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# EFFECT OF POTASSIUM FERTILIZER TYPE ON THE CONTENT OF NUTRITIVE COMPONENTS IN THE LEAVES AND FRUITS OF HOT PEPPER (*CAPSICUM ANNUUM* L.)

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ABSTRACT. Potassium fertilizers: KCl, $K_2SO_4$ and KCl + $K_2SO_4$ (1:1 K) differentiated the content of nutritive components in the leaves and fruits of hot pepper. Fertilization with $K_2SO_4$ in comparison to KCl fertilizer to KCl fertilizer decreased the content of total N, Ca, Mg, Cl in leaves and fruits of hot pepper. On the other hand, the content of K and S-$SO_4$ in leaves was greater, while in the fruits, it was smaller in case of $K_2SO_4$ application as compared with KCl.

**Key words:** hot pepper, potassium fertilizer type, nutritive components in leaves and fruits

## Introduction

Among all nutritive components, potassium is taken up by plants in the greatest amounts and it has a significant effect on their biological value (**Bubicz** et **al.** 1981, **Dobrzańska** and **Szwonek** 1989).

Potassium belongs to nutritive components significantly influencing the chemical composition of hot pepper. This component regulates water economy in the plant, it activates over 60 enzymatic reactions and it increases the resistance of plants against different types of abiotic and biotic stresses. It also stimulates $CO_2$ assimilation and enhances the transport of assimilates (**Mengel** and **Kirkby** 1983, **Czuba** et **al.** 1994).

So far, the fertilization recommendations for horticultural practice referring to vegetables of Solanaceae family including hot pepper (syn. annual pepper, annual paprika) primarily advise to use potassium fertilizers of the sulphate type, although in the literature, the views regarding this problem are not explicit (**Nurzyński** 1986, 1994 b, **Nurzyński** et **al.** 2001).

In the horticultural production, the most frequently used mineral fertilizers containing potassium include saltpeter potassium sulphate and potash salt. Potassium occurs as

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single-valued $K^+$ cation, however, these fertilizers differ by their accompanying anion $Cl^-$, $SO_4^{-2}$ and $NO_3^-$ which act differently on the chemical composition of plants (**Nurzyński** 1986, 1994 a, b, **Nurzyński** and **Michałojć** 1998).

The objective of the presented studies was the determination of the effect of potassium fertilizer type and particularly of $Cl^-$ and $SO_4^{-2}$ anions accompanying $K^+$, as well as the effect of the mixtures of these anions on the content of nutritive components in leaves and fruits of hot pepper.

## Material and methods

In the years 2002 and 2003, two-factor pot experiments were carried out in an unheated greenhouse on the area of Experimental Station 'Marcelin', Agricultural University of Poznań.

The experiments were established in a completely random block design, in an independent system, in 6 replications (one replication included one plant). Hot pepper cultivars grown in Poland: 'Cyklon', 'Orkan', 'Wulkan' and foreign cultivars: 'Chillina' and 'Devilla' were used in the studies. The second experimental factor was the type of potassium fertilizer: KCl, $K_2SO_4$ and KCl + $K_2SO_4$ in proportion 1:1 K.

The hot pepper plants were grown in pots of 5 $dm^3$ volume filled with substrate consisting of a mixture of mineral soil and raised peat (v:v = 4:1) limed to pH = 6.5 on the basis of the neutralization curve. The substrate was pre-vegetationally enriched with macro- and micro-components basing on critical values determined for sweet paprika (**Golcz** 1987). Per 1 $dm^3$ of substrate, the following amounts of elements were applied: 0.32 g N in the form of $NH_4NO_3$; 0.10 g P as granulated superphosphate; 0.40 g K using KCl or/and $K_2SO_4$; 0.08 Mg in the form of $MgSO_4 \cdot 7H_2O$; 0.10 g LS-7 Polychelate about pure component content: 2.9% Mg and 2.9% Fe, 1.9% Zn, 1.4% Mn, 1.3% Cu, 0.7% B and 0.1% Mo. In top dressing (end of June), nitrogen was supplemented by using 0.16 g N $\cdot$ $dm^{-3}$ of substrate in the form of $NH_4NO_3$.

Seedlings of hot pepper were prepared according to the agrotechnical recommendations of this species, and in the phase of correctly developed proper leaves, the plants were planted in mid-May into their permanent place in pots filled with substrate, in a density of 4 plants per 1 $m^2$.

During vegetation, no cuttings of hot pepper plants were carried out. Such treatments as irrigation and chemical protection against pests were done according to the actually accepted principles.

In the third decade of August, when the fruits of hot pepper reached their physiological maturity, all fruits were hervested.

Samples of the indicative parts – leaves were taken for analysis in the phases of full blooming and full fruiting, in one month intervals, while fruit samples were taken once after their harvest.

