The Effect of Potassium and Micronutrient Foliar Fertilisation on the Content and Accumulation of Microelements, Yield and Quality Parameters of Potato Tubers

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Abstract: The objective of this three-year study was to evaluate the effect of foliar application of dedusted potassium sulphate and chelated forms of microelements on the contents and accumulation of zinc (Zn), copper (Cu), manganese (Mn) and iron (Fe) as well as on the quality parameters of potato tubers at the stage of full maturity. Four treatments were analysed, including the control, where only nitrogen, phosphorus and potassium fertilisation was applied. Consistent with the experimental design adopted, other trials included: (I) Double foliar treatment with potassium sulphate in the combined dose of 8.6 K kg ha\(^{-1}\) (SOP); (II) double foliar treatment with micronutrients: 12 g Zn ha\(^{-1}\), 12 g Cu ha\(^{-1}\), 300 g Mn ha\(^{-1}\) and 500 g B ha\(^{-1}\) (Micro) and (III) combined application of SOP and Micro on two scheduled terms (SOP + Micro). Two potato varieties were tested: The French fries variety Zorba and the crisps variety Hermes. The experiment was arranged in a randomised complete block design with four replicates for each potato variety. Both the two-fold foliar spray with micronutrients and the treatment combined with the application of potassium sulphate resulted in the enhanced content and accumulation of the elements examined. The significant effect of the experimental factor was especially visible for the content and uptake of manganese and iron. Moreover, a highly significant relationship was determined between the tuber contents of protein and starch. The tuber quality parameters were most significantly conditioned by manganese and iron for the French fries variety and by zinc, copper and manganese for the crisps variety.

Keywords: micronutrient content and accumulation; potato varieties; protein content; starch content

1. Introduction

Balanced micronutrient supply is the prerequisite to ensure normal plant growth no less than the supply of essential macronutrients. In the plant metabolism, the mutual proportions between the individual macro- and micronutrients are of greater importance than the absolute element contents [1]. Securing the proper quality of staple food, both at regional and global scale, imposes the necessity of taking into account the increase in micronutrient content in plant products [2–4]. Depending on the nutrient supply, the interaction between nutrients can modify plant growth and yield. Interactions can be assessed by examining the relationship between nutrient supply and nutrient concentrations in plants and by examining the relationship between nutrient supply and plant growth [5]. Potato is
the third most important crop in terms of production scale worldwide with the highest significance as a staple food [6]. Given the high commercial value of the crop, potato growers are encouraged to substantially enhance agricultural investments in order to increase tuber yields [7]. However, over the past several years, there have appeared worrisome reports of declines in the availability of vital soil elements in some regions worldwide, including Poland [8,9]. This is attributed to diverse factors, among others, to the low content of organic matter in the soil, decreased proportions of manure versus inorganic fertilisers, high demand for modern potato varieties, enhanced purity of chemical fertilisers and micronutrient loss due to soil erosion and leaching [9]. One of the causes of the current stagnating yield levels is the deficiency or imbalance of nutrients [10]. The lack of balanced nutrient supply to meet crop nutrition requirements results in the malfunctioning of individual elements and the low efficiency of their use by crops [11–14]. At the same time, it is a low availability of elements in the soil, and not their low soil content, that is largely responsible for plant nutrient deficiencies [12]. Furthermore, crops differ in their micronutrient contents depending on species, variety and physiological features [15,16].

Among the important factors regulating the crop nutrient supply is the root system temperature, fluctuations of which balance plant physiological processes and, consequently, control the plant nutrient supply [17–19]. Another reason underlying micronutrient deficiency in crops is the low use efficiency of elements taken in from fertilisers applied to the soil. Field factors which affect micronutrient uptake by plants include: High soil pH, weakly developed root system, limited soil–root interface, low soil temperatures as well as agricultural drought [20–24]. Potato crop is classified as sensitive to water stress [25,26]. Reducing water during tuber initiation severely hinders plant physiological processes and penalizes tuber yield [25]. Given the abovementioned limiting factors, it is foliar fertiliser application that explicitly increases the nutrient content and uptake at the phase of maximal nutrition requirement [27]. Foliar fertilisation is currently a highly efficient agronomic crop fertilisation technique since it favours the assimilation of the nutrients in the plant and consequently the utilisation of the nutrients applied with the fertiliser, thus increasing crop yields and quality [28–30].

