

APPLICATION OF FOLIAR FERTILIZER AGROARGENTUM FORTE IN CULTIVATION OF SEEDLINGS OF THREE SPECIES *TILIA*

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ABSTRACT

Species of the genus *Tilia* are some of the most common plants in our landscaping practice. One of the key problems in the production of seedlings of these species is the slow growth of seedlings in the first years of their cultivating. The application of foliar fertilizers is one way to solve this problem. This study examines the impact of foliar fertilizer AgroArgentum Forte on growth processes and biometric characteristics of annual seedlings of three species of linden: *T. cordata* Miller; *T. platyphyllos* Scop. and *T. tomentosa* Moench. Foliar fertilizer AgroArgentum Forte was used in 5 different concentrations: 0.3%; 0.6%; 0.9%; 1.2% and 1.5%. Treatment began with the formation of the first leaf at 90% of the plants and was applied every 14 days throughout the growing season to the end of September. It was found that the growth characteristics of the treated plants exceed substantially those of the untreated control plants. With the highest and thickest stems of seedlings are the three types of linden treated with 0.9% Agro Argentum Forte. Treatment with 1.2% concentration positively influences the number and size of leaves. Impact on biometric characteristics of the root system was not established. No difference was observed in biometric characteristics between the three types of linden treated with different concentrations of foliar fertilizers. We suggest the use of AgroArgentum Forte in nursery practice in concentration 1.2%.

Keywords: *Tilia*, seedlings, foliar fertilizer, AgroArgentum Forte

INTRODUCTION

The ecological requirements for protection of the natural environment and human health require us to comply with the type of fertilizers and preparations used, the norms and terms of their application in order for the residues in the production and soil to be in the permissible quantities required by international standards (Atanasova, 2012; Malinova, 2007). A large number of ecologically friendly fertilizers are mass-produced and offered on the market, which have not been studied in all agricultural crops (Sengalevich, 2007; Valchovski et al., 2007). To ensure a balanced nutrition, flowers require a rational fertilization system for their development (Ivanova et al., 2005; Ivanova and Kadum 1996; Sapundjieva et al., 2001). In our country, scientific research on biological testing of ecologically friendly fertilizers in flowers and ornamental trees and shrubs is less than in other crops. In Bulgaria such experiments were carried out on a number of flower species (asters, gypsophila, calendula, chrysanthemum, lily, mini carnation, etc.) to establish the effect of complex mineral fertilizers – HortiGrow, Lactofol, Kristalon and Vege (Atanasova et al., 1999; Atanasova et al. 2000;; Atanassova, 2013; Ivanova and et al., 1995; Kotopanova et al., 1999; Kotopanova and Atanasova, 2008;), as well as the effect of fertilization with organic fertilizers - Baikal, Biostim, Humustim and Lumbricol, for ornamental crops for cut flowers (gypsophila, chrysanthemum and mini carnation), for potted

flowering species (petunia, impatiens, mini rose, carnation and chrysanthemum) and for other ornamental crops (Atanasova, 2011, Atanasova, 2012; Atanassova et al., 2007; Kotopanova and Nencheva, 2008; Atanassova and Nencheva, 2012; Zapryanova and Atanassova, 2013). The aim of the present study was to investigate the effect of the biomineral fertilizer AgroArgentum Forte on the growth and development of linden seedlings and to determine the optimal concentration for plant treatment.

MATERIAL AND METHODS

During the period 2017-2019 in the Agricultural University - Plovdiv a pot experiment was carried out with 3 species of linden *Tilia cordata* Mill., *Tilia platyphyllos* Scop., *Tilia tomentosa* Moench. to study the influence of the biomineral fertilizer AgroArgentum Forte in foliar treatment of plants in the following concentrations 0.3%, 0.6%, 0.9%, 1.2% and 1.5%. AgroArgentum Forte works by accelerating the growth of the components of the classic fertilizers, by improving the absorption of light, thanks to the silver particles and by a strong systemic effect, stimulating the production of phytoalexins in high concentrations. The manufacturer of the fertilizer is ECE Technology group Ltd. To carry out the experiment, seeds were collected from the available trees in the Dendrological Park of the Agricultural University - Plovdiv, sown on September 10 in a polyethylene greenhouse, in pots № 12 with substrate of soil, peat and perlite, in a ratio of 2: 2: 0.5. The experiment was set in 5 variants with different concentrations, with 10 plants in each variant, and untreated plants were used for control. The treatment began the following spring, after the germinating seeds formed the first true leaf. A total of 19 foliar treatments were carried out in 14 days, the last being in the second half of September. Measurements of the height, diameter of the plant stem, number and size of leaves, as well as the indicators of the root system were performed at the end of the experiment. Statistical data processing was performed by ANOVA test. The significant difference between the control and the variants is represented by the sign * ($P \leq 0.05$), ** ($P \leq 0.01$), *** ($P \leq 0.001$), and the unproven difference - ns.

Results

The results of the influence of the biomineral fertilizer AgroArgentum Forte on the biometric characteristics of the root system of plants are presented in Table 1. At all tested concentrations of foliar treatment with AgroArgentum Forte, a positive effect was found on the number of roots, the length of the root system and its volume in all three species of linden, but the differences compared to the control are small and statistically unproven. Regarding the biometric characteristics of the stem (Table 2.) the increase in height at all concentrations (variants) exceeds that of the control and varies from 7.7% - 18.5% for small-leaved linden, from 6.3% - 8.6% for large-leaved and from 0.5% - 4.8% for silver-leaved linden.

