# EFFECT OF CHLORIDE ANIONIC STRESS ON THE YIELD AMOUNT AND SOME QUALITY PARAMETERS OF STRAWBERRY (*Fragaria ananassa*)

*Imre VÁGÓ*[1] *– László TOLNER*[2] *– Jakab LOCH*[1]

[1] Department of Agricultural Chemistry and Soil Science, Faculty of Agricultural Sciences, University of Debrecen, H-4032 Debrecen, Böszörményi street 138. vago@agr.unideb.hu, loch@agr.unideb.hu
[2] Department of Soil Science and Agricultural Chemistry, Szent István University, H-2103 Gödöllő. tolner.laszlo@gmail.com

**Abstract:** To study the effect of chloride stress, and potassium and magnesium supply of soils, we set up field trials on acidic sandy soil with different fertilizers, such as potassium chloride, potassium sulphate and Patentkali (which contains both of magnesium sulphate and potassium sulphate). It was stated, that the application of the potassium chloride was ineffective on the strawberry yield. The most favourable conditions for the berry development were ensured by the joint treatments with potassium sulphate and magnesium sulphate. Nutrients applied in form of sulphate inhibited the uptake of chloride ions. It is presumable, that the decrease in the chloride ion content of plants contributed to the yield and quality increment.

**Keywords:** strawberry, yield and quality, chloride stress, potassium chloride, potassium sulphate, Patentkali

## Introduction

Potassium plays an important role in the plant's development: it promotes the elongation of the cells, takes part in the water management of plant and in the synthesis of all kinds of carbohydrates: sugar, starch, and cellulose (Bergmann and Neubert, 1976). Strawberry that is well supplied with potassium synthetizes more sugar, so the yield will be sweeter (Babicz, 2002). In plant production mostly potassium chloride is used as potassium fertilizer. Strawberry – like many horticultural plants (Nagy et al., 2008) – reacts sensitive to chloride ions, because elevated chloride ion content inhibits the translocation of assimilates. Therefore a comparison of the application of potassium chloride and chloride-free fertilizers such as potassium sulphate is reasonable.

Besides potassium, magnesium plays also a relevant role in plant life (Loch and Nostíczius, 1992). It is important to watch out on magnesium supply on soils that are treated with a higher potassium dosage: because of the antagonism between the two ions, high potassium content can hinder magnesium utilization (Kátai et al., 2008).

To study the effect of chloride stress, of potassium and magnesium supply of soils, we set up field trials on acidic sandy soil with different fertilizers, such as potassium chloride, potassium sulphate and Patentkali (which contains both magnesium sulphate and potassium sulphate).

## Materials and methods

The field experiment was set up on an acidic soil (pH-KCl = 4.4) with sandy texture, near to Újfehértó, Eastern Hungary. The initial ammonium-lactate – acetic acid (AL-) extractable nutrient content is the following: 129.6 mg $kg^{-1}$ $P_2O_5$; 208.8 mg $kg^{-1}$ $K_2O$, 1 243 mg Ca and 67.3 mg Mg $kg^{-1}$ soil. The area of each plot was: 2.8 m * 3.75 m = 10.5 $m^2$, the distance between rows was 0.75 m, and the plant to plant distance was

 DOI: 10.1556/CRC.37.2009.Suppl.1

0.25 m, so these were 60 plants in each plot. We used the sort "Polana" in our experiment. To reach a higher statistical reliability we set up our experiment in 6 replications, in a randomised arrangement.