The aim of the present study was to evaluate the effect of foliar application of potassium sulphate and microelements on the content and accumulation of zinc, copper, manganese and iron as well as on the quality parameters of potato tubers at the stage of full maturity. The present study was based on a working hypothesis that foliar fertilisation with potassium sulphate (SOP) and micronutrients would increase not only tuber yields but also nutrient content and nutrient accumulation and would improve the quality traits. To achieve the abovementioned objective, the following research questions need to be answered: (1) Is the nutrient accumulation response in tubers due to foliar supply of potassium and microelements equal for every micronutrient examined? (2) Which of the foliar treatments is most effective in increasing micronutrient accumulation? (3) Which of the micronutrients examined contributed mostly to determine the tuber yield? and (4) Is there a relationship between the uptake of micronutrients and the potato quality parameters.

2. Materials and Methods

Field trials were conducted at the Jagrol farm in Pierzchno (52°14′51″ N, 17°05′22″ E) in the Wielkopolska province in 2014–2016 (Figure 1). The soils used in the study were rich in available phosphorus (74–100 mg P kg\(^{-1}\) of soil) and contained medium levels of potassium (125–180 mg K kg\(^{-1}\)). The content of available magnesium ranged from medium to high (61–80 mg Mg kg\(^{-1}\)). The soil reaction was slightly acidic (pH 6.3–6.7 1 M KCl). Two potato varieties with different ways of tuber use were tested: The French fries (Zorba) and the crisps (Hermes) varieties. The one-factor experiment was established using a randomised complete block design with four replicates for each fertilisation treatment.
The two experiments were replicated three times using the same one-way factorial design with four treatments randomized in four complete blocks. The experiment with foliar applications included the following treatments: The control, where only nitrogen, phosphorus and potassium (NPK) fertilisation was applied; (I) double foliar treatment with potassium sulphate in the combined dose of 8.6 kg K ha\(^{-1}\) (acronym SOP); (II) double foliar treatment with micronutrients: 12 g Zn ha\(^{-1}\), 12 g Cu ha\(^{-1}\), 300 g Mn ha\(^{-1}\) and 500 g B ha\(^{-1}\) (acronym Micro); and (III) combined application of SOP and Micro on two scheduled terms (SOP + Micro). According to the experimental design adopted, potassium sulphate and micronutrients were sprayed twice. The first foliar application of potassium (SOP) and micronutrients was performed at the beginning of tuberization phase (BBCH 40), and the second one to two weeks later. Micronutrients were applied as chelates, whereas boron was applied as disodium tetraborate. Foliar treatments with potassium and microelements were performed against the background of the conventional permanent mineral fertilisation with nitrogen, phosphorus and potassium (NPK). Dedusted potassium sulphate (K\(_2\)SO\(_4\), 43.17% K and 18.42%) was used for foliar application. The two-fold combined foliar doses consisted of the total of 8.6 kg K ha\(^{-1}\) of potassium and the following quantities of micronutrients: Zinc (12 g ha\(^{-1}\)), copper (12 g ha\(^{-1}\)), manganese...
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(300 g ha\(^{-1}\)) and boron (500 g ha\(^{-1}\)). A detailed description of the methodology is presented in Gaj and Borowski [31].

Nitrogen was applied in the spring before potato planting, in the split dose system using different nitrogen forms, i.e., (1) ammonium phosphate and (2) Urea-Ammonium Nitrate solution plus Sulphur (UAN + S, 26 + 3). In the preceding fall, fertilisation with one dose of phosphorus and potassium was carried out in the site intended for cultivation of the French fries variety, whereas in the case of the crisps variety, potassium was applied in a split dose. Phosphorus was introduced into the soil as diammonium phosphate of the DAP type (18% N, 20.05% P). Potassium was applied as Korn Kali 40 potassium salt (33.2% K, 3.62% Mg, 5.01% S, 1.48% Na). Given the high magnesium content in the soil it was applied solely for foliar treatments, using magnesium sulphate heptahydrate (MgSO\(_4\) × 7H\(_2\)O) twice. All cultivation and harvest practices were carried out in accordance with the agricultural requirements for potato. The local climate, classified as intermediate between the Atlantic and Continental climates, is seasonally variable, particularly in summer. Meteorological conditions varied over the study period (Figure 2). To compare the level and distribution of precipitation and temperatures, the data from the study year were juxtaposed against those from 1991–2015.

