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ORIGINAL PAPER

Comparison of the content and uptake of selected macronutrients in relation to the yield of potato tubers with different flesh colours*

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Abstract

The aim of this study was to compare the content and uptake with tuber yield of selected macronutrients (nitrogen, calcium and phosphorus) in potato tubers of different flesh colours: Eurostar (light yellow), Rote Emma and Herbie 26 (red flesh), Provita, Salad Blue, Blaue Annelise, Vitelotte Noire (purple flesh) and Bora Valley (dark purple flesh) in three growing seasons from 2021-2023. The content of Ca and P was analyzed using Inductively Coupled Plasma – Optical Emission Spectrometry (ICP-OES). The macronutrients were quantified by reference to the calibration curve of a multi-element standard solution Standard in its linear range. Total nitrogen was determined with the Kjeldahl's method on a 2300 Kjeltec Analyser Unit (ISO 1871 2009). Macronutrient intake was calculated as the product of the potato tuber dry matter yield and the content of each element. Potato varieties with red and purple flesh accumulated similar or higher amounts of selected macronutrients (nitrogen, calcium and phosphorus) than those with light flesh. The content and uptake of the analysed macronutrients were influenced by the weather conditions during the study years.

Keywords: potato, flesh colour, nitrogen, calcium, phosphorus

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INTRODUCTION

Potato (*Solanum tuberosum* L.) is one of the most important food crops widely cultivated worldwide for its edible and nutrient-rich tubers (Guo et al. 2023, Subrahmanyeswari et al. 2024). The colourful tubers of *Solanum tuberosum* are of growing interest worldwide for their health-promoting properties, taste and aesthetic appeal (Burmeister et al. 2011). Such potatoes can include tubers with red and purple flesh (Saar-Reismaa et al. 2020). Potato tubers are a good source of minerals, which, after digestion and absorption into the blood, are used by the body as a source of energy, building material or factor regulating vital processes (Barbas et al. 2023). Even small improvements in the chemical composition of potatoes to make them healthier, more nutritious and more flavoursome can significantly affect human health and well-being. They contribute 18% of the recommended daily dietary intake of potassium, 6% of copper, phosphorus and magnesium, and 2% of calcium (Chatzistathis et al. 2025). Increased public interest in improving the nutritional value of foods has prompted an assessment of the content and intake of selected minerals in potato tubers of different flesh colours (Pandey et al. 2023). The nutrient content of potato tubers is shaped by genetic factors, climate and soil conditions, fertilisation and cultivation techniques (Karan 2023). Genetics plays an important role in determining the basic characteristics of the plant: the ability to use minerals from the soil efficiently or to accumulate nutrients. Numerous studies have shown that potato varieties can differ in macronutrient and micronutrient content (Barbaś et al. 2023). The potato uses soil nutrients efficiently, although the use of fertilisers is still recommended to improve yield and tuber quality. The potato is highly adaptable to the environment, readily adapting to different growing conditions, and it is grown in many climate types such as the Mediterranean, tropical and temperate monsoon ones. However, temperature extremes can affect plant growth and development, which can determine the final chemical composition of the tubers. The amount of water available, both excess and deficit, is crucial for plant development and affects the nutrient content. To date, there have been few publications comparing the macronutrient content of potato tubers with different flesh colours (Zhou et al. 2019).

It was, therefore, hypothesised that potato varieties with red and purple flesh may have higher levels of key macronutrients compared to those with light yellow flesh. The content and uptake of selected macronutrients in the tubers of seven potato varieties with different flesh colours may depend on varietal characteristics as well as climatic and agronomic conditions. The aim of the study was to determine the content of macronutrients important for health – nitrogen (N), calcium (Ca) and phosphorus (P) – in potato tubers with different flesh colours: light, red and purple (including the new Provita variety, registered in Poland in 2021), grown in three growing seasons.

