines, most of the potatoes are harvested with relatively simple machines. In particular, under the conditions of Ukraine potato harvesters KKU-2A are widely used.

These serial machines have a number of shortcomings in the quality of harvesting and damage to the tubers. One of the most important components of the potato harvester that affects the quality of harvesting are the digging-separating mechanisms, which take on them a layer of soil with tubers, remove the soil admixtures, leaves and weeds, and separate clean tubers. The task of obtaining clean tubers with minimal damage on soils that are heavy by their mechanical composition is very urgent and can provide a significant economic effect. Experimental studies [3] have shown that the intensification of the separation process utilizing uniform distribution of the heap across the width of the elevator web can improve the quality of the results seen in the use of the potato harvester.

To solve the problem of improving the technological process of distributing heaps across the width of the conveyor, we have developed a new 2-row potato harvester with an improved system for separating soil and plant impurities [5-6].

The purpose of the research is to determine the optimal design and technological parameters of the potato harvester, providing the best indicators of the quality of the technological process.

Materials and methods

On the basis of theoretical investigations and analysis of previous experimental studies [6-7], a field experimental setup was created for further experimental study of the combined digging-separating

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Keywords potatoes, harvesting, experiment, cleaning, quality

EXPERIMENTAL STUDIES OF IMPROVED POTATO DIGGER KRK-2 WITH V-SHAPED HEAP DISTRIBUTOR

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Abstract. Potato harvesting is a labor-intensive technological process that affects the losses of production and the degree of cleaning the tubers. We have improved the design of the KRK-2 potato digger with a V-shaped heap distributor. The purpose of this work was to find the influence of a V-shaped heap distributor upon the quality indicators of harvesting, and to determine rational design and technological parameters. On the basis of the developed methodology experimental dependences of the influence of the parameters of the distributor upon the contamination of the potato heap and damage to the tubers were obtained. By the results of these calculations it was found that the gap between the conveyor and the distributor has the greatest influence upon the weediness of the heap. To a less degree this process is influenced by the distance of the bar drums to the distributor and the opening angle of the distributor wing. The parameters of the distributor significantly affect the intensity of the process of separating the soil impurities from the potato heap since, when varying the variable parameters, the weediness value changes 7.6 times. It was determined that the minimum value of the soil content index will be at a distance $L = 0.55-0.6$ m. When the distances L are reduced, the soil content increases because, due to the small distance, a heap accumulates in front of the distributor, which leads to deterioration of the distribution process of the heap across the width of the conveyor.

Key words: potatoes, harvesting, separation, cleaning quality, damage.

Introduction

Potatoes are a widespread agricultural crop, used for food and industrial purposes. The most complicated and time-consuming operation in the production of potatoes is their harvesting [1-2]. In many cases the harvesting process is complicated by high humidity and the heavy soil texture (for example, loamy soils). The investigations, carried out in various countries to improve the potato harvesting machines, are aimed primarily at improving the quality indicators of cleaning the potato tubers and reducing their damage [3-4].

The problem of improvement is somewhat complicated by the fact that there is a wide variety of potato harvesters (they are produced in almost every country) and each of the machines has advantages in certain soil and climatic conditions, as well as disadvantages. The problem how to improve the quality indicators of the performance of the potato harvesters is a topic of research of many scientists [5-7]. In particular, there was studied the influence upon the degree of cleaning of the tubers of the distance between the slats of the conveyor, the magnitude of the vibration of the support rollers of the conveyor, the angle of inclination, and other parameters. However, the impact of distribution of potatoes along the width of the conveyor upon many design solutions of machines has not been studied fully enough.

Experimental studies [8] have shown that the intensification of the separation process utilizing uniform distribution of the heap across the width of the elevator web can improve the quality of the results seen in the use of the potato harvester.

We have improved the design of the KRK-2 potato digger by supplementing it with a V-shaped heap distributor) [9], which provides a more uniform distribution of the mass of soil with potatoes along the width of the conveyor. However, such a design needs optimization of the existing set parameters.

The aim of this work was to study the influence of the V-shaped heap distributor upon the quality indicators of harvesting, and to determine its rational design and technological parameters when installed on the KRK-2 potato digger.

Bulgakov V., Ivanovs S., Santoro F., Adamchuk V., Ruzhylo Z., Ihnatiev Y., Kaminska V. **Experimental studies of improved potato digger KRK-2 with V-shaped heap distributor.** In: *21st International Scientific Conference "Engineering for Rural Development"*: proceedings, Jelgava, Latvia, May 25-27, 2022. Latvia University of Life Sciences and Technologies. Faculty of Engineering. Jelgava, 2022. Vol. 21, p. 708-713.



Keywords potatoes, harvesting, separation, cleaning quality, damage

High Microplant Densities in Greenhouses – Are they Always Efficient in Small Potato Minituber Production Systems?