The total amount of precipitation in June and July, the critical months for potato growth, was 56.2 mm in 2014, 140 mm in 2015 and 236.6 mm in 2016, while the long-term average was 146.6 mm. The experimental plots were primarily rainfed. During periods of low rainfall, all plots at the same site were irrigated. Total quantities of irrigation water applied over the study years were as follows: For the Hermes variety: 750, 700 and 500 m\(^3\) ha\(^{-1}\); for the Zorba variety: 1150, 250 and 500 m\(^3\) ha\(^{-1}\).

The gross surface of the trial field was 1200 m\(^2\). Potato tubers to the amount of 53,000 were planted in a row-space of 0.90 m, at a distance of 0.30 m within a row. Both potato varieties were planted in the second week of April, and Zorba was cropped in the third week of July, while Hermes was planted during the last week of August. The surface area of the sampling plots was kept at 12 m\(^2\) (1.8 m × 6.66 m). Potato tubers were harvested by hand. Five tubers were randomly selected from each sample, rinsed with deionized water, cut into small pieces and dried at 60 °C for 72 h until a constant weight, and the dry weight (DW) was determined [32]. Dry matter content was determined from the difference in the weight of potato samples before and after drying. Finally, the sample

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**Figure 2.** Monthly mean air temperature and total precipitation at the Pierzchno Meteorological Station.
was grounded in a mill and subject to chemical analyses to determine the content of micronutrients. The prepared plant material was mineralised at 550 °C for 6 h. The ash was mixed with 2 cm³ of dissolved HNO₃ (concentrated nitric acid and distilled water 1:1), placed into 15 mL test tubes and topped up with distilled water. Micronutrients were determined using the method of atomic absorption spectrophotometry (SpectraAA-250Plus Varian spectrometer). Chemical analyses of plant material were based on the SSSA methodological guide [33].

Micronutrients uptake at the phase of full maturity was calculated as the product of the element contents in the tuber dry weight and in the tuber biomass (tuber yield [t·ha⁻¹] × dry mass [%]). Data on potato yields obtained is provided in the paper by Gaj and Borowski-Beszta [31]. The starch content was determined using the Reiman–Parow scale. The protein content was calculated based on the obtained values of nitrogen content multiplied by the coefficient 6.25 [34]. The plant tissue levels of nitrogen was analysed on the Vario Max Analyzer, Elementar Company. Nutrient uptake was calculated as:

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\text{Element uptake expressed as kg ha}^{-1} = (\text{element content [g kg}^{-1}] \times \text{dry mass yield [kg ha}^{-1}]])/1000;
\]

\[
\text{Dry weight yield} = \text{DW content [g/kg]} \times \text{fresh mass yield (tuber yield) [kg ha}^{-1}].
\]

The results of all determinations were tested with ANOVA classical analysis of variance for univariate experiments using STATISTICA® 10 (StatSoft, Krakow, Poland). The mean values of the analysed variables (the content and uptake of micronutrients) were compared separately for the trials tested using one-way ANOVA with the Tukey’s test (\(\alpha = 0.05\)). To determine the correlation between the potential yield (tuber fresh weight, Mg ha⁻¹) and the tuber nutrient content a Pearson correlation analysis (\(p < 0.05\)) was performed. Multiple regression analysis was applied for the evaluation of cause and effect relationships between the parameters examined.