MATERIALS AND METHODS

A single-factorial field experiment on eight potato varieties with different flesh colour Eurostar (light yellow), Rote Emma and Herbie 26 (red flesh), Provita, Salad Blue, Blaue Annelise, Vitelotte Noire (purple flesh) and Bora Valley (dark purple flesh) was conducted at the Agricultural Experimental Station in Zawady, Poland, located at 52°03′ N, 22°33′ E. The field trials were carried out between 2021 and 2023, on soil classified as Haplic Luvisol (LV-ha) with sandy loam texture (WRB 2014), slightly acidic and acidic pH (pH in 1M KCl 5. 00-5.62). The content of bioavailable forms of macronutrients in mg kg^{-1} at soil level 0-30 cm was as follows: phosphorus medium to high (66.0-72.0), potassium medium (123-159) and magnesium medium (46.0-64.0). Tubers were planted manually in the last ten days of April, on plots measuring 12.96 m^2, at a spacing of 40 x 67.5 cm, which meant that 60 plants grew on each plot. Winter triticale was used as the preceding crop for the potato. In autumn, manure was applied at a dose of 25 t ha^{-1}.

Phosphorus fertilisers in the form of triple superphosphate 44 kg P ha^{-1}, potassium fertilisers in the form of potassium salt 124 kg K ha^{-1} and nitrogen fertilisation in the form of ammonium nitrate 100 kg N ha^{-1} were applied each year. Agrotechnical treatments were carried out according to the requirements of good agricultural practice. Weeds were controlled with the herbicide Bandur 600 SC, the active substance of which is aclonifen. Three treatments each were applied during the growing season: Cabrio Duo 112 EC (dimethomorph and pyraclostrobin), Infinito 687.5 SC (propamocarb hydrochloride and fluopicolide), and Carial Star 500 SC (mandiopropamid and difenoconazole) against potato blight, and Coragen 200 SC (chlorantraniliprole), Decis Mega 50 EW (deltamethrin) and Mospilan 20 SP (acetamiprid) against the Colorado potato beetle. All plant protection products were applied in accordance with the recommendations of the Institute of Plant Protection, the National Research Institute. The potatoes were harvested when they reached maturity of 99° on the BBCH scale, which took place between 10th and 20th of September. Afterwards, the yield per hectare was calculated. In addition, a sample of tubers (10 kg) was taken to determine the yield structure. Just before harvesting the potatoes, random samples were taken from each plot by digging up 10 potato seedlings. The yield determination was the same for all varieties. After harvesting the potatoes, samples of tubers were taken for chemical analysis in the laboratory: 10 tubers with a diameter of 35-60 mm were submitted to analysis, and the dry weight of the tubers and the mineral content were determined.

The weather conditions affecting plant growth and development between 2021 and 2023 are illustrated by the graphs of average monthly temperatures and total precipitation sums for the study period (Figures 1 and 2). The weather in the analysed years was significantly varied. The distribution of precipitations in the months decisive for crop yields (July, August, Sep-