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 303 Accesses [Explore all metrics](#) →

Abstract

Four microplant planting densities (PD) for greenhouse production of minitubers of three varieties were used to assess the agronomic and economic efficiencies of increased PD compared to the baseline density (63 microplants m^{-2}). The field performance of minitubers was also included in the agronomic (yield formation) efficiency assessment of minitubers production. The concept of a field value (FV) of greenhouse area and of microplant was introduced. Economic assessment of PD changes was based on partial budget analysis and the marginal rate of return between PDs in ascending order. Agronomic efficiency assessment, as an efficient utilization of greenhouse space, revealed that the number of minitubers per m^2 increased gradually with increasing PD and the magnitude of the increase was up to 2.6 times between PD 63 and 184 microplants m^{-2} making this PD the most effective of the studied. The change in minituber number per microplant due to the increased PDs was closely related to the economic efficiency assessment. In the baseline scenario (microplant cost of 0.54 € and minituber cost of 0.41 €), only the shift from PD63 to PD95 was efficient without trade-offs for only one of three varieties.

Resumen

Se usaron cuatro densidades de siembra de microplantas (DP) para la producción en invernadero de minituberculos de tres variedades para evaluar las eficiencias agronómicas y económicas del aumento de la DP en comparación con la densidad normal (63

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Dimante I., Gaile Z., Cerina S., Proskina L. **High microplant densities in greenhouses – are they always efficient in small potato minituber production systems?** *American Journal of Potato Research*, Vol. 99(1), 2022, p. 243-257.



Keywords multiplication rate, seed potato, minitubers, partial budget

Research of the Possibilities to Improve the Quality of Potatoes Harvesting by Including an Experimental Heap Leveler-Distributor in the Design of Harvesting Machines



2022

Semjons Ivanovs, Volodymyr Bulgakov, Simone Pascuzzi , Valerii Adamchuk, Viktor Kornuchin, Zinovii Ruzhylo, Oleksandra Trokhaniak, Janusz Nowak, Zbigniew Kiernicki, Francesco Santoro , and Oksana Bulgakova

Abstract Improving the quality indicators of the operation of potato harvesters under difficult soil and climatic conditions is an urgent scientific and practical task. The paper reflects a research of the impact upon the quality of operation of two kinds of potato diggers of an experimental design for additional levelling of a heap (mass of soil, potato tubers, plant residues, etc.) on the conveyor. This device evenly distributes the potato heap along the plane of the main rod elevator, improves the separation conditions, reduces the total loss of tubers from 2.5 to 0.8%, that is, 3.1 times. A rational mode of operation of the digger has been determined, which, under these conditions, provides acceptable values for the losses and damage to the tubers.

Keywords Potatoes · Harvesting · Tuber purity · Damage · Additional devices

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Keywords additional devices, damage, harvesting, potatoes, tuber purity

PARAMETERS USED FOR THE EVALUATION OF POTATO (*SOLANUM TUBEROSUM* L.) NITROGEN USE EFFICIENCY: A REVIEW

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Abstract

Potato is one of the important crops worldwide, and cultivation requires a lot of resources and nitrogen (N) to ensure yield. This kind of growing technology can cause environmental pollution. It is necessary to optimize the management and use of potatoes with high nitrogen use efficiency (NUE) varieties as an alternative to the application of large amounts of fertilizers to improve the environmental impact of potato production without affecting yield and quality. The aim of this review is to find various morphological and physiological characteristics of the potato crop that can be used in potato breeding for NUE evaluation and to create new varieties with high NUE. Looking for traits such as yield, protein and starch content, each variety has its limits that can be affected by climatic conditions. Area Under Canopy Cover Progress Curve (AUCPC) is potentially good for detecting NUE in field conditions. Nitrogen-efficient genotypes tend to have early canopy development but a low amount of N in tubers. Due to different factors that can interact with genotypes under field conditions, the experiments in controlled conditions as *in vitro* system can be used for the investigation of genotypes in a short period. Under *in vitro* conditions, root development can be observed very well, which can usually be impossible in soil experiments.

Key words: morphological parameters, *in vitro*, yield, protein, starch.

Introduction

Potato (*Solanum tuberosum* L.) is known to be the third most important crop in the world by production and the fifth by consumption (Haverkort & Struik, 2015; Devaux, Kromann, & Ortiz, 2014). According to Van Dingenen *et al.* (2019), potato tubers are a great source of starch, antioxidants, vitamins, essential amino acids, and important minerals. Historically, potato production in Latvia has been one of the most important branches of agriculture. Since 2000, the potato growing areas decreased by 33 thousand hectares and potato production has taken a downward turn by 370 thousand tonnes. To ensure potato cultivation at the same level as now, extending the potato growing area or increasing the yield is necessary (Ministry of Agriculture, 2021). The potato requires abundant nitrogen (N) (Haverkort, 2018). Most of the N in the soil is partly available for plants (Zebarth & Rossen 2007). Large N fertilization input, combined with the shallow root system of potatoes (Iwama, 2008), can result in nitrate leaching and subsequent contamination of groundwater (Frink, Waggoner, & Ausubel, 1999; Milburn *et al.*, 1990; Sharifi & Zebarth, 2006), and atmosphere through gaseous emissions (Hirel *et al.*, 2007). European legislation (Nitrate Directive (91/676/EEC) and Water Framework Directive (2000/60/EC)) has established limits on the N input in crop production in Europe (Vos, 2009). Still, directives have struggled with the low support of farmers as well as various conflicts between environmental and income support objectives (Hasler *et al.*, 2022). New potato varieties with improved nitrogen use efficiency (NUE) will reduce the environmental impact of potato production without affecting yield and quality (Vos, 2009), will be acceptable for environmentally

