

## Effect of foliar and soil applied fertilizers on strawberry healthiness, yield and berry quality

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**Abstract.** The effect of foliar applied fertilizers (calcium nitrate, Kemira Ferticare 7–27–25, Phosfik 3–27–18 and Biokal 01) and calcium nitrate broadcasted to the soil on strawberries cv. 'Honeoye' was investigated in 2004–2005 at the Lithuanian Institute of Horticulture. Strawberries were sprayed three times starting at full bloom in 8 day intervals. Calcium nitrate was applied to the soil in the rows during full bloom at the rate of 150 kg ha<sup>-1</sup>. Control plants were not fertilized. Ecological preparation Biokal 01 decreased amount of mite-infested strawberry plants by 9 percent units, and the incidence of leaf scorch (*Diplocarpon earlianum* (Ellis & Everh) Wolf) by 8 percent units in comparison with the control. Fertilizers had no effect on white leaf spot (*Mycosphaerella fragariae* (Tul.) Lind) infection. Foliar applied fertilizers had no positive effect on strawberry yield, average berry weight and berry firmness. Calcium nitrate applied to the soil decreased berry firmness. Biokal 01 and foliar applied calcium nitrate increased berry sucrose content. Fertilizers did not influence concentration of soluble solids, total sugars, ascorbic acid, nitrates and titratable acids.

**Key words:** berry firmness, fertilizers, leaf scorch, mites, sucrose

### INTRODUCTION

Proper plant nutrition is very important for good plant healthiness, high productivity and fruit quality. Adequate nutrient content and ratio in the soil is the foundation for good plant nutritional status, but some conditions may interrupt the uptake of nutrients even in soil well-supplied with nutrients. Foliar applied fertilizers usually compensate for or alleviate this inadequacy. Foliar nutrition plays an important role when it is desirable to increase nutrient content in certain above-ground plant organisms (Swietlik & Faust, 1984). An example of widely used foliar fertilizer application is fruit tree treatment with calcium fertilizers. This mean increases apple calcium content and prevents or alleviates physiological fruit disorders, and reduces cherry cracking (Brown et al., 1996; Centkowski & Tomala, 2000). The positive effect of calcium treatments on *Alternaria* and bitter rot control in apple has been reported (Biggs et al., 1993; Biggs, 1999). Calcium fertilizers are used in strawberry plantations as well. Also documented is the positive effect of calcium fertilizers on berry firmness, rot resistance, and storage quality (Cheour et al., 1990, 1991; Na Phun et al., 1995, 1997; Wójcik & Lewandowski, 2003). Less information is available about the effect of recently widely used composite fertilizers. For berry formation, higher amounts of

phosphorus and potassium are required (Lieten & Misoten, 1993; Tagliavini et al., 2004). Fertilizers with enhanced phosphorus and potassium content may be beneficial for berry quality improvement. In recent years concern about both the prevention of environmental pollution and food safety has developed. Foliar application of fertilizers is more ecologically sound than fertilization of the soil. There are special preparations for use in organic farms (Masny et al., 2004). In Lithuania Biokal 01 is certified. This preparation is classified as fertilizer with antifungal and insect-repellent action. The objective of our research was to evaluate the effect of soil and foliar applied fertilizers on strawberry healthiness, yield and berry quality.

## MATERIALS AND METHODS

The investigations were carried out at the Lithuanian Institute of Horticulture in 2004–2005. The scheme of the experiment:

1. No fertilizers;
2. 0,3–0,5%  $\text{Ca}(\text{NO}_3)_2$ ;
3. 0,7% Kemira Ferticare 7–27–25 + 0,3%  $\text{Ca}(\text{NO}_3)_2$ ;
4. 0,7% Kemira Ferticare 7–27–25 + 0,3% Phosfik 3–27–18 + 0,3%  $\text{Ca}(\text{NO}_3)_2$ ;
5. 5% Biokal 01;
6. 150 kg  $\text{ha}^{-1}$   $\text{Ca}(\text{NO}_3)_2$ .

The investigations were carried out in a strawberry plantation of cv. 'Honeoye' planted in 2003. The experiment was designed in random blocks; each experimental field covered 8 m<sup>2</sup> (two adjacent rows of 5 m length), number of replications – 3. The soil in the experimental plot was Epicalcari–Endohypogleic cambisol, clay loam, containing 2.3% of humus, 294 mg kg<sup>-1</sup> P<sub>2</sub>O<sub>5</sub>, 183 mg kg<sup>-1</sup> K<sub>2</sub>O, pH<sub>KCl</sub> – 7.1.

Fertilizers via leaves were applied three times starting at full bloom in 8 day intervals. Calcium nitrate alone was applied with 500 l ha<sup>-1</sup> of water at the concentration 0.3%, 0.4% and 0.5%. 0.3% calcium nitrate in combination with 0.7% Kemira Ferticare 7–27–25 or 0.7% Kemira Ferticare 7–27–25 plus 0.3% Phosfik 3–27–18 was applied with 1000 l ha<sup>-1</sup>. Ecological fertilizer Biokal 01 was sprayed with 200 l ha<sup>-1</sup> of water at the concentration 5%. Calcium nitrate was applied to the soil in the rows during full bloom at the rate of 150 kg ha<sup>-1</sup>. Control plants were not fertilized.