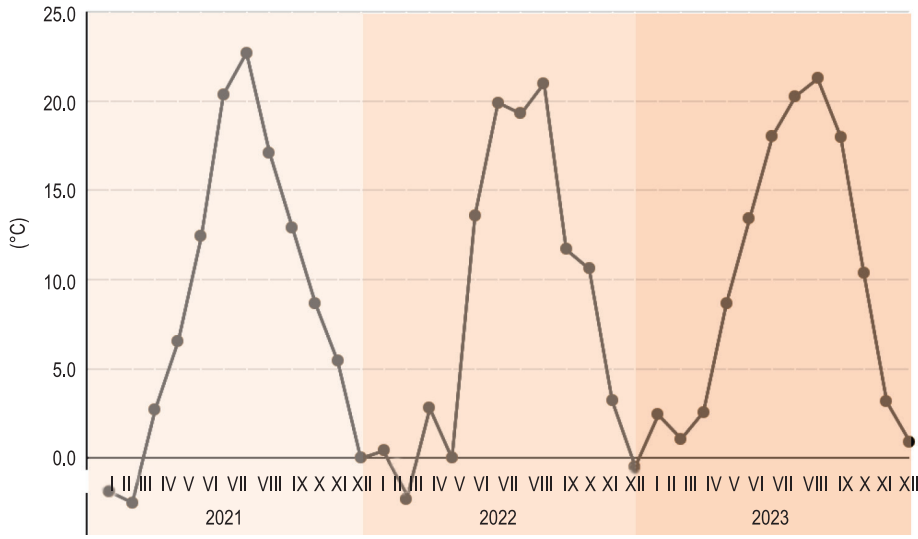

Fig. 1. Average air temperature (°C) at the Zawady Meterological Station

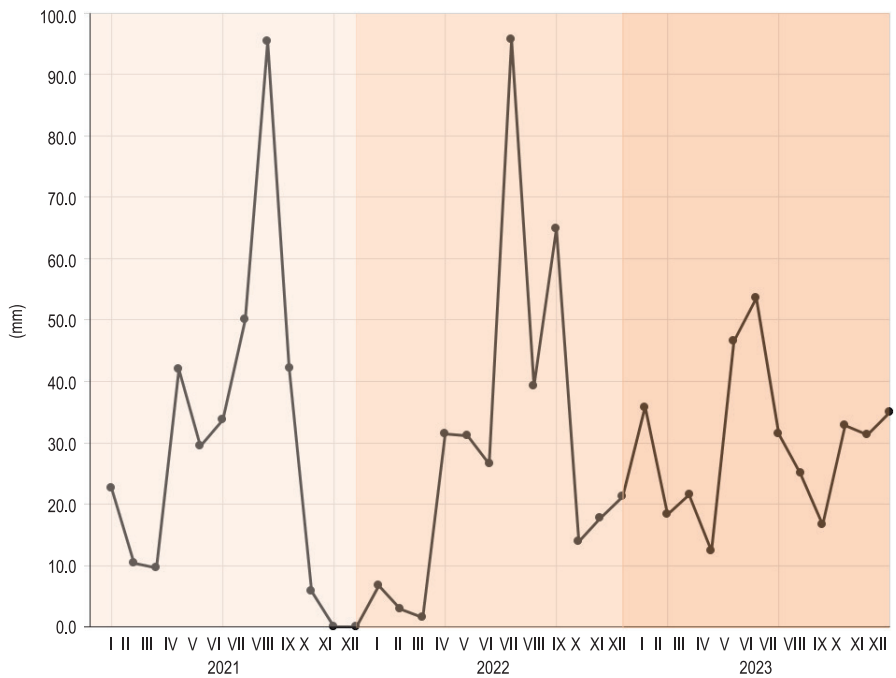

Fig. 2. Total precipitation (mm) at the Zawady Meterological Station

tember) was more favourable in 2021 than in 2022 (Figure 2). In contrast, the 2023 growing season was characterised by higher temperatures and a significant rainfall deficit, which meant that it was warm and very dry (Figure 1).

Potato tubers were dried at 105°C to dry weight using the dryer-weight method. Total nitrogen (N) was determined using the Kjeldahl method for high-temperature combustion (Nelson, Sommers, 1973), while calcium and phosphorus minerals (Ca and P) were determined by spectrometric analysis (ICP-OES) according to the Polish Standard (PN-EN 12145, 2001) in nitric and hydrochloric acid mineralized solution. The elemental content of Ca and P was quantified with reference to the calibration curve of a multi-element standard solution in its linear range.

The growing season for potato tubers is between April and September, but the key months for tuber formation are June, July and August. During this time, the plant develops the underground part intensively, and the weather conditions – especially rainfall and temperature – have a decisive influence on the efficiency of these processes. To assess hydrothermal conditions, the K-factor, calculated from monthly rainfall and average temperature (Skowera et al. 2014), was used (Table 1). In 2021, the K-factor values in June, July and August were respectively: 0.6, 0.7 and 1.9. These values classify June and July as very dry, while August is relatively humid. In 2023, the K-factor values were lower: 1.0 (June), 0.5 (July) and 0.4 (August), which according to the classification means very dry and dry conditions. Such conditions are unfavorable for the development of the potato, which is sensitive to water deficit, especially during tuber formation.

Table 1

Selyaninov hydrothermal index (K), based on Skowera et al. (2014)

Years	Months						
	April	May	June	July	August	September	April-Sept.
2021	2.1 (h)	0.8 (d)	0.6 (vd)	0.7 (d)	1.9 (rh)	1.1 (rd)	1.2 (rd)
2022	3.0 (vh)	0.8 d)	0.4 (vd)	1.7 (rh)	0.6 (vd)	1.8 (rh)	1.4 (o)
2023	0.5 (vd)	1.2 (rd)	1.0 (d)	0.5 (vd)	0.4 (ed)	0.3 (ed)	0.7(vd)