friendly farming systems and be beneficial to improve nutrient management. The aim of this review is to find various morphological and physiological traits of the potato crop that can be used in potato breeding for NUE evaluation in order to create new varieties with improved NUE.

Materials and Methods

The semi-systematic monographic method was used to analyse and summarise the main information on potato NUE and traits that could possibly be implemented as an alternative for NUE evaluation. NUE is considered as potatoes' ability to use uptake N in the development of canopy cover, protein and starch content, and yield.

Results and Discussion

Many crops, including potato, have high genetic variation, making breeding of NUE practical (Lammerts van Bueren 2010; Lammerts van Bueren *et al.*, 2014). Unfortunately, when it comes to potatoes breeding strategies towards NUE, there is lack of information (Lammerts van Buren & Struik, 2017). Various quality traits such as tuber starch content, tuber protein content, tuber yield, and tuber size distribution are affected by the available N amount (Zebarth *et al.*, 2004). Weather conditions need to be considered as well (Vos, 2009). Cohan *et al.* (2018) explained how the variation of results can be determined by Nitrogen × Environmental interaction.

Nitrogen Use Efficiency

Potato varieties with improved NUE will perform well under high and low N availability (Ospina *et al.*, 2014). Various definitions of NUE have been described, but it may differ in various crops (Fageria

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Keywords morphological parameters, in vitro, yield, protein, starch



Research Article

Potato variety essential traits and their stability for organic starch production

Ilze Skrabule, Ilze Dimante, Aide Tsahkna, Terje Tahtjarv & Lasma Rabante-Hane

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ABSTRACT

In organic production of potatoes for processing into starch, it is essential to obtain high and stable starch yields, as determined by the yield of tubers and the content of starch in the tubers. The stability of these traits in potato varieties is especially important in variable environments affected by soil properties and climatic conditions. Pre-sprouting of the seed tubers before planting can accelerate plant development and promote acceptable starch yields in a shorter growing period. This study evaluated traits of seven potato varieties important for organic starch production, assessed trait stability in different environments and determined the effect of seed tuber pre-sprouting on plant development and stability parameters. Significant effects of genotype, growing environment, and their interactions on tuber yield, starch yield and starch content of the tubers were observed. No significant effects were found of seed tuber pre-sprouting on the performance of the tested traits. Four trait stability evaluation methods were applied to tuber yield, starch yield and starch content, including a modified Kang's yield-stability approach, and these showed inconsistent results. The modified Kang's stability rating could be further used for determination of the best performing varieties, with high values for the essential traits and relatively high stability for each individual trait.

KEYWORDS: Organic farming, potato, pre-sprouting, starch yield, tuber yield, trait stability

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Disclosure statement

No potential conflict of interest was reported by the author(s).

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Keywords

Organic farming; potato; pre-sprouting; starch yield; trait stability; tuber yield

EFFECT OF STORAGE CONDITIONS ON BIOLOGICALLY ACTIVE COMPOUNDS IN PURPLE-FLESHED POTATOES

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Communicated by Tatjana Ķince

*Potatoes (*Solanum tuberosum* L.) are an important crop. They are a source of natural phenolic compounds with high biological activity. Stress factors may decrease phenolic concentration and increase concentration of the toxin glycoalkaloid as a result of plant self-protection against stress. The aim of the current study was to evaluate the effect of storage under light on the concentration of biologically active compounds in purple-fleshed potatoes. The purple-fleshed potato variety 'Blue Congo' was harvested from test fields of the Institute of Agricultural Resources and Economics in Latvia. Storage under light was performed in a climate chamber ICH110 (Mettler GmbH + Co. KG, Germany) with constant pre-set relative air humidity 85%, temperature +22 °C, and full-spectrum light (Eecoo, 1200 W, LED) intensity of 2000 lux and total time seven days. Total phenolic concentration, antioxidant activity and total glycoalkaloid concentration was measured using spectrophotometry, and moisture was determined according to standard LVS 272:2000. Storage under artificial light of purple-fleshed variety 'Blue Congo' potatoes caused decrease of total phenolic concentration and antioxidant activity, no change in moisture level, and increase of total glycoalkaloid concentration.*

Keywords: *Blue Congo potatoes, phenolic compounds, glycoalkaloids, antioxidant activity, storage under light.*

