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INFLUENCE OF Ca-FOLIAR APPLICATION ON YIELD AND QUALITY OF SWEET PEPPER IN GLASSHOUSE CONDITIONS

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SUMMARY

Calcium is an extremely important nutrient in highly productive fruit growing such as glasshouse-grown sweet pepper. Good bioavailability of calcium can be achieved by calcisation, but in many cases owing to its high prices, long-term effects, along with a delayed initial effect, as well as problems that appear due to radical change in availability of other nutrients in soil, its application is restricted. This paper deals with research on effects of foliar applications of the commercial chemical named "CalcioGreen", as a supplement to the standard fertilization in greenhouse growing, on yield and quality of pepper fruits of the Cecil cultivar in the region of East Croatia.

Key words: sweet pepper, glasshouse, Ca-deficiency, foliar spray

INTRODUCTION

Calcium is an extremely important nutrient in highly productive fruit growing such as glasshouse-grown sweet pepper. Plants, microorganisms and animals need this element in high quantities. At the cell level, calcium fortifies cell walls and stabilizes biomembranes, provides for a strong vigor, sound growth and diseases resistance, as well as protection from toxins. In deficiencies or surpluses of calcium, cell division is slow, shoot tops grow less, growth of roots and fruits is poorer. This manifests with clear symptoms, such as, for example, local decay of tomato and pepper fruits (*blossom-end rot* = *BER*), so that a strong cell wall reflects adequate supply of calcium in plants, which ensures longer storage life of fruits, resistance of plants and fruits to diseases, allow longer roots and shoots function and higher tolerance on either lower or higher temperatures.

Good bioavailability of calcium can be achieved by calcisation, but in many cases owing to its high prices, long-term effects, along with a delayed initial effect, as well as problems that appear due to radical change in availability of other nutrients in soil, its application is restricted (Vukadinović and Lončarić, 1998). However, growth on substrates with high concentrations of NH_4^+ , K^+ and Mg^{2+} may result in insufficient absorption of calcium (Kastori, 1983). Therefore, liquid Ca-fertilizers are often used instead, being particularly popular in horticulture. Most often, this means a solution of $\text{Ca}(\text{NO}_3)_2$, CaCl_2 or even liquid $\text{Ca}(\text{OH})_2$, along with some other chemical and biological additives, whilst the highest effects have been found with chelates and calcium complexes with either synthetic or organic molecules.

This paper deals with research on effects of foliar applications of the commercial chemical named "CalcioGreen", as a supplement to the standard fertilization in greenhouse growing, on yield and quality of pepper fruits of the Cecil cultivar in the region of East Croatia.

MATERIALS AND METHODS

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In 1999, in the region of East Croatia, the pepper (*Capsicum annum L.*), of the cultivar *Cecil F1*, type HRF-halfpod, was grown in heated greenhouse on the substrate made of a mixture of turf, cattle manure and sand of the following chemical properties: humus 7,88%, pH 6,93 (in 1M KCl), AL-P₂O₅ 120 mg/100 g, AL-K₂O 44 mg/100 g of soil. The growing technology was Holland, of the "Rijk Zwaan" company. Plant population was 30.000 plants/ha, two fertilization treatments, in 3 repetitions:

- (a) Standard fertilization was done prior to planting on entire trial plot of 270 m² with 600 kg/ha 8:26:26 and 200 kg/ha of urea CO(NH₂)₂, whilst during fruit formation there were 9 fertigrations by christalon (5x60 kg/ha 13:40:13 and 4x30 kg/ha 15:5:30),
- (b) Growing plot was divided in two equal parts. On one part, along with the standard fertilization, 0,5% solution of Ca ("Calciogreen") was additionally applied in the form of foliar treatment every 5 days over the period of 25.05. to 25.07., which means a total of 30,6 kg Ca/ha.

There were 14 harvests of fruits (12.05. – 05.10.), and the results obtained with regard to the number and size of all fruits, as well as total yield and yields per harvests were analyzed according to the standard statistical procedures.

RESULTS AND DISCUSSION

Average values of the mass and fruits number, average and total yields and percentages of commercial fruits of the Cecil pepper cultivar in the studied treatments, are presented in the Table 1.

Tab 1 Average values of the studied properties and their statistical significance

Tab 1 *Prosječne vrijednosti istraživanih parametara i njihov statistički značaj*

Treatments Tretmani	Average fruit mass in g prosječna masa ploda u g	Average fruit number per plant prosječan broj plodova po biljci	Average yield t/ha prosječan prinos t/ha	% of commercial fruits % komercijalnih plodova
a) Standard pepper fertilization a) Standardna gnojidba paprike	133,6	38,6	154,7	40,2
b) Standard fertilization + foliar Ca application b) Standardna gnojidba + folijarna primjena Ca	127,6	43,6	166,7	100,0
LSD 0.05	2.22	n.s.	n.s.	33.92
LSD 0.01	5.14	n.s.	n.s.	78.23

By means of the bi-directional variance analysis, significant difference was determined in an average fruits mass (for all 14 harvests) between the standard fertilization and supplemental foliar calcium application. Somewhat smaller fruits size at foliar calcium application was compensated by greater number of fruits per plants and thus by higher total yields, although not significantly. However, it is very important to note that foliar calcium application completely eliminated BER (blossom-end rot), so that, in respect of a growing and especially commercial aspect, a successful production of sweet pepper, Cecil cultivar, was achieved. Mass onset of BER, especially at the beginning of fruit production, is illustrated in Fig 1. Namely, absolutely positive reaction of the Cecil cultivar on foliar treatment with calcium was not expected because data can be found in literature indicating that the reaction is contributed to the properties of a particular cultivar (Morley et al, 1992), with partial reaction of some cultivars on calcium application and higher susceptibility of pepper to BER in the spring part of the growth period (Marcelis, 1999).