K= P/ 0.1 Σt, where: P – the sum of the monthly rainfalls in mm, Σt – monthly total air temperature > 0°C,
Ranges of values of this coefficient were classified as follows:
$K \leq 0.4$ – extremely dry (ed), $0.4 < K \leq 0.7$ – very dry (vd), $0.7 < K \leq 1.0$ – dry (d), $1.0 < K \leq 1.3$ – relatively dry (rd), $1.3 < K \leq 1.6$ – optimal (o), $1.6 < K \leq 2.0$ – relatively humid (rh), $2.0 < K \leq 2.5$ – humid (h), $2.5 < K \leq 3.0$ – very humid (vh), $K > 3.0$ extremely humid (eh)

The results were statistically analysed using analysis of variance (ANOVA). The significance of sources of variation was assessed using the Fisher--Snedecor *F* test, while the significance of differences between means was

determined using the Tukey's test (HSD) at a significance level of $p \leq 0.05$. Statistical calculations were performed using a proprietary algorithm developed in Excel, according to the mathematical model.

RESULTS AND DISCUSSION

Nitrogen content and uptake in potato tuber yield

Nitrogen (N) is a macronutrient present in relatively large amounts in all living organisms. It is a crucial component not only of proteins but also of other biologically important compounds, including nucleic acids, nucleotides, porphyrins, plant hormones, secondary metabolites, and energy carriers such as ATP. A deficiency of N in the human body disrupts N balance, leading to symptoms such as weight loss and oedema. Prolonged N deficiency may result in more severe conditions, including tissue necrosis and liver cirrhosis (Barbaś et al. 2023). The average N content of potato tubers depended significantly on the cultivars and years of study, and equalled 14.79 g kg^{-1} DM (Table 2), which corresponds to the results of other researchers, 15.9 g kg^{-1} DM. (Gianquinto, Bona 2000). In contrast, (Wierzbicka 2012) recorded lower values (12.2 g kg^{-1} DM). The highest average N content was obtained by the cultivars Herbie 26 (red flesh) and Vitelotte Noire (purple flesh), and the lowest – by the cultivars Blaue Annelise (purple flesh) and Eurostar (light yellow flesh). The N content of the potato tubers was influenced by the climatic conditions in the study years. The highest N content, reaching an average of 15 g kg^{-1}, was accumulated in 2022, which was a dry year (Table 2) with the Selyaninov index of 1.4 (tab. 1), followed by an average of 14.78 g kg^{-1} DM achieved in 2021 (Table 2). The interaction of varieties in the study years is confirmed by the interaction of N content in tubers with the weather conditions. The highest N was accumulated by the Herbie 26 variety (18.23 g kg^{-1}) (Table 2) in the favourable 2022 year in terms of moisture and thermal conditions, and the lowest N was accumulated by the light yellow-fleshed Eurostar variety. These results are in line with previous studies of coloured tubers, which showed an increase in minerals in potatoes with purple flesh compared to light yellow tubers.

The study also determined N uptake by tubers, which averaged 80.19 kg ha^{-1}. The uptake in 2021, the period of maximum yield, was 131.02 kg ha^{-1}, while the uptake in the period of lowest yield was 41.01 kg ha^{-1} (Table 2).

The uptake and accumulation of minerals in tubers can vary depending on soil type, soil mineral concentration and climatic conditions (Wekesa et al. 2014). Fertilisation, irrigation, and washing off water-soluble soil minerals due to excessive rainfall may also play an important role in the final mineral composition of tubers.

Table 2

Nitrogen content and uptake in potato tubers of different flesh colours in 2021-2023

Cultivars	Content of N (g kg^{-1} DM)				Uptake of N (kg ha^{-1})			
	2021	2022	2023	mean	2021	2022	2023	mean
Eurostar	9.65 ^{D}	11.13^{D}	10.95^{C}	10.58^{D}	114.11^{AB}	108.27 ^{A}	80.62^{AB}	101.00^{A}
Provita	16.95 ^{AB}	16.50^{B}	16.30^{A}	16.58^{AB}	131.02^{A}	108.99 ^{A}	58.06^{BC}	99.36^{A}
Rote Emmalie	16.40 ^{AB}	16.33^{B}	16.20^{A}	16.31^{B}	108.29^{ABC}	93.60 ^{A}	47.88^{C}	83.26^{A}
Salad Blue	15.80^{B}	16.20^{B}	15.97^{AB}	15.99^{B}	81.62^{BCDE}	85.52 ^{A}	71.40^{ABC}	79.51^{A}
Blaue Annelise	12.45 ^{C}	10.10^{D}	9.10^{C}	10.55^{D}	56.45^{EF}	49.01 ^{A}	47.77^{C}	51.08^{B}
Vitelotte Noire	16.99^{AB}	17.43^{AB}	16.83^{A}	17.08^{A}	79.87^{CDE}	95.27^{A}	47.96^{C}	74.37^{AB}
Herbie 26	17.55^{A}	18.23^{A}	17.43^{A}	17.74^{A}	65.10^{DE}	84.93^{A}	95.42^{A}	81.82^{A}
Bora Valley	12.45^{C}	14.10^{C}	13.87^{B}	13.47^{C}	90.99^{BCD}	81.51^{A}	41.01^{C}	71.17^{B}
Mean	14.78^{A}	15.00^{A}	14.58^{A}	14.79	90.93^{A}	88.39^{A}	61.27^{B}	80.19