Leaf samples were dried in an extraction drier at ±55°C, while fruit samples were dried at ±35°C, and after homogenization of the plant material, it was subject to extraction in an extract of 2% $CH_3COOH$ (according to **Nowosielski** 1988). In the leaves and fruits, the following determinations: total N after mineralization by Kjeldahl's method; P colorimetric method; K and Ca were photometric; Mg was determined by the atomic spectrometry adsorption method; S-$SO_4$ and Cl were analyzed by the nephelometrical method.

## Results and discussion

The cultivars of hot pepper were characterized by similar values of nutritive components both in leaves and fruits within the same potassium fertilizer (Tables 1 and 2). Among the studied cultivars, there occurred differences in the content of nutritive components in leaves and fruits under the influence of the applied potassium fertilizer, however, the dependences in the particular cultivars were not the same.

Leaves of all cultivars, independent of the applied potassium fertilizer, in the phase of full fruiting in comparison to the phase of full blooming, contained less total N, P, K Cl (except the combination with KCl), and more of Ca, Mg, S-$SO_4$ (except KCl+$K_2SO_4$ combination).

The content of total N in leaves in all cultivars was higher in both developmental phases in the combination with KCl as compared to the combination with $K_2SO_4$. Only in the cultivars 'Orkan' and 'Chillina', in the phase of full blooming, a different dependence was recorded. On the other hand, in combination KCl+$K_2SO_4$, intermediate contents of nitrogen were determined.

The studies of **Nurzyński** (1994 b) and **Nurzyński** et **al.** (2001) did not confirm the above dependence. The present authors have shown a higher content of total N as well as N-$NO_3$ in leaves of plants fertilized with $K_2SO_4$ as compared to the fertilization with KCl.

Differences in the content of phosphorus in leaves between KCl and $K_2SO_4$ did not show the same dependences in all cultivars.

The type of potassium fertilizer exerted a particularly high effect on the content of potassium in leaves ranging on a lower level in plants fertilized with potassium chloride than in plants fertilized with potassium sulphate in all cultivars and in both developmental phases of hot pepper. The leaves of all cultivars in full blooming and in full fruiting phases in KCl combination contained significantly more Ca and insignificantly more Mg than in the $K_2SO_4$ combination.

Similarly as total N in case of the application of KCl+$K_2SO_4$, the contents of potassium, calcium and magnesium in leaves showed intermediate values. The results of our own studies agree with the results of **Nurzyński** (1986, 1994 b) and **Nurzyński** et **al.** (2001). A higher value of potassium and lower values of Ca and Mg in the leaves of plants fertilized with $K_2SO_4$ could have resulted from the antagonistic effect of the single-valued element ($K^+$) on the two-valued ions ($Ca^{+2}$, $Mg^{+2}$).

The $Cl^-$ value in leaves was higher when KCl was applied than case of $K_2SO_4$ application. The analysis of the studied cultivars did not show any recurrent regularities in the content of $SO_4^{-2}$ in the indicative parts of plants and in fruits. In the combination in which cation $K^+$ was accompanied by the anion $SO_4^{-2}$, usually the amount of sulphates was higher. Similar dependences were obtained by **Nurzyński** (1994 b) and **Nurzyński** et **al.** (2001).

In fruits, analogically as in leaves, a higher content of total N, Ca, Mg and Cl was found in KCl combination as compared to the $K_2SO_4$ combination. However, a different dependence was obtained in case of potassium. The fruits contained more K with KCl application in comparison to the use of $K_2SO_4$. The results of fruit analyses confirm the view represented by **Lityński** and **Jurkowska** (1982), that $NO_3^-$ and $Cl^-$ ion exerts a favorable effect on potassium uptake by plants, while $SO_4^{-2}$ ions make the assimilation of this component difficult.