Leaf infection with white leaf spot (*Mycosphaerella fragariae* (Tul.) Lind), leaf scorch (*Diplocarpon earlianum* (Ellis & Everh) Wolf) and mites, berry yield, average berry weight, berry firmness, natural berry weight loss and biochemical berry composition were measured. Soluble solids were determined by refractometer, sucrose and total sugars, by Bertran method; ascorbic acid by titration with 2.6 dichlorophenolindophenol solution; titratable acids by titration with 0.1 N NaOH solution (Yermakov et al., 1987), and nitrates by potentiometric method.

Experimental data were subjected to analysis of variance. For mean separation a Duncan's test at  $P = 0.05$  was used. Data were analysed by 'ANOVA' statistical program.

## RESULTS AND DISCUSSION

Ecological preparation Biokal 01 decreased the incidence of leaf scorch (*Diplocarpon earlianum* (Ellis & Everh) Wolf) by 8 percent units in comparison with the control and tended to decrease its intensity (Table 1). Biokal 01 had no effect on

the prevalence and intensity of white leaf spot (*Mycosphaerella fragariae* (Tul.) Lind). White leaf spot is the most harmful strawberry leaf disease in Lithuania (Uselis & Rašinskienė, 2001). Its infection starts at the beginning of flowering, i. e., earlier than that of leaf scorch. We started foliar fertilizer applications at full bloom. Earlier application of Biokal 01 could be somewhat more effective. Biokal 01 decreased the number of mite-infested strawberry plants by 9 percent units in comparison with the control. Treatment with the other fertilizers had no effect on leaf spot and mite control. Fertilizers didn't influence berry yield and average fruit weight (Table 2). Berry firmness was not enhanced by foliar calcium fertilizer application as expected, in support of analogous experiments (Na Phun et al., 1995; Wójcik & Lewandowski, 2003). Positive calcium effect on berry firmness isn't observed in all cases (Makus & Morris, 1989, 1994; Erincik et al., 1998). Calcium nitrate broadcasted to the soil had a negative effect on berry firmness. It softened berries by 0.9 N cm<sup>-2</sup> in comparison with the control. This adverse effect was most likely induced by nitrogen. The possible negative effect of nitrogen on berry firmness has been reported (Tagliavini et al., 2004). Foliar applied calcium nitrate and Biokal 01 increased berry sucrose content respectively by 0.7 and 0.8 percent units. Fertilizers had no effect on total sugars, soluble solids, nitrates, ascorbic and titratable acid content and natural berry weight loss.

**Table 1.** Effect of fertilizers on leaf spot and mite infections on strawberries cv. 'Honeoye'. LIH, 2004–2005.

| Treatment | Leaf scorch (%) |           | White leaf spot (%) |           | Mites               |                           |
|-----------|-----------------|-----------|---------------------|-----------|---------------------|---------------------------|
|           | prevalence      | intensity | prevalence          | intensity | infested plants (%) | abundance (in 1–10 score) |
| 1         | 15 b*           | 3.7 ab    | 60 a                | 21.0 a    | 50 b                | 1.6 a                     |
| 2         | 17 b            | 4.2 ab    | 60 a                | 20.9 a    | 49 b                | 1.5 a                     |
| 3         | 11ab            | 2.5 ab    | 55 a                | 18.5 a    | 43 b                | 1.5 a                     |
| 4         | 14 b            | 3.5 ab    | 56 a                | 19.5 a    | 48 b                | 1.5 a                     |
| 5         | 7 a             | 1.7 a     | 62 a                | 23.1 a    | 41 a                | 1.4 a                     |
| 6         | 11 ab           | 2.2 ab    | 57 a                | 20.3 a    | 45 b                | 1.8 a                     |

\*In this and further tables, figures in the columns marked with the same letters don't differ statistically at  $P = 0.05$ .

**Table 2.** Effect of fertilizers on berry yield, average weight, firmness and sucrose content of strawberries cv. 'Honeoye'. LIH, 2004–2005.

| Treatment | Yield (kg 100 m <sup>-2</sup> ) | Average berry weight (g) | Berry firmness (N cm <sup>-2</sup> ) | Berry sucrose content (%) |
|-----------|---------------------------------|--------------------------|--------------------------------------|---------------------------|
| 1         | 156 a                           | 10.2 a                   | 4.8 b                                | 1.1 a                     |
| 2         | 147 a                           | 10.6 a                   | 4.6 b                                | 1.8 b                     |
| 3         | 152 a                           | 11.0 a                   | 4.5 b                                | 1.3 ab                    |
| 4         | 154 a                           | 10.3 a                   | 4.9 b                                | 1.5 ab                    |
| 5         | 158 a                           | 10.4 a                   | 4.1 ab                               | 1.9 b                     |
| 6         | 154 a                           | 11.1 a                   | 3.9 a                                | 1.6 ab                    |