Fast growth of pepper, particularly of that grown in glasshouse, correlates with lower calcium absorption from substrates and its low concentration in pepper fruits (Marcelis, 1999), along with induction of BER. Therefore, at growing of Cecil cultivar it is recommendable to preventively apply calcium as a foliar spraying, due to the extremely positive reaction of this variety to the treatment, as

found in the trial, especially to the dosage of 30 kg Ca/ha. The necessary dosage may be even higher and up to the point where a critical concentration of Ca is established in the fruits in relation to the BER occurrence, i.e. the doses really necessary. Since high temperature in glasshouses (>28°C) and low relative air humidity (<60%), the summer conditions commonly found in glasshouses, favor BER onset, it is possible, by means of preventive foliar calcium application, to bring pepper fruits damage down to only 3-7% (Benoit and Ceustermans, 1999) or even manage having a production without BER occurrence, which was achieved in this study.

Height of pepper fruits yield per harvests had a typical trend, increasing by the time of high temperatures (02.07.) and falling down to the end of growth period. During the summer heats, the drop was expected (Graph 1). Also, at first harvests a significantly higher yield of fruits was found if calcium was supplemented foliar (19.05.-23.06.) in relation to the standard fertilization, keeping the trend up to the end of the growth period (Graph 2), although this difference is statistically insignificant. Nevertheless, the total yield increase of 12 t/ha has a commercial justification for sure.

CONCLUSION

Based upon the studied foliar calcium application, along with the standard fertilization, aimed at prevention of blossom-end rot, a damage of sweet pepper of Cecil cultivar, in standard conditions of a glasshouse production, may be concluded as follows:

- It was found that foliar calcium application prevents completely onset of blossom-end rot damage of pepper, but, as a side effect, it significantly reduced fruit mass (133,6 g down to 127,6 g).
- Also, some significant effect of foliar calcium application was not found either with regard the average number of fruits per plants (38,6 to 44,1) or the total fruit yield average (154,7 to 166,7), although the difference of 12 t/ha in favor of Ca application must certainly be commercially important.
- Average fruit yield during the growth period ranged from 6-18 t per harvest, being typically distributed, which means a drop in the warmest period of growth, but also a clear advantage of calcium foliar application over others after fruit formation during the first harvests (2-7 harvest).

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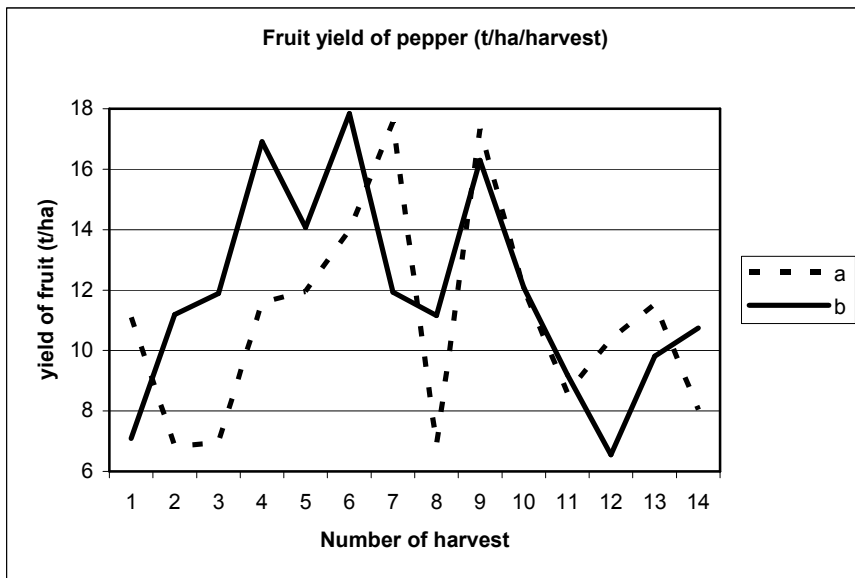
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SAŽETAK

Kalcij je izrazito važan nutrijent u visokoproduktivnoj povrćarskoj proizvodnji kao što je i staklenička proizvodnja paprike. Dobra bioraspoloživost kalcija može se postići kalcizacijom, ali u mnogim slučajevima njena visoka cijena, višegodišnji efekti uz odloženo početno djelovanje te problemi koji nastaju radikalnom promjenom raspoloživosti drugih hraniva u tlu ograničavaju njenu primjenu. U ovom radu ispitivan je utjecaj folijarne primjene kalcija u obliku komercijalnog preparata "Calciogreen" kao dopuna standardne gnojbe u stakleničkom uzgoju na prinos i kvalitet plodova paprike sorte Cecil na području istočne Hrvatske.

Ključne riječi: slatka paprika, staklenik, Ca-nedostatak, folijarna primjena Ca

Graph 1 Fruit yield of Cecil sweet pepper cultivar by treatments
 (- - - a, — b = varijantes)
 Graph 1 Prinos plodova paprika Cecil po tretmanima
 (- - - a, — b = varijante)



Graph 2 Aggregate growth of yield (b = foliar Ca application)
 (- - - a, — b = varijantes)

Graph 3 Kumulativan porast prinosa (b = folijarna primjena Ca)
 (- - - a, — b = varijante)

