Influence of foliar application of magnesium, calcium and boron on some yield parameters of apple

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The largest quantity of fruits which are grown in temperate zones of the Earth is apple (*Malus domestica*). Around 20 % of the world's full areas of apple orchards, one million hectare, are in Europe, the yearly yield of the continent is hovering around 16 million tons.

Hungary's climate is excellent for growing apples, despite that the area of apple orchards is only 48,000 ha, which the annual apple harvest is between 0.6 million and 0.8 million tons. The 71 % of apple growing area is concentrated in the north-eastern region of Hungary, where the apple orchards are mostly on the low to moderate humus content, acidic sandy soils with magnesium and boron deficiency and low buffer capacity is installed. Therefore, the proper nutrient supply of plants is of utmost importance.

Magnesium has an important role primarily as a constituent of chlorophyll, when it is deficient, photosynthetic activity is reduced. In addition, it has a significant effect on phosphorilation and carbon-dioxide assimilation as an enzyme activator, too. **Calcium** has a significant influence on the characteristics of plasma colloids and their osmotic potential. It promotes longitudinal growth and cell division in meristematic tissues, has a specific effect on cell elongation and differentiation. **Boron** is one of the most important micronutrients for plants. Its peculiarity is that (differently from most of the microelements, but similarly to molybdenum) it can be found in the soil and in the plant as an anion. Among the microelements, boron has the greatest effect on the yield quality and quantity of plants. If it is not available in the necessary amount, then problems can be detected in flower formation and fertility, furthermore, carbohydrate and lipid formation and the cell wall stability is inhibited, too.

Apple, similarly to other dicots, requires **boron** for normal development and fruit formation. It is especially valid for crops produced sugar and starch content. In winter apple, calcium

and magnesium supply is also important in addition to that of boron, since the deficiency or improper ratio of these elements can reduce yield and storability.

When selecting the **method** of fertilization, it should be considered that large applied amounts of lime might have a negative effect on yields. A further problem is that trees can uptake the mezo- and micronutrients applied to the soil only partially and after a relatively longer way. An alternative is the application of water-soluble nutrients as a leaf fertilizer. The advantage of this method is, in addition to the practically immediate availability of nutrients, that the losses in the soil due to binding and leaching can be avoided.

The experiment was carried out in a six-year old apple orchard with cv. 'Golden Spur' on humus sandy – sandy loam soil in Nagykálló in north eastern Hungary. The visible color of the soil was heterogenous, therefore, the size of the plots was selected to be 250 m^2 with 14 trees per plot. For enabling statistical evaluation, all treatments were performed in 4 replications. There was a row for isolation between the treated rows, so that the high-pressure spray application could not reach the trees of a different treatment. Treatments were applied three times with 400 dm^3 ha^{-1} spray volume. The total amount of sprayed nutrients per ha was 2.4 kg boron, 3.6 kg calcium and 12 kg magnesium.

In addition to the control, six treatments and treatment combinations were applied. The mono-elemental treatments were Solubor (sodium octaborate), calcium nitrate and Epsom salt (magnesium sulfate), the combined treatments were Solubor + calcium nitrate, Solubor + Epsom salt, and calcium nitrate + Epsom salt.

At harvest, the total yield and the diameter of apple fruits were measured. The statistical evaluation was calculated by analysis of variance with the help of a Microsoft Excel 2010 program written in macro by László Tolner. The basis of the program was the algorithm written by SVÁB (1981).

The average apple yield was 33.3 t ha^{-1}. The highest yield was achieved by the combined application of boron and calcium. The obtained yield was 7.3 t ha^{-1} higher than that of the control (significance level was P = 0.1 %). This can be explained by the synergistic effect of boron and calcium as also observed earlier by other plants too.

The overall average diameter of the apples was 77.1 mm. The biggest diameter, 83.8 mm in average, was measured by the sodium octaborate treatment. Most of the treatments reduced fruit size as compared to the control, but the probability level was lower than 90 %

(not significant). The determination of the reason of the observed phenomenon needs further investigation.

The penetration resistance on different places of fruits influenced by the mentioned plant nutrition combinations and the storage at 1-4 °C, was also determined.

Summing up, it can be stated about foliar boron, calcium and magnesium fertilization under field conditions, that the combined application of sodium-octaborate (Solubor) and calcium-nitrate increased the apple yield by the highest amount on an acidic humous sandy soil with low boron and magnesium content. Our results reconfirm, that the best yields are obtained under harmonic plant nutrient supply.