INTRODUCTION

Nowadays there is a growing trend in the use of food with higher levels of natural antioxidants (Kumar *et al.*, 2015). Potato (*Solanum tuberosum* L.) production has increased tremendously in developing countries in the past two decades (Paul *et al.*, 2012). They are rich in phenolics, a biologically active compound that has proven positive influence on human wellbeing (Akyol *et al.*, 2016), and are source of phenolic compounds. They are ranked as the third consumed crop (Paul *et al.*, 2012). Phenolic compounds have antioxidant, antibacterial, anticarcinogenic, anti-inflammatory, antiglycemic, antiviral, and vasodilatory effects (Berghe, 2012; Kazeem *et al.*, 2012; Konaté *et al.*, 2012), and a positive effect on human longevity, ocular organs, mental health, and the cardiovascular system (Manach *et al.*, 2004; Scalbert *et al.*, 2005). Positive correlation between phenolic concentration and total antioxidant activity in potatoes has been found (Andre *et al.*, 2007). Phenolics

are found in the whole tuber, but the peels have highest saturation of phenolics (Lewis *et al.*, 1999; Nara *et al.*, 2006). They are present in all potato varieties, but the phenolic amount almost double in purple-fleshed (also red-fleshed) varieties compared to white-fleshed and yellow-fleshed varieties (Ezekiel *et al.*, 2013). This difference in the amount of phenolic compounds might be explained by anthocyanins, which are the main colour pigments in purple-fleshed potatoes (Im *et al.*, 2008; Al-Weshahy and Rao, 2009).

In addition to nutritional compounds, potatoes contain also glycoalkaloids, which are natural toxins. Glycoalkaloid build-up is caused by natural and human caused stress factors (Papathanasiou *et al.*, 1999). The major glycoalkaloids in potatoes are α -solanine and α -chaconine (Friedman, Levin, 2009; Omayio *et al.*, 2016). The World Health Organisation reported that the safe level of glycoalkaloids in fresh potato tubers is from 20 to 100 mg·kg⁻¹ (Evaluation of

Zariņš R., Krūma Z., Skrabule I. **Effect of storage conditions on biologically active compounds in purple-fleshed potatoes.** *Proceedings of the Latvian Academy of Sciences. Section B. Natural, Exact and Applied Sciences*, Vol. 76(1), 2022, p. 83-88.



Keywords

Blue Congo potatoes, phenolic compounds, glycoalkaloids, antioxidant activity, storage under light



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Evaluation of patatin content in proteins of potato genotypes grown in Latvia

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Abstract. Potato proteins contains essential amino acids in considerably high concentration, therefore potatoes are considered to be one of the most valuable plant origin food for human consumption. Patatin forms one of the largest group of potato proteins with high potential to be used in food industry as a novel food. This study has been performed to approbate patatin determination method for evaluation of protein quality of potato genotypes, as well as evaluate patatin relative abundance (PRA) for breeding programmes to create in the future potato cultivars with higher value and potential to develop new products.

The evaluation of patatin was performed in following steps– extraction proteins from potato, determination of patatin concentration and calculation of its relative abundance in proteins. Separation of patatin from potato tubers was made using extraction by SDS extraction buffer and determination of patatin in organically and conventionally (with different N supply) grown samples of 20 potato genotypes. The results of one-year study showed that patatin relative abundance of different cultivars varied from 1.65% to 50.2% and it was significantly different among genotypes. The nitrogen content of soil and maturity type of potato did not affect PRA significantly. Results provide impetus for further research.

Key words: patatin relative abundance, potato genotypes, chip electrophoresis.

Introduction

One of the world's major and important crop grown in temperate zone and in other geographic territories is potato (*Solanum tuberosum* L.). Due to the growing population, climate changes and following deficiency of food, new and effective use of grown crop is the main challenge for coming years. Potatoes are commonly used in many countries as one of the main food crop, in which protein is the second major component after carbohydrates — (Bárta et al., 2012). Study of five potato varieties bred and grown in Latvia had shown that the protein content of the tubers before storage ranged from 1.3 to 2.0% of fresh weight (Murniece et al., 2011). Potato protein has great biological value even higher than soybean (Camire et al., 2009). Patatin, protease inhibitors and high molecular weight proteins are the three major groups of potato soluble proteins (Pots et al., 1999). The major component of potato protein is patatin, which makes about 40% of the potato soluble protein. Patatin belongs to group of glycoproteins within the range of molecular weight 40 to 45 kDa (Kärenlampi & White, 2009). Most recent studies show,

that patatin is not only a storage protein, but it has much more functional meaning such as enzymatic activity and it takes a part in potato defence regulation. — (Barta & Bartova, 2008; Bartova et al., 2013). In review by Waglay et al. (2016) it is said that as plant origin protein patatin has high nutritional benefit which is equal to an egg albumen and have considerable emulsifying properties, better than soy proteins.