3. Results and Discussion

At times of intensive crop production, it is vitally important to evaluate the crop nutrient content from the perspective of its nutritional and feed value. The data on plant micronutrient composition is also critical in order to evaluate the biological value of crops [35,36]. For many authors, foliar fertilisation can be used to satisfy the essential micronutrient requirements in crop grains, increasing yields and the quality of production [27,36]. The tests showed that the microelement content (Zn, Cu, Mn, Fe) in tubers varied due to both the effect of the experimental factor and the year of study (Figures 3 and 4). For the Zorba variety, statistically significant differences between the treatments were recorded only for the contents of iron and manganese. Two-fold foliar sprays with potassium sulphate and micronutrients increased the tuber content of iron as compared to the control, regardless of the study year. On the other hand, the effect of foliar application on the manganese content was ambiguous, while a significant difference in the Mn content, was recorded only in 2016. According to Bergmann [37], available Mn²⁺ levels are usually higher in moist soils, and differences in the moisture content of the soil can cause variations in the Mn contents of plants. The highest contents of zinc, copper and manganese were recorded in 2015. At the same time, the tuber yield was then lowest; hence, we found the increased nutrient concentrations in potato tubers as compared to the control, regardless of the study year. On the other hand, the effect of foliar application on the manganese content was ambiguous, while a significant difference in the Mn content, was recorded only in 2016. According to Fageria et al. [38], the amounts of nutrients exploited in the harvested portion of the crop will depend on the yield and the concentration of nutrients in time and space as well as on the variety, soil and environmental factors.
The analysis of correlation between tuber yield of the Zorba variety and the contents of zinc, copper, manganese and iron carried out for each treatment separately, provided evidence of significant relationships only for two of the treatments, including SOP (for zinc, copper and iron) and Micro (for zinc and iron) (Table 1). On the other hand, the analysis of regression with stepwise backward elimination showed that it was the content of iron, among all the nutrients tested, which determined tuber yield in the Zorba variety, within the range 40–45%. The above relationships are illustrated
by the regression (1) and (3) given in Table 2. Under the combined treatment with SOP and Micro, the variability in yield was explained by the contents of iron and manganese at the level of 72%, while the increased iron content had a positive, and that of manganese a negative, effect on tuber yield ((2), Table 2). Petrie and Jackson [39] described some positive responses to nutrients, which may result from soil reactions such as the acidifying or reducing effect of the fertiliser nutrient. NH$_4$ fertilizers and reduce Mn (IV) in soil and increase the Mn uptake by Mn-deficient plants [40].

Table 1. Correlation analysis for the relationships between tuber yield, protein and micronutrient contents in potato tubers.

| Varieties | Parameters | Treatments | Zn     | Cu     | Mn     | Fe     |
|-----------|------------|------------|--------|--------|--------|--------|
| **Zorba** | Yield      | Control    | −0.292 | 0.142  | −0.451 | 0.129  |
|           |            | SOP        | 0.636  | *       | 0.632  | *       | 0.183  | 0.674  |
|           |            | SOP + Micro| −0.212 | 0.013  | −0.752 | **      | 0.069  |
|           |            | Micro      | 0.573  | 0.520  | 0.109  | 0.638  |
|           | Protein    | Control    | 0.142  | 0.557  | 0.672  | *       | −0.421 |
|           | content    | SOP        | 0.295  | 0.149  | 0.413  | −0.034 |
|           |            | SOP + Micro| 0.536  | *       | 0.304  | *       | 0.247  |
|           |            | Micro      | −0.210 | −0.145 | 0.898  | ***     | 0.141  |
| **Hermes**| Yield      | Control    | −0.633 | *       | −0.687 | *       | −0.128 | −0.163 |
|           |            | SOP        | −0.393 | −0.240 | 0.032  | 0.0150 |
|           |            | SOP + Micro| −0.196 | −0.160 | 0.061  | 0.054  |
|           |            | Micro      | −0.229 | −0.223 | −0.403 | −0.393 |
|           | Protein    | Control    | 0.552  | 0.471  | −0.264 | −0.001 |
|           | content    | SOP        | 0.727  | **      | 0.675  | *       | 0.421  |
|           |            | SOP + Micro| 0.274  |         | 0.191  | −0.045 | −0.077 |
|           |            | Micro      | 0.480  | 0.466  | −0.126 | −0.139 |

***, **, * significant at $p < 0.001$, $p < 0.01$, $p < 0.05$, respectively.

Table 2. Regression models of potato yield, protein and starch as the function of microelement content at the stage of full maturity.