Treatment factors were the following:

1. Treatment without K- and Mg-fertilization („control")
2. 120 kg $K_2O$ $ha^{-1}$ (KCl)
3. 120 kg $K_2O$ $ha^{-1}$ ($K_2SO_4$)
4. 120 kg $K_2O$ $ha^{-1}$ ($K_2SO_4$) + 40 kg MgO $ha^{-1}$ ($MgSO_4$) = Patentkali

Chemical fertilization was executed a week before planting, so on 6th of April. We chose to give the same potassium dosage (120 kg $K_2O$ $ha^{-1}$) to each treatment combination with fertilization, so we had the opportunity to study and compare the effects of anions. In treatment Nr 4 we used Patentkali that besides potassium-sulphate contains magnesium-sulphate as well, to test, how the applied magnesium affects the yield. At the same time we treated the whole experimental area with a standard joint fertilizer of 100 kg N $ha^{-1}$ and 100 kg $P_2O_5$ $ha^{-1}$ in form of ammonium nitrate (AN) and mono-ammonium phosphate (MAP). We avoided using superphosphate because of its sulphate content. During the experimental period we adjusted the care of the crop and plant protection to the needs of plants. Unfortunately we did not have any opportunity for irrigation.

In the first vegetation period we could not collect any considerable and evaluable amount of berry yield. Therefore we measured the yield per plot and its quality parameters only a year after plantation. In the second year between the 21st of May and 11th of June we collected and measured the yield amount continually, 16 times altogether.

Plants' dry matter was analysed for their carbon and nitrogen content by an Elementar analyser, using a dry combustion method in oxygen atmosphere (Nagy, 2000). From the fresh berry samples of the 6th picking we determined the vitamin C-content of the berries per each plot. For that we used iodometric titration method. Beside this we determined the reducing sugar content expressed in fructose with $Cu^{2+}/Cu^{+}$ redoxy titration method and the chloride ion content of the yield with HPLC ion-chromatography method (Balláné Kovács A., 2000; Balla Kovács et al., 2007). The results were statistically evaluated with single factor ANOVA.

## Results and discussion

An overview table from the results of the experiment and its statistical analysis was made (*Table 1.*). The consolidated yield amounts, the vitamin-C-, the reducing sugar- (expressed in fructose) and the chloride-ion-content are shown per plot in this table.

In accordance to the better perspicuity we also represent the results on figures.

*Figure 1.* shows the yield mass of strawberry of the second year in the average of the 6 replications. The summarized yield was the highest in this year, depending on the

treatments it varied between 17.2 and 20.6 kg per plot. It can be stated, that the yield was the highest in treatments with both potassium-sulphate and magnesium-sulphate (Patentkali).

Compared to the treatments with potassium-chloride, potassium-sulphate itself resulted in a statistically significant yield increment, but this increment fell short of that in treatments with magnesium. As the results of the analysis of variance shows, the effects of the treatments were statistically proved at P = 0.1 % significance level (***).

*Table 1.* The total yield of strawberry and the vitamin-C-, fructose and chloride-ion-content of berries (Újfehértó)

| Treatments | Parameters | | | |
|---|---|---|---|---|
| | Total yield kg plot$^{-1}$ | Vitamin C mg kg$^{-1}$ | Fructose g kg$^{-1}$ | Chloride ion mg kg$^{-1}$ |
| Without K and Mg (control) | 17.2 | 556 | 42.4 | 698 |
| 120 kg $K_2O$ ha$^{-1}$ (KCl) | 17.3 | 503 | 39.9 | 727 |
| 120 kg $K_2O$ ha$^{-1}$ ($K_2SO_4$) | 19.7 | 586 | 49.0 | 449 |
| 120 kg $K_2O$ ha$^{-1}$ ($K_2SO_4$) + 40 kg MgO ha$^{-1}$ ($MgSO_4$) | 20.6 | 495 | 44.5 | 401 |
| $SD_{5\%}$ | 1.1 | 96 | 9.2 | 118 |
| F value | 21.4*** | n.s. | n.s. | 16.4*** |

*** significant at P = 0.1 % level n.s. = not significant

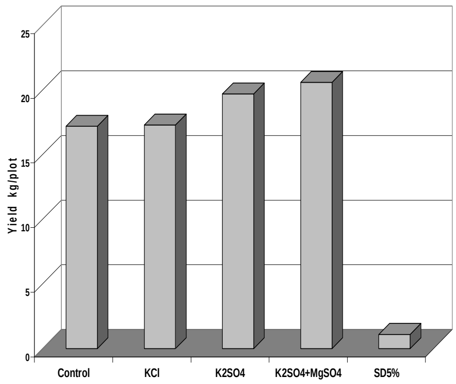


*Figure 1.* The consolidated yield of strawberry in the average of 6 replications (kg plot$^{-1}$)