Patatin as a novel food has good prospects in food industry, where apart as foaming and emulsifying agent it could be used as gel former. During the past years, researchers are exploring the benefit of patatin on health and found several properties such as antioxidant, ACE-inhibitory, anti-inflammatory and anticancer activities. Patatin stimulating glucose uptake and inhibiting neuropeptides (Camire et al., 2009; Fu et al., 2020). Thereby further research directions could be selection of cultivars with improved nutritional quality of potato proteins.

To date, isolation of potato proteins had been performed in several ways. Main studies for industrial purposes are based on different protein isolation methods from potato tuber juice. The potato tuber juice is a side stream and

Berga D., Sterna V., Sokolova E., Taskova I., Seile S., Dimante I., Skrabule I. **Evaluation of patatin content in proteins of potato genotypes grown in Latvia.** No: *Rural Sustainability Research*. Scientific Journal of Latvia University of Life Sciences and Technologies. Warsaw: De Gruyter Open. No. 46, 2021, p. 125-132.



Keywords patatin relative abundance, potato genotypes, chip electrophoresis

THEORETICAL INVESTIGATION OF ROTARY DIGGING TOOL PARAMETERS FOR POTATO TUBERS

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Abstract. The development, design and research of the parameters of new potato harvesters is an important and urgent task in the field of potato production. The aim of this research is to substantiate rational design and kinematic parameters of the lower and the upper blades of the beaters of the vertical rotor of a potato harvester by determining the velocities of collision of the blades with the tuberous layer of their most characteristic points. Theoretical investigations have been carried out, and then, using the calculations on a PC, graphical dependencies of the main parameters of the process under study were constructed. The values of absolute velocities of collision of the lower and upper blades of the vertical rotor beaters, respectively, at the initial and final points with the tuberous layer of the soil, were determined. The values of the absolute velocities of collision of the lower and the upper blades of the vertical rotor blades were determined, respectively, at the initial and final points with the tuberous layer of the soil. Rational kinematic parameters of the lower and the upper blades of the vertical rotor beaters are calculated, respectively, at the initial and the final points, where the greatest destruction of the tuberous layer occurs. For the lower blade of the beater, the absolute collision speed at the angle of rotation $\omega_{\text{rot}} = 120^\circ$ at the starting point is $V_{\text{sp}}^{\text{a}} = 1.69 \text{ m}\cdot\text{s}^{-1}$, at the end point – $V_{\text{sp}}^{\text{a}} = 1.94 \text{ m}\cdot\text{s}^{-1}$. For the upper blade of the beater, the absolute speed of collision at a turning angle $\omega_{\text{rot}} = 120^\circ$ at the starting point is $V_{\text{sp}}^{\text{b}} = 1.63 \text{ m}\cdot\text{s}^{-1}$, at the end point – $V_{\text{sp}}^{\text{b}} = 1.92 \text{ m}\cdot\text{s}^{-1}$. The angular velocity of the rotational motion of the upper and the lower rotor blades was equal to $\omega = 10.46 \text{ s}^{-1}$.

Keywords: potatoes, digging, rotor, blade, turnability, lumps.

Introduction

Potatoes are an important food and industrial crop [1; 2]. Potato production is an important agricultural sector in many countries, including Ukraine, Poland and the Baltic countries [3; 4].

Harvesting potatoes is one of the most complex and energy-intensive technological operations in their production, the quality of which largely depends on the labour intensity of further processing operations and the duration of storage of the resulting product [5-7]. Unlike many other crops, for harvesting potatoes it is necessary to dig in and raise a layer of soil, significant in volume and mass, and separate the tubers from it with a purity of at least 80% and a degree of damage of no more than 3% [8]. One of the main directions how to improve the harvesting quality of potatoes is the operation of cutting out a whole potato bed and its further destruction. During digging the potato bed and transporting it to the separating tools the tuberous layer is subjected to a static and dynamic action of the lump-grinding tools, as a result of which the formed lumps of soil with potato tubers are destroyed. The most widespread use on modern potato harvesters for crushing lumps of a potato bed is the dynamic impact of working tools.

We have developed a new two-row trailed potato harvester, which implements the above principle of the tuber harvesting, i.e. unloading of two adjacent potato beds, their destruction with the help of vertical rotor beater blades. In this case, the beater consists of the lower and the upper blades, mounted together with a drive reducer on a vertical rotor, located in the inter-row spacing. The driven planetary gearbox ensures opposite directions of the rotary movements of the lower and the upper blades with the same angular velocities. A structural and technological diagram of the potato harvester is shown in Fig 1. The technological process of digging potatoes out of the soil takes place in this way. Rollers 1 copy two adjacent potato rows and deform them under the impact of their weight. Further, the vertical rotor 2, which actually performs the functions of a digging tool, moving in the inter-row spacing, due to the upper and lower blades of the beater, destroys the soil layer of the inter-row spacing, as well as the layer containing the potato tubers from both rows, and efficiently destroys it. Besides, the two lower blades of the beater form a conical shape, i.e. they are fixed on the drive shaft obliquely; and the surface, formed

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Theoretical investigation of rotary digging tool parameters for potato tubers. In: *20th International Scientific Conference "Engineering for Rural Development"*: proceedings, Jelgava, Latvia, May 26-28, 2021. Latvia University of Life Sciences and Technologies. Faculty of Engineering. Jelgava, 2021. Vol. 20, p. 1781-1788.