| Varieties | Treatments | Parameters | Regression Models                  | $R^2$  |
|-----------|------------|------------|------------------------------------|--------|
| **Zorba** | SOP        | Yield      | (1) $y = 0.6428Fe + 3.36 ± 11.71$ * | 0.4056 |
|           | SOP + Micro| Yield      | (2) $y = 0.5227Fe-2.8978Mn + 39.43 ± 6.25$ ** | 0.7721 |
|           | Micro      | Yield      | (3) $y = 0.3382Fe + 25.24 ± 6.63$ * | 0.4554 |
|           | Control    | Protein    | (4) $y = -0.6792Fe + 15.48Mn + 27.05 ± 7.27$ ** | 0.7497 |
|           | SOP + Micro| Protein    | (5) $y = 2.5528Mn + 62.36 ± 10.82$ * | 0.4954 |
|           | Micro      | Protein    | (6) $y = 10.3804Mn + 13.97 ± 6.98$ *** | 0.8078 |
|           | SOP        | Starch     | (7) $y = 0.0543Fe + 8.79 ± 0.89$ ** | 0.5425 |
|           | SOP + Micro| Starch     | (8) $y = -0.1545Mn + 14.33 ± 0.61$ ** | 0.5322 |
|           | Micro      | Starch     | (9) $y = 0.0583Fe + 8.29 ± 0.96$ * | 0.4550 |
| **Hermes**| SOP        | Yield      | (10) $y = -3.7827Cu + 71.67 ± 7.06$ * | 0.4733 |
|           | Control    | Protein    | (11) $y = 5.2410Zn-9.1092Mn + 79.01 ± 9.68$ ** | 0.7465 |
|           | SOP        | Protein    | (12) $y = 3.1316Zn + 48.42 ± 12.78$ ** | 0.5234 |
|           | Control    | Starch     | (13) $y = -0.6500Cu + 17.85 ± 1.08$ ** | 0.6022 |
|           | SOP        | Starch     | (14) $y = -0.4730Cu + 17.89 ± 1.01$ * | 0.4530 |
|           | SOP + Micro| Starch     | (15) $y = -0.2613Mn + 16.78 ± 0.5851$ * | 0.3801 |

***, **, * significant at $p < 0.001$, $p < 0.01$, $p < 0.05$, respectively.

Just like for the Zorba variety, for the Hermes variety, significant differences in the tuber nutrient contents due to foliar fertilisation were recorded only for iron and manganese. The synthesis of results obtained over the three study years revealed a significant increase in the contents of Mn and Fe as compared to the control for the treatments SOP + Micro and Micro only. For the latter treatments, the increase in the content of manganese was 57% and 66%, respectively, while that of iron was 51%
and 59%, respectively. Unlike the Zorba variety, under conditions of foliar fertilisation in Hermes variety no significant correlations could be established between tuber yield and the nutrient content. However, the analysis of regression using stepwise backward elimination provided evidence that tuber yield significantly relied on the copper content only under the control, and the above dependence is illustrated by the regression (10) (Table 2). The high copper content in tubers of the Hermes variety negatively affected the tuber yield and was responsible for its variability in 47%.