Means followed by the same letters do not differ significantly at $p \leq 0.05$. Means in columns followed by capital letters refer to interactions between cultivars and years. The values in the last 'mean' column and the values in the last 'mean' row (followed by lower case letters) refer to cultivars and years.

Calcium (Ca) content and uptake in potato tuber yield

The Ca content depended significantly on the varieties tested during the potato growing season and ranged from 0.100 g kg^{-1} to 0.470 g kg^{-1} DM. The highest average Ca content was obtained by the cultivar Herbie 26 (red flesh), and the lowest one – by Bora Valley (dark purple) and Eurostar with light yellow flesh. Interactions between varieties and years were determined, indicating different responses of varieties in the years of the study. The highest Ca accumulation was found in dry 2022 (Table 3). Our study corresponds with the studies of Subramanian et al. (2017) and Singha et al. (2022), who proved in their work that Ca concentrations ranged from 0.2-1.0 g kg^{-1} DM and the Ca content in cream-coloured potatoes was lower compared to the other three coloured potatoes. In a study by Brown et al. (2012), Ca levels averaged 0.470 mg kg DM, being similar to previously reported values, with the highest concentration at 0.729 mg kg^{-1} DM and the lowest at 0.270 mg kg^{-1} DM. They concluded that the Ca content of potatoes increases the resistance of potato tubers to internal brown spot, heat necrosis, infection by the soft rot pathogen *Pectobacterium spp*., heat tolerance and frost tolerance; therefore, the low Ca content of cream-coloured potatoes can be considered as low resistance to the above-mentioned stress factors. Ca accounts for approximately 2% of adult body weight, 99% of which is found in bones and teeth (Cashman 2002).

On average, Ca uptake by the tubers amounted to 1.335 kg ha^{-1}, with the highest uptake observed in the Eurostar cultivar in 2022. The highest Ca uptake was recorded in 2022, a year that proved favourable in terms of pre-

Table 3

Calcium content and uptake in potato tubers of different flesh colours in 2021-2023

Cultivars	Content of Ca (g kg^{-1} DM)				Uptake of Ca (kg ha^{-1})			
	2021	2022	2023	mean	2021	2022	2023	mean
Eurostar	0.100^{A}	0.310^{D}	0.215^{D}	0.208^{c}	1.182^{A}	3.010^{A}	1.588^{AB}	1.927^{a}
Provita	0.100^{A}	0.330^{CD}	0.328^{A}	0.253^{b}	0.770^{B}	2.183^{BC}	1.163^{BCD}	1.372^{b}
Rote Emmalie	0.100^{A}	0.450^{AB}	0.317^{A}	0.289^{a}	0.660^{B}	2.575^{AB}	0.936^{BCD}	1.390^{b}
Salad Blue	0.100^{A}	0.360^{BC}	0.196^{D}	0.218^{c}	0.516^{B}	1.904^{BC}	0.893^{CD}	1.104^{b}
Blaue Annelise	0.100^{A}	0.360^{BC}	0.284^{BC}	0.248^{b}	0.451^{B}	1.750^{C}	1.488^{ABC}	1.230^{b}
Vitelotte Noire	0.100^{A}	0.400^{B}	0.271^{C}	0.257^{b}	0.470^{B}	2.180^{BC}	0.773^{CD}	1.141^{b}
Herbie 26	0.110^{A}	0.470^{A}	0.349^{A}	0.309^{a}	0.408^{B}	2.170^{BC}	1.902^{A}	1.493^{ab}
Bora Valley	0.100^{A}	0.300^{D}	0.198^{D}	0.199^{c}	0.755^{B}	1.740^{C}	0.584^{D}	1.026^{b}
Mean	0.101^{c}	0.373^{a}	0.270^{b}	0.248	0.652^{a}	2.189^{b}	1.166^{c}	1.335