Keywords potatoes, digging, rotor, blade, turnability, lumps

CROP QUALITY ASPECTS OF POTATO VARIETIES AND BREEDING CLONES IN ORGANIC FARMING SYSTEMS

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One of the indicators of quality is the starch content of the tubers. In order to evaluate the starch content for each genotype, the Institute of Agricultural Resources and Economics had set up a field trial in organic crop production system with 10 potato varieties and 10 breeding clones. A field trial was carried out in 2018-2020. The aim of the study was to evaluate and select potato varieties and clones with high starch content in the organic farming system.

The results proved impact of meteorological conditions on the starch content in the potato tubers. Starch content of varieties and clones varied from 12.68% to 20.63% on average in 3 years, significant impact of genotypes and years were observed ($p < 0.05$). The highest starch content was found in 2019 for the variety 'Kuras' (21.32%) and for clones 19922.29 (21.0%) and 2008-6.5 (21.11%), also the following year these clones had a high starch content of (20.9%) and (21.17%), respectively. The high starch content in 2020 was also for the early varieties 'Monta' and 'Rigonda', 'Prelma' (21.17%). In 2018, many varieties and clones had a significantly lower starch content compared to 2019 and 2020 ($p < 0.05$).

Keywords: potato, starch content, starch yield, meteorological conditions.

INTRODUCTION

In breeding program of new potato varieties, not only the yield potential of the genotype, disease resistance, but also the quality aspects of the tubers are always taken into account. One of the indicators of quality is the starch content in the tubers. Starch is a polysaccharide, consisting of two polymers: amylose and amylopectin (Li et al., 2006). In potatoes, starch is formed by photosynthesis, first in the green leaves and then accumulates in the tubers (Soest, 1996). Starch from potato tubers is one of the most important ingredients as it is used as a raw material in many industrial processes. The main nutrient of potatoes are carbohydrates, particularly starch and starch is the second main ingredient after water in tubers (Kuur et al., 2002). Potatoes have a high energetic value (340 kJ) due to their starch content (Jimenez et al., 2009). Potato starch ranks third in world production after maize and wheat starches. Its unique properties differ from those of cereal and pulse starches and are directly related to its molecular structure and organization (Stijn et al., 2020). If the starch content is above 20%, the genotype will be useful for processing into starch. Table potato varieties contain from 14 to 19 % starch in tubers. Potato genotypes with starch content less than 14% are useful as dietary products (Смряков, 2008). Starch content depends on several factors: genotype, maturity, growing conditions (Kita, 2002). A multi-year field trial with varieties revealed that tuber yield and tuber size differed significantly between farming systems. Studies in Latvia proved impact of growing conditions on starch content changes for several varieties (Skrabule et al., 2018). However, the effect of the farming system on the dry matter and starch content in tubers is inconsistent: J. Hajšlova et al. (2005) and J.F. Herencia et al. (2011) reported significantly lower dry matter and starch contents in tubers grown conventionally, whereas other studies did not find significant differences between farming systems.

In Latvia, a potato starch processing company ('Aloja Sterkelsen') expands starch production each year. In 2020, a total of 1853 tons of potato starch was produced, including 100 tons of organic starch. It is planned to increase the production of organic starch in the future, as it is in demanded both in Latvia and abroad.

The aim of the study was to evaluate and select potato varieties and clones with high starch content in the organic farming system.

MATERIALS AND METHODS

The research was arranged at AREI Stende Research Center in 2018 -2020 in the field of the organic farming system in 4 replicates with 10 potato varieties: 'Monta', 'Rigonda', 'Lenora', 'Prelma', 'Brasla', 'Jogla', 'Imanta',

Vojevoda L., Skrabule I. Crop quality aspects of potato varieties and breeding clones in organic farming systems. In: *The 10th International Scientific Conference "Rural Development 2021: Challenges for Sustainable Bioeconomy and Climate Change"*, Kaunas, Lithuania, 21-23 September, 2021. Vytautas Magnus University. Kaunas, 2021, p. 53-56.



Article

A New Spiral Potato Cleaner to Enhance the Removal of Impurities and Soil Clods in Potato Harvesting

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Abstract: Sustainability in the agricultural field suggests the conservation and maintenance of a natural environment of soil. Nevertheless, in the potato production chain, the mechanized harvest is carried out with the concurring removal of impurities and fertile soil. The authors have developed a new spiral potato cleaner which is able to capture and efficiently remove soil lumps of various sizes and shapes, as well as various plant residues. Theoretical and experimental studies have been performed on this soil clod cleaner to determine the structural and kinematic parameters that provide efficient capturing, motion and sifting down of the soil, through the gaps between the helices of its cleaning spirals. An analytical description of the motion of the clod of soil has been made and a system of differential equations has been compiled, whose numerical solution made it possible to determine the indicated reasonable operative parameters of the developed spiral potato cleaner. The results of the experimental research confirmed those ones obtained through the numerical solution of the mathematical model, i.e., rational angular speed ω of the rotation of the spirals from 20.0 to 30.0 rad s⁻¹ and the radius R of spirals between 0.12 and 0.15 m.