The existing literature states that the availability of copper and manganese in the soil may be increased given the adequate level of mineral fertilisation, what would also fortify the element content in plants [41]. Interactions between nutrients that affect yield need to be accounted for since nutrients also can have an effect on the content or uptake of other nutrients [42]. In many publications, the effects on concentrations, or accumulation in plants, is used as the main parameter to assess nutrient interactions [43]. In addition, nutrient uptake by plants is regulated by the presence of several elements, which may mutually interrelate either as antagonists or synergists [1]. An example of synergism is the combination of Fe foliar fertiliser with urea, which stimulates the uptake of Fe via wheat leaf penetration [44] similar to the synergism between urea and Zn or Mn in foliar fertilisation [45]. Foliar fertilisation of S alone did not increase soybean grain yield, whereas soybean responded positively if S was applied in a mixture with NPK [46] suggesting a synergism in which nutrients have to be applied together. Numerous studies concentrate around the impact of nitrogen fertilisation on the micronutrient content [47,48], while there is little literature data on the effect of foliar sprays with potassium on the content and accumulation of nutrients in potato tubers. Nitrogen fertilisation could dilute some micronutrients, while increasing others (i.e., biofortification). Nitrogen fertilisation also influences the amount of residue returned to the soil, potentially altering soil organic carbon (SOC) and micronutrients [49]. Agronomic biofortification is recognised as an effective tool in alleviating the micronutrient deficiency in plants, where nitrogen (N) supply is considered as an important factor in enhancing the concentrations of Zn and Fe in the crops [50]. Under conditions of our study, foliar sprays with both potassium sulphate and micronutrients significantly affected the relationship between the quality parameters (protein, starch) and the element content in tubers. From among the nutrients analysed, this effect was particularly evident for manganese and iron in the variety bred for French fries. The latter relationships are described by the regressions (4)–(9) given in Table 2. The significant effect of zinc on the tuber protein content was determined only under the treatment with SOP in the variety bred for crisps. Zinc was responsible for the protein content at the level of 52% ((12), Table 2). The content of starch in tubers of the Hermes variety depended largely on the concentration of copper and manganese, while significant relationships were found for the treatments with SOP and SOP + Micro. The above nutrients controlled the level of starch in tubers the Hermes variety in 45 and 38%, respectively ((14) and (15), Table 2). Tuber quality is significantly affected by plant nutrition. According to Joudu [51] the starch content of tubers was affected by a cultivation method, fertilisation and storage conditions. Despite the low protein content of potato tubers, potato proteins are of high quality and have high nutritional value [52,53], in addition to having important attributes that determine the quality of tubers [54,55]. The impact of foliar fertilisation with potassium and micronutrients on the nutrient accumulation in tubers of both varieties varied depending on the nutrient and from year to year (Figures 5 and 6). Irrespective of the treatment tested, the increase in the tuber nutrient accumulation due to the foliar application, as compared to the control, was found only for one year of study (2016). The above difference was particularly visible for zinc, manganese and iron for the Zorba variety and manganese in Hermes variety under trials (Micro), where foliar sprays with micronutrients were applied twice. Moreover, a higher level of microelement accumulation was noted for the Hermes than for the Zorba variety. These differences were due to a higher yield and later date of tuber harvest. Rene et al. [42] suggested that the micronutrients content in plants remains relatively constant with increasing yield and increased application of macronutrients, if sufficient micronutrients are available to the crop. Gómez et al. [56] emphasizes that assimilate transportation from the above-ground organs to tubers at the stage of maturity may be extended through an extended
duration of leaf area. Taking account of the average values of microelement accumulation in tubers over the three study years, no significant differences were shown due to the effect of the experimental factor for the Zorba variety, while for the Hermes variety, there was a significant increase in the accumulation of iron and manganese under the treatments with SOP + Micro and Micro as well as of copper under the treatment Micro. Compared to the control, the highest average increase in the tuber accumulation of Cu, Mn and Fe was noted under the treatment with Micro, amounting to 61%, 74% and 66%, respectively. The accumulation of zinc was observed to show a growing trend under the influence of the experimental factor, in the direction: Control < SOP + Micro < SOP < Micro.

Figure 5. Effect of foliar fertilization with potassium and micronutrients on micronutrient uptake in the variety Zorba at the stage in full maturity.

Figure 6. Effect of foliar fertilization with potassium and micronutrients on micronutrient uptake in the variety Hermes at the stage in full maturity.
For the Zorba variety, the analysis of correlation between the tuber yield and the microelement accumulation showed strongest relationships for the accumulation of zinc, iron and copper, regardless of the treatment (Table 3). For manganese, the significant relationship was noted only under the treatment Micro. Given the effect of accumulation of individual elements on the tuber yield and quality parameters (protein and starch contents), the analysis of regression with stepwise backward elimination was made (Table 4). We found that in the Zorba variety, the tuber nutrient accumulation determined both the size of tuber yield and its content of starch and protein to a much greater degree ((1)–(10)) than in the Hermes variety ((11)–(17)). The abovementioned relationship is corroborated by a higher number of regression equations of significance for explaining the variability of the dependent variables tested as well as by the higher values of the determination coefficients $R^2$ in relation to yield.

**Table 3.** Correlation analysis for the relationships between tuber yield and microelement uptake by potato.

| Variety | Treatments | Zn  | Cu  | Mn  | Fe   |
|---------|------------|-----|-----|-----|------|
| Zorba   | Control    | 0.664 * | 0.598 * | 0.811 ** | 0.771 ** |
|         | SOP        | 0.961 *** | 0.872 *** | 0.377 | 0.891 *** |
|         | SOP + Micro| 0.841 *** | 0.632 * | −0.113 | 0.853 *** |
|         | Micro      | 0.960 *** | 0.830 *** | 0.880 *** | 0.923 *** |
| Hermes  | Control    | 0.083 | −0.413 | 0.499 | 0.436 |
|         | SOP        | 0.184 | 0.142 | 0.644 * | 0.521 |
|         | SOP + Micro| 0.608 * | 0.383 | 0.201 | 0.183 |
|         | Micro      | 0.295 | −0.076 | −0.268 | −0.274 |

***, **, * significant at $p < 0.001$, $p < 0.01$, $p < 0.05$, respectively.

**Table 4.** Regression models of potato yield and the content of protein and starch as the function of micronutrient uptake at the stage of potato full maturity.