**Table 1**

**Effect of potassium fertilizer kind on nutrient contents in the index part of cultivars of hot pepper**

**Wpływ rodzaju nawozu potasowego na zawartość składników pokarmowych w częściach wskaźnikowych odmian papryki ostrej**

| Cultivar Od-miana | Potassium fertilizer kind Rodzaj nawozu potasowego | Stage of deve-lopment Faza roz-wojowa | N-total N-ogółem | P | K | Ca | Mg | Cl | $S\text{-}SO_4$ |
|---|---|---|---|---|---|---|---|---|---|
| | | | % d.m. | | | | | | |
| Cyklon | KCl | I | 3.68 | 0.26 | 6.80 | 0.33 | 1.03 | 2.51 | 0.71 |
| | | II | 3.48 | 0.22 | 5.13 | 0.43 | 1.17 | 1.65 | 0.67 |
| | $K_2SO_4$ | I | 3.51 | 0.21 | 7.75 | 0.22 | 0.89 | 1.74 | 0.58 |
| | | II | 3.15 | 0.21 | 5.72 | 0.28 | 1.01 | 0.93 | 0.56 |
| | $KCl+K_2SO_4$ | I | 3.47 | 0.24 | 7.13 | 0.28 | 0.94 | 2.07 | 0.71 |
| | | II | 3.08 | 0.19 | 5.34 | 0.32 | 0.99 | 1.34 | 0.54 |
| Orkan | KCl | I | 4.01 | 0.24 | 7.08 | 0.25 | 0.81 | 1.56 | 0.38 |
| | | II | 3.27 | 0.22 | 5.58 | 0.33 | 0.96 | 2.36 | 0.45 |
| | $K_2SO_4$ | I | 4.15 | 0.23 | 8.29 | 0.20 | 0.77 | 1.34 | 0.44 |
| | | II | 2.91 | 0.21 | 6.09 | 0.28 | 0.85 | 1.31 | 0.51 |
| | $KCl+K_2SO_4$ | I | 4.24 | 0.26 | 8.12 | 0.23 | 0.82 | 1.36 | 0.46 |
| | | II | 3.65 | 0.23 | 6.13 | 0.33 | 0.95 | 1.74 | 0.47 |
| Wulkan | KCl | I | 3.67 | 0.23 | 6.89 | 0.28 | 1.06 | 2.05 | 0.52 |
| | | II | 3.11 | 0.19 | 5.27 | 0.38 | 1.13 | 2.30 | 0.53 |
| | $K_2SO_4$ | I | 3.44 | 0.25 | 7.26 | 0.23 | 1.02 | 1.36 | 0.51 |
| | | II | 2.87 | 0.22 | 5.13 | 0.30 | 1.04 | 1.09 | 0.50 |
| | $KCl+K_2SO_4$ | I | 3.68 | 0.32 | 7.01 | 0.27 | 1.09 | 2.46 | 0.59 |
| | | II | 3.04 | 0.21 | 4.57 | 0.32 | 1.12 | 2.19 | 0.43 |
| Chillina | KCl | I | 4.18 | 0.26 | 6.94 | 0.38 | 1.00 | 1.78 | 0.52 |
| | | II | 3.17 | 0.20 | 4.35 | 0.43 | 1.01 | 1.78 | 0.53 |
| | $K_2SO_4$ | I | 4.29 | 0.27 | 7.57 | 0.32 | 0.92 | 1.20 | 0.64 |
| | | II | 2.95 | 0.20 | 4.88 | 0.36 | 0.99 | 0.79 | 0.64 |
| | $KCl+K_2SO_4$ | I | 4.09 | 0.25 | 7.53 | 0.36 | 1.00 | 1.53 | 0.57 |
| | | II | 3.01 | 0.19 | 4.51 | 0.38 | 1.01 | 1.46 | 0.59 |
| Devilla | KCl | I | 4.50 | 0.30 | 7.83 | 0.32 | 0.96 | 1.73 | 0.47 |
| | | II | 2.94 | 0.19 | 4.62 | 0.43 | 1.02 | 1.66 | 0.52 |
| | $K_2SO_4$ | I | 4.20 | 0.26 | 7.93 | 0.31 | 0.99 | 1.28 | 0.52 |
| | | II | 2.82 | 0.21 | 4.37 | 0.34 | 0.92 | 0.73 | 0.57 |
| | $KCl+K_2SO_4$ | I | 4.36 | 0.24 | 7.68 | 0.31 | 0.97 | 2.08 | 0.64 |
| | | II | 2.74 | 0.20 | 4.07 | 0.41 | 0.94 | 1.19 | 0.49 |
| Mean Średnia | KCl | I | 4.01 | 0.26 | 7.11 | 0.31 | 0.97 | 1.93 | 0.52 |
| | | II | 3.20 | 0.20 | 4.99 | 0.40 | 1.06 | 1.95 | 0.54 |
| | $K_2SO_4$ | I | 3.92 | 0.24 | 7.76 | 0.26 | 0.92 | 1.38 | 0.54 |
| | | II | 2.94 | 0.21 | 5.24 | 0.31 | 0.96 | 0.97 | 0.56 |
| | $KCl+K_2SO_4$ | I | 3.97 | 0.26 | 7.49 | 0.29 | 0.96 | 1.90 | 0.59 |
| | | II | 3.10 | 0.20 | 4.92 | 0.35 | 1.00 | 1.58 | 0.50 |

I – full of flowering, II – full of fructification.

I – pełnia kwitnienia, II – pełnia owocowania.