## CONCLUSIONS

Ecological preparation Biokal 01 decreased the amount of mite infested strawberry plants by 9 percent units, and the incidence of leaf scorch, by 8 percent units in

comparison with the control. Fertilizers had no effect on white leaf spot infection. Foliar applied fertilizers had no positive effect on strawberry yield, average berry weight and berry firmness. Calcium nitrate applied to the soil decreased berry firmness. Biokal 01 and foliar applied calcium nitrate increased berry sucrose content. Fertilizers did not influence concentration of soluble solids, total sugars, nitrates ascorbic and titratable acids.

## REFERENCES

- Biggs A.R., 1999. Effect of calcium salts on bitter rot caused by two *Colletotrichum* spp. *Plant Disease* **83**, 1001–1005.
- Biggs, A. R., Ingle, M. & Solihati, W. D. 1993. Control of *Alternaria* infection of fruit of apple cultivar ‘Nittany’ with calcium chloride and fungicides. *Plant Disease* **77**, 976–980.
- Brown, G.S., Kitchener, A.E., McGlasson, W.B. & Barnes, S. 1996. The effect of copper and calcium foliar sprays on cherry and apple fruit quality. *Scientia Hort.* **67**, 219–227.
- Centkowski, J. & Tomala, K. 2000. The effect of spraying with different Ca products on quality and ‘Sampion’ apple storability. *Zeszyty naukowe Instytutu Sadownictwa i Kwiaciarnictwa* **8**, 319–326 (in Polish).
- Cheour, F., Willemot, C., Arul, J., Makhlof, J., Charest, P.M. & Gosselin A. 1990. Foliar application of calcium chloride delays postharvest ripening of strawberry. *Journaj of the American Society for Horticultural Science* **115**, 789–792.
- Cheour, F., Willemot, C., Arul, J., Makhlof, J. & Desjardins, Y. 1991. Postharvest response of two strawberry cultivars to foliar application of  $\text{CaCl}_2$ . *HortScience* **26**(9), 1186–1188.
- Erincik, O., Madden, L.V., Scheerens, J.C. & Ellis, M.A. 1998. Evaluation of foliar application of calcium chloride for control of Botrytis fruit rot on strawberry and effects on strawberry fruit quality. *Adv. Strawberry Res.* **17**, 7–13.
- Lieten F. & Misotten C. 1993. Nutrient uptake of strawberry plants (cv. Elsanta) grown on substrate. *Acta Hort.* **348**, 299–306.
- Makus, D.J. & Morris, J.R. 1989. Influence of soil and foliar applied calcium on strawberry fruit nutrient and postharvest quality. *Acta Hort.* **265**, 443–446.
- Makus, D.J. & Morris, J.R. 1994. Effect of preharvest calcium applications on firmness, decay and mineral distribution in strawberry fruit. *HortScience*. **29**, 533.
- Masny, A., Basak, A. & Żurawich, E. 2004. Effect of foliar application of Kelpak SL and Goëmar BM 86® preparations on yield and fruit quality in two strawberry cultivars. *Journal of Fruit and Ornamental Plant Research* **12**, 23–27.
- Na Phun, W., Kawada, K. & Kusunoki, M. 1995. Effect of preharvest calcium application on postharvest quality of ‘Nyoho’ strawberries. *J. Japan Soc. Hort. Sci. Suppl.* **2**, 638–639.
- Na Phun, W., Kawada, K. & Kusunoki, M. 1997. Effect of spray timing, spray part and calcium formula on the effectiveness of calcium spray on ‘Nyoho’ strawberries. *J. Japan Soc. Hort. Sci. Suppl.* **2**, 70–71.
- Swietlik, D. & Faust, M. 1984. Foliar nutrition of fruit crops. *Hort. Reviews* **6**, 287–356.
- Tagliavini M., Baldi E., Nestby R, Ryanal–Lacroix C., Lieten P., Salo T., Pivot D., Lucchi P.L., Baruzzi G. & Faedi W. 2004. Uptake and partitioning of major nutrients by strawberry plants. *Acta Hort.* **649**, 197–200.
- Uselis, N. & Rašinskienė, A. 2001. Assessment of biological and economic properties of strawberry varieties. *Sodininkystė ir daržininkystė* **20**(2), 18–31 (in Lithuanian).
- Wójcik, P. & Lewandowski, M. 2003. Effect of calcium and boron sprays on yield and quality of ‘Elsanta’ strawberry. *Journal of Plant Nutrition* **26**(3), 671–682.
- Yermakov, A.I., Arasimovic, V.V., Yarosh, N.P., Peruanskij, J.V., Lukovnikova G.A. & Ikonnikova, M.I. 1987. *Methods of biochemical plant analyses*. Agropromizdat, Leningrad, 431 pp. (in Russian).