| Varieties | Treatments | Parameters | Regression Models | $R^2$ |
|-----------|------------|------------|-------------------|------|
| Zorba     | Control    | Yield      | (1) $y = +0.0267 \times \text{UpFe} + 0.4359 \times \text{UpMn} + 10.16 \pm 3.89$ *** | 0.7998 |
|           | SOP        | Yield      | (2) $y = +0.2655 \times \text{UpZn} + 0.0635 \times \text{UpMn} + 20.51 \pm 1.89$ *** | 0.9602 |
|           | SOP + Micro| Yield      | (3) $y = +0.1324 \times \text{UpZn} + 0.0398 \times \text{UpFe} + 0.2171 \times \text{UpMn} + 24.20 \pm 3.90$ *** | 0.9212 |
|           | Micro      | Yield      | (4) $y = +0.2751 \times \text{UpZn} + 13.78 \pm 4.21$ *** | 0.9231 |
|           | Control    | Protein    | (5) $y = -0.0715 \times \text{UpFe} + 0.0278 \times \text{UpCu} + 57.16 \pm 6.76$ * | 0.5648 |
|           | SOP        | Protein    | (6) $y = -0.0433 \times \text{UpFe} + 0.6257 \times \text{UpMn} + 64.74 \pm 10.23$ * | 0.5938 |
|           | SOP + Micro| Protein    | (7) $y = -0.4933 \times \text{UpMn} + 0.9579 \times \text{UpMn} + 87.80 \pm 10.05$ ** | 0.6415 |
|           | Micro      | Protein    | (8) $y = +0.0040 \times \text{UpFe} + 9.98 e \pm 0.77$ ** | 0.6595 |
|           | SOP + Micro| Starch     | (9) $y = +0.0025 \times \text{UpFe} + 11.69 \pm 0.72$ * | 0.3428 |
|           | Micro      | Starch     | (10) $y = +0.0373 \times \text{UpMn} + 9.98 \pm 0.71$ *** | 0.6997 |
| Hermes    | Control    | Yield      | (11) $y = -0.4779 \times \text{UpCu} + 0.0278 \times \text{UpFe} + 57.16 \pm 6.76$ * | 0.5648 |
|           | SOP        | Yield      | (12) $y = +0.2319 \times \text{UpMn} + 39.88 \pm 5.63$ * | 0.4153 |
|           | SOP + Micro| Yield      | (13) $y = +0.1264 \times \text{UpZn} + 34.11 \pm 8.18$ * | 0.3699 |
|           | Micro      | Yield      | (14) $y = -0.2449 \times \text{UpCu} + 0.2559 \times \text{UpZn} + 26.99 \pm 5.75$ ** | 0.6941 |
|           | Control    | Protein    | (15) $y = +0.4905 \times \text{UpZn} - 0.8333 \times \text{UpMn} + 77.50 \pm 9.90$ ** | 0.7353 |
|           | SOP        | Starch     | (16) $y = -0.0252 \times \text{UpCu} + 16.91 \pm 0.54$ * | 0.4726 |
|           | Micro      | Starch     | (17) $y = -0.0266 \times \text{UpCu} + 0.0261 \times \text{UpZn} + 12.42 \pm 0.72$ * | 0.6105 |

***, **, * significant at $p < 0.001$, $p < 0.01$, $p < 0.05$, respectively.

The effect of zinc and of the remaining micronutrients was evidenced in numerous studies concerning the production of grain crops and maize [57–60], though little information has been provided concerning the effect on the potato quality parameters.
4. Conclusions

1. Foliar fertilisation with potassium and micronutrients increased the accumulation of zinc, copper and manganese in tubers of the Hermes variety, irrespective of the treatment analysed. In the Zorba variety, the increase in the nutrient accumulation in tubers due to foliar sprays varied between treatments and depending on the individual element. Compared to the control, the increase in the accumulation of manganese and iron was observed for all the treatments, while copper increased under the treatments with SOP + Micro and zinc—only under the Micro treatment.

2. Compared to the control, the highest increase in the accumulation of nutrients in tubers was found under the regime of double foliar spray with micronutrients.

3. From among the nutrients examined, it was zinc accumulation that was found to largely determine the tuber yield in the French fries variety, while no significant relationships were noted for the Hermes variety.

4. The accumulated micronutrients determined the contents of protein and starch within the range 34–96% in tubers of both varieties.

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