Keywords: potatoes; tuber cleaning; kinematic; spiral separator; soil structure

1. Introduction

Sustainability is a key concept in relevant social, economic and political activities, which therefore have to aim at safeguarding the environment and natural resources [1]. In the agricultural sector, the sustainable approach requires the conservation and maintenance of a natural environment of soil, a subject closely related to the technologies used during cultivation and harvesting [2]. Nevertheless, research studies carried out within the potato cultivation sector highlighted the low tendency of the farmers to employ sustainable agricultural techniques [3]. An important phase in the potato production chain is the mechanized harvest, which is carried out with the concurring removal of impurities and fertile soil [4,5]. As is known, the potato is an irreplaceable ingredient of the food tradition of many countries and is cultivated at all latitudes, from areas close to the Arctic Circle to the southern end of the South American continent [6,7]. Europe was the greatest potato producer in the world for most of the twentieth century and currently, while accounting for 38.5% of the world's production, it has been overtaken by Asia (42.4%) [8]. On the other hand, the Ukraine was the third largest potato producer in the world in 2018, with more than 22,503,970 Mg [8].

Bulgakov V., Pascuzzi S., Ivanovs S., Ruzhylo Z., Fedosiy I., Santoro F. A new spiral potato cleaner to enhance the removal of impurities and soil clods in potato harvesting. *Sustainability*, Vol. 12, issue 23, 2020, Article number 9788.



Key words potatoes, tuber cleaning, kinematic, spiral separator, soil structure

EXPERIMENTAL RESEARCH AND JUSTIFICATION OF PARAMETERS OF SPIRAL POTATO CLEANER FROM ADMIXTURES

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Abstract. When digging potato tubers from the soil, one of the main problems is separation of a large amount of the soil and plant admixtures from the heap, which is fed into the potato harvester. We have developed a new design for a potato heap cleaner that consists of five cantilever-fixed cleaning driving spirals, arranged in a wave-like manner, significantly expanding the working zone of separation of the incoming potato heaps, and this, in turn, will contribute to its better dispersal over the working surface of the cleaner, more intense destruction of the soil lumps, and, consequently, improved screening of the soil and plant admixtures, and reduced clogging of the cleaning spirals. The experimental studies conducted under the field conditions showed that the process of cleaning tubers from the soil and plant admixtures, using this cleaner, occurs due to intense movement of the potato heaps by means of the coils of the cantilever-fixed cleaning spiral springs. The springs are rotating at a pre-set angular velocity, making oscillatory movements because of the deflection of their longitudinal axes under the impact of the weight of the heap arriving into the working zone of the cleaner. There was built a mathematical model of the movement of the body of a potato across the surface of the spiral separator. In addition, there was analytically considered the relative motion of a single body of the potato tuber across the surface of the spiral coil with a pre-set radius and angle of the pitch of the helix. As a result of mathematical simulation, a system of differential equations of the movement was compiled, the solution of which made it possible to determine, at the pre-set design parameters, the optimal kinematic characteristics that ensure the guaranteed movement of the potato tuber across the surface of the cleaning spiral spring.

Keywords: potato, cleaner, admixtures, parameters.

Introduction

Potato growing is an important agricultural sector in many countries, including Ukraine, Belarus and the Baltic countries [1-3].

Potato harvesting is the most time-consuming operation in the technological cycle. One of the important problems when harvesting potatoes is cleaning of its tubers from the soil admixtures and plant residues. The solution to this problem will ensure not only the quality of the obtained products, but also eliminate the removal from the fields the soil which is fertile. Therefore, the development of potato cleaners from admixtures immediately after extracting the tuberous layer from the soil (potato tubers, soil admixtures, as well as rigid soil formations, rhizomes, left over tops, stones, etc.) is an important urgent scientific and technical problem in the field of agricultural engineering.

Many researchers have dealt with the problem of creating and optimising the potato tuber cleaners [4-7]. However, the problem how to improve the machines is still relevant. We have developed a new design of a potato heap cleaner [3], which consists of three cantilever driving spirals, which ensures an active cleaning surface of a wave-like shape, to which the dug-out heap is delivered. In addition, there is a possibility to change the angle of inclination of the indicated cleaning surface, which ensures the intensity of separation of admixtures and guarantees the movement of the tubers in the direction of the unloading elevator.

All this also contributes to better distribution of the heap over the working surface of the cleaner, more intensive destruction of the soil lumps, and, consequently, to better sifting down of soil and the plant admixtures and reducing clogging of the cleaning spirals. As a result, the cleaning efficiency and productivity of the potato cleaner from the soil and plant admixtures [8] increases. In order to optimise the parameters of this cleaner, it is necessary to conduct a series of investigations.