Means followed by the same letters do not differ significantly at $p \leq 0.05$. Means in columns followed by capital letters refer to interactions between cultivars and years. The values in the last 'mean' column and the values in the last 'mean' row (followed by lower case letters) refer to cultivars and years.

cipitation and temperature. Calcium is essential for the proper functioning of the skeletal and nervous systems, as well as for metabolism. Although the Ca content in potato tubers is insufficient to provide significant dietary benefits, it is used as an indicator of tuber quality and storage potential (Olsen 1996).

Phosphorus (P) content and uptake in potato tuber yield

Phosphorus is one of the main mineral components of potato tubers |(Raghothama 2005). In the present study, P concentrations ranged from 1.469 to 3.975 g kg^{-1} DM, with a mean of 2.59 g kg^{-1} DM (Table 4). The differences in P content varied significantly with the cultivars and weather conditions of the study years. The highest P concentration was obtained by the red-fleshed variety Herbie 26, while the lowest concentration was recorded in the light yellow-fleshed variety Eurostar. Singh et al. (2022) in their study obtained similar elemental concentrations of 2.100-3.500 g kg^{-1}. Sing at al. (2023) showed higher P content (4.500 g kg^{-1}) compared to our study. The average phosphorus (P) uptake by potato tubers was 14.29 kg ha^{-1}. The highest phosphorus uptake values were observed in the 2021 growing season. Among the analysed varieties, the Eurostar variety showed the highest uptake of this component. The variation in P content may be the result of environmental factors, such as climatic conditions and soil mineral composition, as well as anthropogenic factors, including the agrotechnical practices used (Shen et al. 2011).

Table 4

Phosphorus content and uptake in potato tubers of different flesh colours in 2021-2023

Cultivars	Content of P (g kg^{-1} DM)				Uptake of P (kg ha^{-1})			
	2021	2022	2023	mean	2021	2022	2023	mean
Eurostar	2.475^{C}	1.469^{E}	1.535^{D}	1.826^{e}	29.26^{A}	14.26^{A}	11.34^{A}	18.29^{a}
Provita	3.177^{B}	2.195^{D}	2.377^{B}	2.583^{b}	24.45^{A}	14.52^{A}	8.43^{A}	15.80^{ab}
Rote Emmalie	2.975^{B}	3.055^{BC}	2.723^{A}	2.918^{a}	19.63^{B}	17.48^{A}	8.04^{A}	15.05^{abc}
Salad Blue	3.175^{B}	2.864^{B}	1.728^{A}	2.589^{b}	16.38^{B}	15.15^{A}	7.87^{A}	13.14^{abcd}
Blaue Annelise	3.825^{A}	3.267^{D}	2.074^{BC}	3.055^{a}	17.24^{B}	15.88^{A}	10.87^{A}	14.66^{abcd}
Vitelotte Noire	3.075^{B}	2.227^{A}	1.933^{C}	2.412^{c}	14.46^{B}	12.14^{A}	5.52^{A}	10.70^{d}
Herbie 26	3.975^{A}	3.774^{A}	2.067^{BC}	3.272^{a}	14.74^{B}	17.42^{A}	11.26^{A}	14.48^{abcd}
Bora Valley	2.625^{D}	2.120^{C}	1.537^{D}	2.094^{d}	19.83^{B}	12.29^{A}	4.53^{A}	12.22^{abcd}
Mean	3.16^{a}	2.62^{a}	2.00^{c}	2.59	19.50^{a}	14.89^{a}	8.48^{b}	14.29

Means followed by the same letters do not differ significantly at $p \leq 0.05$. Means in columns followed by capital letters refer to interactions between cultivars and years. The values in the last 'mean' column and the values in the last 'mean' row (followed by lower case letters) refer to cultivars and years.