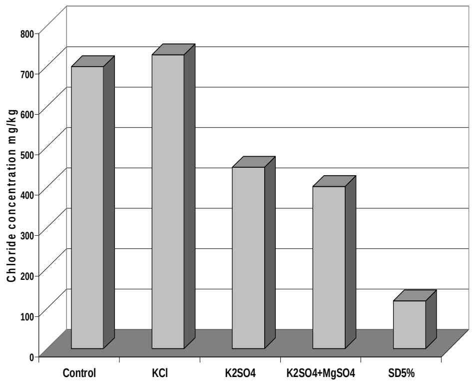


*Figure 2.* The chloride-ion-content of strawberry berries (mg kg$^{-1}$)

On *Figure 2*. the chloride-ion-content of the fresh berries is shown.

It became also evident, that there was a really close significant treatment effect on the chloride-ion-content of strawberry. Of course the chloride-concentration of strawberry increased parallel to the potassium-chloride treatments.

 DOI: 10.1556/CRC.37.2009.Suppl.1

In treatments with potassium-sulphate, and potassium-sulphate in combination with magnesium-sulphate (Patentkali) the chloride-content of the berries fell back. This relationship proved close significant (P = 0.1 % probability level). This fact contributed definitely to the yield increment of strawberry.
It can also be stated, that none of the treatments had a significant effect on the vitamin-C- and the reducing sugar-content of berries. The smaller differences weren't confirmed by the statistical analysis. There were also no significant differences in the plant's dry matter carbon and nitrogen content either.

## Conclusions

Summarizing our results, we can state, that the most favourable conditions for the strawberry development and for the amount of yield were ensured by the treatments with a combination of potassium-sulphate and magnesium-sulphate (Patentkali). This positive effect was confirmed by the statistical analysis at P = 0.1 % probability level.
From the quality parameters vitamin-C- and sugar-content of berries were not affected by any of the treatments, but nutrients applied in form of sulphate inhibited the uptake of chloride-ions. It is presumable, that the decrease in the chloride-ion concentration of plants contributed to the yield increment.

## Acknowledgements
This research work was financially supported by the "Internationales Kali Institut" (Horgen, ZH, Switzerland).

## References

Babicz Sz.: 2002. Minőségi szamócatermesztés gazdaságosan. Agrofeld Mg. Mérnöki Iroda Bt. Nyíregyháza.

Balláné Kovács A. (2000): Az ionkromatográfia lehetőségei és alkalmazása talaj- és növénykivonatok aniontartalmának meghatározására. Doktori (PhD) értekezés, Debrecen.

Balla Kovács A. – Kincses I. – Vágó I. (2007): Effects of nitrogen and different N:S ratio on yield and nutrient uptake of mustard (*Sinapis alba L.*) Cereal Research Communications. **35.** 201-205.

Bergmann, W. – Neubert, P. (1976): Pflanzendiagnose und Pflanzenanalyse. G. Fischer Verlag, Jena.

Kátai J. – Sándor Zs. – Tállai M. (2008): The effect of an artificial and a bacterium fertilizer on some soil characteristics and on the biomass of the rye-grass (*Lolium perenne L.*) Cereal Research Communications. **36.** 1171-1174.

Loch J. – Nostíczius Á. (1992): Agrokémia és növényvédelmi kémia. Mezőgazda Kiadó, Budapest.

Nagy P. T. (2000): Égetéses elven működő elemanalizátor alkalmazhatósága talaj- és növényvizsgálatoknál. Agrokémia és Talajtan 49. (3-4): 521-534.

Nagy P. T. – Nyéki J. – Szabó Z. – Sándor Zs. (2008): Floral analysis as an early plant analytical tool to diagnose nutritional status of fruit trees. Cereal Research Communications. **36.** 1335-1338.