**Table 2**

**Effect of potassium fertilizer kind on nutrient contents of cultivars of hot pepper fruits**
**Wpływ rodzaju nawozu potasowego na zawartość składników pokarmowych w owocach odmian papryki ostrej**

| Cultivar Od-miana | Potassium fertilizer kind Rodzaj nawozu potasowego | N-total N-ogółem | P | K | Ca | Mg | Cl | S-$SO_4$ |
|---|---|---|---|---|---|---|---|---|
| | | % d.m. | | | | | | |
| Cyklon | KCl | 2.66 | 0.36 | 3.34 | 0.19 | 0.23 | 0.46 | 0.26 |
| | $K_2SO_4$ | 2.45 | 0.32 | 3.11 | 0.14 | 0.20 | 0.36 | 0.21 |
| | KCl+$K_2SO_4$ | 2.20 | 0.36 | 2.83 | 0.17 | 0.20 | 0.43 | 0.24 |
| Orkan | KCl | 2.36 | 0.24 | 2.94 | 0.21 | 0.24 | 0.28 | 0.20 |
| | $K_2SO_4$ | 2.27 | 0.30 | 2.89 | 0.18 | 0.26 | 0.22 | 0.22 |
| | KCl+$K_2SO_4$ | 2.22 | 0.28 | 2.94 | 0.20 | 0.25 | 0.18 | 0.19 |
| Wulkan | KCl | 2.48 | 0.24 | 3.29 | 0.16 | 0.23 | 0.46 | 0.15 |
| | $K_2SO_4$ | 2.40 | 0.20 | 3.19 | 0.13 | 0.24 | 0.42 | 0.17 |
| | KCl+$K_2SO_4$ | 2.51 | 0.22 | 3.18 | 0.14 | 0.24 | 0.42 | 0.17 |
| Chillina | KCl | 1.82 | 0.25 | 2.44 | 0.25 | 0.20 | 0.47 | 0.22 |
| | $K_2SO_4$ | 1.89 | 0.33 | 2.51 | 0.28 | 0.20 | 0.18 | 0.25 |
| | KCl+$K_2SO_4$ | 1.86 | 0.28 | 2.58 | 0.22 | 0.19 | 0.47 | 0.23 |
| Devilla | KCl | 2.49 | 0.48 | 3.51 | 0.21 | 0.23 | 0.27 | 0.31 |
| | $K_2SO_4$ | 2.46 | 0.39 | 3.23 | 0.18 | 0.22 | 0.20 | 0.27 |
| | KCl+$K_2SO_4$ | 2.31 | 0.35 | 3.50 | 0.20 | 0.22 | 0.23 | 0.28 |
| Mean Średnia | KCl | 2.36 | 0.31 | 3.12 | 0.20 | 0.23 | 0.39 | 0.23 |
| | $K_2SO_4$ | 2.29 | 0.31 | 2.99 | 0.18 | 0.22 | 0.28 | 0.22 |
| | KCl+$K_2SO_4$ | 2.22 | 0.30 | 3.01 | 0.19 | 0.22 | 0.35 | 0.22 |

## Conclusions

1. The presented studies have shown a differentiated action of potassium fertilizers on the value of nutritive components in leaves and fruits of hot pepper.

2. Leaves and fruits of hot pepper fertilized with $K_2SO_4$ contained less total N, Ca, Mg, Cl and in fruits, also the contents of K and S-$SO_4$ were smaller in case of KCl fertilization.

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## ODDZIAŁYWANIE RODZAJU NAWOZU POTASOWEGO NA ZAWARTOŚĆ SKŁADNIKÓW POKARMOWYCH W LIŚCIACH I OWOCACH PAPRYKI OSTREJ (*CAPSICUM ANNUUM* L.)

S t r e s z c z e n i e

Odmiany papryki ostrej: 'Cyklon', 'Orkan', 'Wulkan', 'Chillina' i 'Devilla' uprawiano w nieogrzewanej szklarni w wazonach o objętości 5 $dm^3$ wypełnionych podłożem (gleba mineralna + torf wysoki w stosunku v:v = 4:1). W nawożeniu potasem zastosowano KCl, $K_2SO_4$ i KCl + $K_2SO_4$ w stosunku 1:1 K.

W liściach i owocach oznaczono: N-ogółem oraz rozpuszczalne formy P, K, Ca, Mg, Cl i S-$SO_4$. Zastosowane nawozy potasowe różnicowały zawartość analizowanych składników pokarmowych w materiale roślinnym. Nawożenie $K_2SO_4$ w porównaniu z KCl spowodowało obniżenie zawartości N-ogółem, wapnia, magnezu, chlorków w liściach i owocach papryki. Natomiast zawartości potasu i siarczanów w liściach były większe, a w owocach mniejsze w przypadku zastosowania $K_2SO_4$ w porównaniu z KCl.