CHANGES OF YIELD AMOUNT AND SOME CONTENT PARAMETERS OF STRAWBERRY (*FRAGARIA ANANASSA*) AS AFFECTED BY POTASSIUM AND MAGNESIUM FERTILIZATION

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Abstract

The potassium supply is important in strawberry production. Potassium plays a role in the plant's water management, promotes the cell elongation, it takes part in the synthesis of all kinds of carbohydrates: sugar, starch, and cellulose. Strawberry that is well supplied with potassium synthetizes more sugar, so the yield will be sweeter. In plant production mostly the potassium chloride is used as potassium fertilizer. Some plants – and so strawberry as well – react sensitive to chloride ions, because high chloride-concentration hinders the translocation of assimilates. Therefore the application of chloride-free fertilizers such as potassium-sulphate might be reasonable. Besides potassium, magnesium plays also a relevant role in plant life. It is important to watch out on magnesium supply on soils that are treated with a higher dosage of potassium, because of the antagonism between different ions, high potassium content can hinder magnesium utilization.

To study the potassium and magnesium supply of soils we set up field experiments in acidic sandy soil with different fertilizers, such as potassium-chloride, potassium-sulphate and Patentkali (that contains also magnesium-sulphate beside potassium-sulphate). It was stated, that the most favourable conditions for the strawberry development were ensured by the treatments with a combination of potassium-sulphate and magnesium-sulphate. The positive effect was confirmed by the statistical analysis at P = 0.1% probability level. 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.

Keywords: strawberry, fertilization, potassium chloride, potassium sulphate, Patentkali, mass and quality of berries

INTRODUCTION

The adequate potassium-supply is outstanding important in strawberry production (Bergmann and Neubert, 1976). Potassium plays an important role in the water management of plants. Plants that are well-supplied with potassium can take up and use soil water better, with a better regulation of the guard cells of stomata the plant is able to control the transpiration therefore the water will be used more efficient. Plants that are well supplied with potassium endure dry periods easily, besides their assimilation potential is higher under dry conditions. Potassium promotes the elongation of cells, so has a positive effect on plant growth (Loch and Nostíczius, 1992).

Potassium activates more than 60 enzymes. By an insufficient potassium supply the appropriate sugar, starch, cellulose and protein synthesis is not ensured. Strawberry that is well supplied with potassium synthetizes more sugar, so the yield will be sweeter (Babicz, 2002).
Potassium enhances the stress-resistance of plants: it improves the frost tolerance, enhances the resistance to many bacteria and fungi species. The explanation for this is, that by a good potassium supply the cell walls will be stronger that hinders causative agents to enter the cells. Beside sugar potassium promotes the production of flavour and aroma substances as well, that improves the organoleptic parameters of strawberry (Mengel, 1979).

Farmers use mostly potassium chloride in potassium fertilizers because it is less expensive than other kind of them. By the way it is well-known, that some plants – and so strawberry as well – react sensitive to chloride ions, because high chloride-concentration hinders the translocation of assimilates. Therefore the application of chloride-free fertilizers such as potassium-sulphate might be reasonable.

Besides potassium, magnesium plays also an important role in plant life. For it is the central ion in chlorophyll it has a key role in photosynthetic activity, but it also has an important function as an activator of enzymes in phosphorylation processes and in the synthesis of carbohydrates.

It is especially important to watch out on magnesium supply on soils that are treated with a higher dosage of potassium, because of the antagonism between different ions, high potassium content can hinder magnesia utilization.

To study the potassium and magnesium supply of soils we set up field experiments with different fertilizers, such as potassium-chloride, potassium-sulphate and Patentkali (that contains also magnesium-sulphate beside potassium-sulphate). We studied the effect of different treatment combinations on the yield and on some quality parameters.

MATERIALS AND METHODS

We set up the field experiments near to Újfehértó, in an acidic soil (pH-KCl = 4.4) with sandy texture. The ammonium-lactate – acetic acid soluble 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 net area of each plot was: 2.8*3.75 m = 10.5 m^2, the distance between rows was 0.75 m, and the plant to plant distance was 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 the anion-effect. In treatment Nr 4 we used Patentkali that contains magnesium-sulphate, to test, how the applied magnesium affects the yield.