The purpose of this research is to substantiate the optimal design and kinematic parameters of a new spiral-type potato heap cleaner, using the results of an experimental multifactor field study.

Materials and methods

Structurally, the spiral cleaner of potatoes from admixtures consists of several driven cleaning spiral rollers 1, made in the form of cantilever mounted spiral springs, and forming a wave-shaped

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Keywords potato, cleaner, admixtures, parameters

EVALUATION OF POTATO VARIETIES AND CLONES OF BREEDING MATERIAL IN THE INTEGRATED MANAGEMENT SYSTEM IN THE NORTH KURZEME REGION OF LATVIA



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Rationale.

In Latvia, the potato market has a very wide range of varieties from abroad, and with aim to introduce and offer created in Latvia potato varieties to farmers, a research trial was set up according project founded by the Latvian Ministry of Agriculture: "Support for the Evaluation of Breeding Material to Implement Integrated and Organic Agriculture Crop management"

Key words: potato variety, tuber yield, yield structure.

Objective. To assess the suitability of potato varieties and clones of breeding material to an integrated farming system.

To achieve the goal, a field trial was set up with 9 potato varieties: Monta, Rigonda, Lenora, Prelma, Brasla, Imanta, Magdalena, Jogla, Gundega and 10 breeding clones: S 07169-35, 2002-3317, 07131 -15, S10063 -178, S 10063 -48, S 09035-22, 19694.5, S 07156-22, 19922.29, 2008 -6.5.

Methods.

The study was carried out over several years (2015-2020). Evaluated traits: potato tuber yield, yield structure, phenological phase, resistance of varieties and clones to diseases during the growing season and post-harvest tuber infection.

Results. The analysis of the data shows that the potato tuber yield, using all agrotechnical measures, achieved very good results in average of three (2018 -2020) years. Yields varied significantly between varieties (Ffact> F crit), but the average yield varied from 42.19 t ha⁻¹ (variety 'Brasla') to 63.89 t ha⁻¹ (variety 'Jogla'). When evaluating the yield level of clones of breeding material, the most highyielding were: S 07131-15 (63.92 t ha⁻¹); S 10063-128 (58.33 t ha⁻¹); 19922.29 (61.93 t ha⁻¹). When evaluating the yield structure, varieties and breeding clones with the highest commercial yield and larger tubers of food fraction (> 50 mm) were noted (S09035 - 22; S07169-35; S07156 -22; 19922.29; 'Jogla', 'Rigonda', 'Monta').

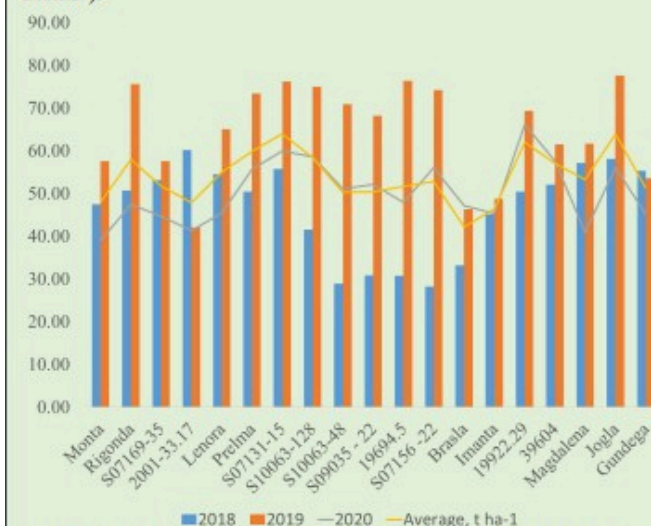


Figure 1. Yield of tuber in integrated growing systems in Stende RC, 2018-2020.

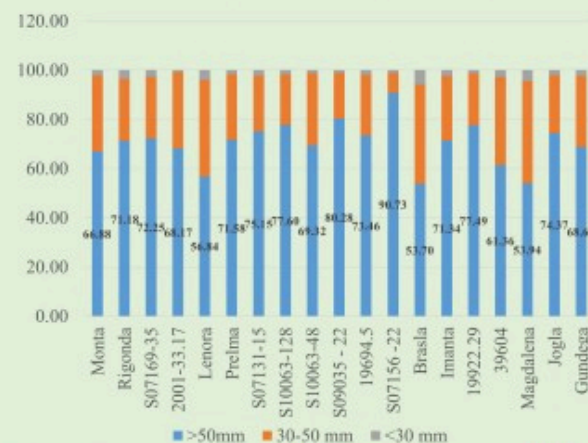


Figure 2. Potato variety and clones yield structure %, on average in 3rds 2018-2020.

Conclusion

Breeding clones and varieties will be selected from the evaluated material, the traits of which are best suited to the integrated management system in Latvia.



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Keywords potato variety, tuber yield, yield structure

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