Changes in the N, Ca and P content in potato tubers over the three years of the study were also analysed (Tables 2, 3, and 4). The highest N and Ca content was recorded in 2022, while the highest P content was found in 2021. The lowest P and N concentrations occurred in 2023, while the lowest Ca content was observed in 2021. Similar trends were observed for nutrient uptake. N and P uptake was lower in 2023 compared to the other years. For Ca the lowest uptake was found in 2021, while the highest uptake was determined in 2022.

Low temperatures can lead to a slowdown of metabolic processes in the plant, negatively affecting its ability to uptake and assimilate nutrients. Conversely, low precipitation limits water availability, which reduces the solubility and mobility of mineral nutrients in the soil. Consequently, reduced water availability results in limited uptake of essential nutrients, potentially causing their chronic deficiency within the plant. Potatoes, with their relatively shallow root system, have a limited adaptive capacity to prolonged drought conditions (Shi et al. 2023).

The dry matter yield depended significantly on the variety and weather conditions during the years of the study. The highest yields were obtained for the Eurostar variety with light yellow flesh, while Provita stood out among the varieties with coloured flesh (Table 5). A significant interaction between varieties and years of research was also found, indicating a significant impact of weather conditions on yield.

Table 5

Dry matter yield of tubers (kg ha^{-1})

Cultivars	Dry matter yield of tubers (kg ha^{-1})			
	2021	2022	2023	mean
Eurostar	11.82^{A}	9.71^{A}	7.39^{A}	9.64^{e}
Provita	7.70^{B}	6.62^{B}	3.55^{BC}	5.95^{b}
Rote Emmalie	6.60^{BC}	5.72^{B}	2.95^{C}	$5,09^{b}$
Salad Blue	5.16^{CD}	5.29^{B}	4.56^{BC}	5.00^{b}
Blaue Annelise	4.51^{CD}	4.86^{B}	5.24^{B}	4.87^{b}
Vitelotte Noire	4.70^{CD}	5.45^{B}	2.85^{C}	4.34^{b}
Herbie 26	3.71^{CD}	4.62^{B}	5.45^{BC}	4.59^{b}
Bora Valley	7.55^{CD}	5.80^{B}	2.95^{D}	4.43^{b}
Mean	6.47^{a}	6.01^{a}	4.37^{c}	2.59
$NIR_{0.05}$	2.25			
cultivars	2.25	3.91	3.18	1.66
years x cultivar				2.19
cultivar x year				2.89

Means followed by the same letters do not differ significantly at $p \leq 0.05$. Means in columns followed by capital letters refer to interactions between cultivars and years. The values in the last 'mean' column and the values in the last 'mean' row (followed by lower case letters) refer to cultivars and years.

CONCLUSIONS

The study showed that the genetic traits of potato varieties determine both the content and uptake with tuber yield of the determined macronutrients. In the group of the analysed minerals N, Ca and P, the varieties with red and purple flesh showed higher levels of these macronutrients, compared to the Eurostar variety with light yellow flesh. Both the content and the uptake of N, Ca and P in the tubers of the seven tested potato varieties with light yellow to dark purple flesh colour can be influenced by factors such as the variety genotype, climatic conditions and cultivation method. In the comparison of the varieties: Eurostar (light yellow flesh), Rote Emma and Herbie 26 (red flesh), Provita, Salad Blue, Blaue Annelise, Vitelotte Noire (purple flesh) and Bora Valley (dark purple flesh), it was the Herbie 26 variety that was found to have the highest content of the analysed macronutrients in the tubers. The weather conditions during the growing season had a significant impact on the content and uptake of N, Ca, P by plants. Significantly higher values for these parameters were recorded between 2021 and 2023, with the 2023 season being characterised by a particularly severe rainfall deficit and classified as very dry. Information on the mineral content

of tubers of potato varieties with varying flesh colour can contribute to consumer acceptance and sales potential of these varieties, including newly registered varieties entering cultivation.

The cultivation of potatoes with coloured flesh represents an interesting alternative to traditional varieties, offering farmers an opportunity to diversify production and stand out in the market. Thanks to their unique aesthetic qualities, such potatoes attract the interest of restaurateurs, health food stores, and consumers seeking original and high-value products.

Author contributions

I.M – conceptualisation, writing – review & editing, writing – original draft preparation, funding acquisition K.Z. – methodology A.G. – editing, M.G. – visualization. All authors have read and agreed to the published version of the manuscript.

Conflicts of interest

The authors have no conflicts of interest to declare.

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