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 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 the 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 (Nagy, 2000). From the fresh berry samples of the 6th picking we determined the vitamin C-content of the berries of each plot. For that we used iodometric titration method. Besides we determined the reducing sugar content expressed in fructose with Cu^{2+}/Cu^{+} redoxi titration method and the chloride ion content of the yield with HPLC ion-chromatography method (Balláné Kovács A., 2000). We evaluated the results with one factor ANOVA using the computer programme of László Tolner (Tolner et al., 2007).

RESULTS AND DISCUSSION

We made an overview table from the results of the experiment and its statistical analysis (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.

Table 1

The yield of strawberry and the vitamin-C-, fructose, chloride-ion-content of the 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	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	21.4***	n.s.	n.s.	16.4***

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

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 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.

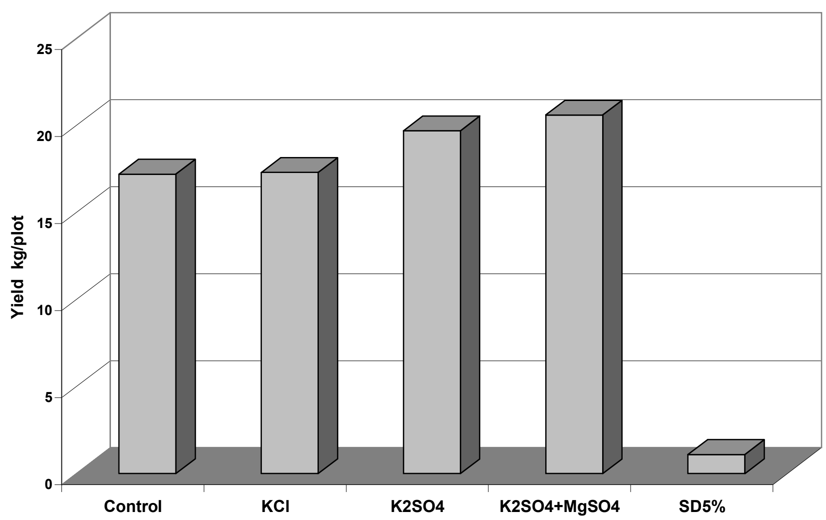

Figure 1.: The consolidated yield of strawberry in the average of the 6 replications (kg $plot^{-1}$)

Compared to the treatments with the potassium-chloride the 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 (***).

On Figure 2 the chloride-ion-content of the fresh berries are 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.

In treatments with 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.

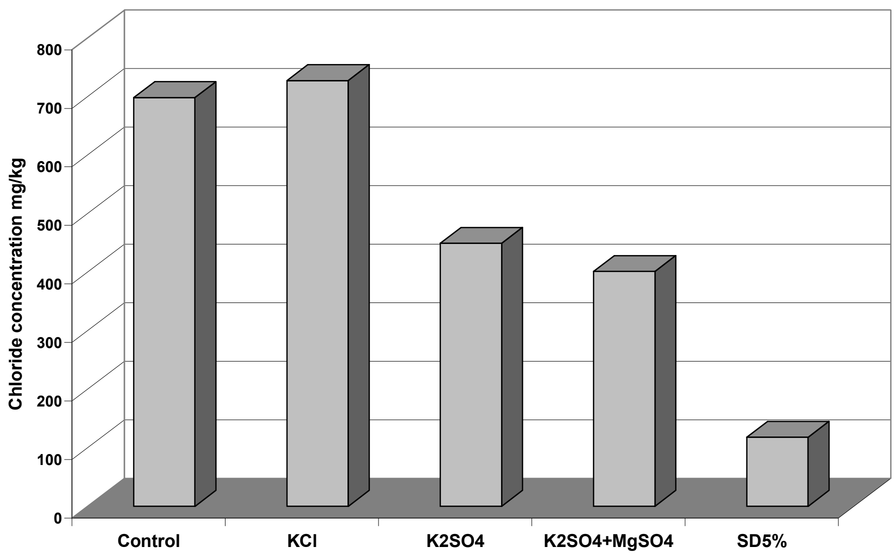

Figure 2.: The chloride-ion-content of strawberry berries (mg kg^{-1})

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 stated by the statistical analysis. There were also no significant differences found 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 were ensured by the treatments with a combination of potassium-sulphate and magnesium-sulphate. This positive effect was confirmed by the statistical analysis at P = 0.1% probability level.

From the quality parameters vitamin-C- and sugar-content were not affected by 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.

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