Table 1. Influence of Agro Argentum Forte foliar fertilizer on the biometric characteristics of the root system in linden seedlings

| Variants | <i>Tilia cordata</i> | | | <i>Tilia platyphyllos</i> | | | <i>Tilia tomentosa</i> | | |
|----------|----------------------|--------------------|-----------------|---------------------------|-----------------|-----------------|------------------------|-----------------|-----------------|
| | Number of roots | Length of roots | Volume of roots | Number of roots | Length of roots | Volume of roots | Number of roots | Length of roots | Volume of roots |
| Control | 2,48 | 3,81 | 1,38 | 4,51 | 4,18 | 2,38 | 7,84 | 4,32 | 3,01 |
| 0,3% | 2,34 ^{ns} | 4,01* | 1,54* | 4,23 | 4,21* | 2,44* | 7,91 ^{ns} | 4,51* | 3,21* |
| 0,6% | 2,57 ^{ns} | 3,93 ^{ns} | 1,48* | 4,81 | 4,38* | 2,48* | 7,98* | 4,48* | 3,11* |
| 0,9% | 2,38 ^{ns} | 4,21* | 1,49* | 4,54 | 4,59* | 2,58* | 7,78 ^{ns} | 4,78** | 3,17* |
| 1,2% | 2,74 ^{ns} | 4,11* | 1,53* | 4,48 | 4,66* | 2,44* | 7,70 ^{ns} | 4,59* | 3,28** |
| 1,5% | 2,51 ^{ns} | 4,17* | 1,68** | 4,73 | 4,53* | 2,47* | 7,54 ^{ns} | 4,63* | 3,33** |

*(P≤0.05), ** (P≤0.01), *** (P≤0.001), non - significant– ns

Table 2. Influence of AgroArgentum Forte foliar fertilizer on the biometric characteristics of a stem in linden seedlings

| Variants | <i>Tilia cordata</i> | | <i>Tilia platyphyllos</i> | | <i>Tilia tomentosa</i> | |
|----------|----------------------|--------------------|---------------------------|--------------------|------------------------|--------------------|
| | stem height | stem diameter | stem height | stem diameter | stem height | stem diameter |
| Control | 7,18 | 0,18 | 9,47 | 0,21 ^{ns} | 12,51 | 0,24 ^{ns} |
| 0,3% | 7,73* | 0,18 ^{ns} | 10,07* | 0,22 ^{ns} | 12,73* | 0,25 ^{ns} |
| 0,6% | 8,18** | 0,19 ^{ns} | 10,15** | 0,24 ^{ns} | 13,04** | 0,25 ^{ns} |
| 0,9% | 8,48** | 0,18 ^{ns} | 10,28** | 0,28 ^{ns} | 13,57*** | 0,27 ^{ns} |
| 1,2% | 8,51*** | 0,19 ^{ns} | 10,17** | 0,27 ^{ns} | 13,07** | 0,25 ^{ns} |
| 1,5% | 8,40** | 0,19 ^{ns} | 10,08* | 0,26 ^{ns} | 13,11** | 0,23 ^{ns} |

*(P≤0.05), ** (P≤0.01), *** (P≤0.001), non - significant – ns

The differences with the control are very well proven at P≤0.001. The highest plants in all three types of lindens were reported when treated with 0.9% solution of AgroArgentum Forte. The indicator of stem diameter also showed a positive effect of the biomineral fertilizer, but less pronounced than that of height. The number of leaves (Table 3) of the plants treated with different concentrations exceeds those in the control variant by 1.9% - 147.4% for small-leaved linden, from 2.2% - 13.6% for large-leaved linden and from 8.4% - 57.9% for silver-leaved linden. The following trend was observed - with increasing concentration the number of leaves increases. In all three species, the best growth results were reported with 1.2% concentration of AgroArgentum Forte. The results have a high level of evidence, with the exception of 0.3% and 0.6% for large-leaved linden. The obtained results for the influence of the biomineral fertilizer

AgroArgentum Forte on the size of one leaf in all three tested species linden confirm the trend observed in the number of leaves - with increasing concentration, the size of the leaves increases. There is evidence of differences in all variants of the three species.

Table 3. Influence of foliar fertilizer AgroArgentum Forte on the biometric characteristics of the leaf in linden seedlings

| Variants | <i>Tilia cordata</i> | | <i>Tilia platyphyllos</i> | | <i>Tilia tomentosa</i> | |
|----------|----------------------|-----------|---------------------------|--------------------|------------------------|-----------|
| | Number of leaves | leaf size | Number of leaves | leaf size | Number of leaves | leaf size |
| Control | 1,54 | 2,45 | 2,71 | 4,38 | 1,78 | 2,38 |
| 0,3% | 1,58 ^{ns} | 2,81* | 2,57 ^{ns} | 4,54* | 1,93* | 2,54* |
| 0,6% | 1,57 ^{ns} | 2,90* | 2,63 ^{ns} | 4,38 ^{ns} | 1,99* | 2,68* |
| 0,9% | 2,34*** | 2,93* | 2,77* | 4,75* | 2,24** | 2,75* |
| 1,2% | 3,81*** | 3,07*** | 3,08** | 4,98* | 2,78*** | 2,98** |
| 1,5% | 3,47*** | 2,98** | 3,00** | 4,58* | 2,81*** | 2,78** |

*($P \leq 0.05$), ** ($P \leq 0.01$), *** ($P \leq 0.001$), , non - significant – ns

Discussion

The positive results obtained in the foliar treatment of linden seedlings with AgroArgentum Forte are due to the included in a completely new formula of silver particles, which interact with chlorophyll molecules and thus significantly increase photosynthesis. This process causes more intensive absorption of carbohydrates, which leads to an increase in the size of the individual vegetative parts of plants and makes them healthier. The overall functional action of the microbial complex on plant development, which stimulates the root system, improves the overall habit of plants and increases the productivity of photosynthesis. The good results found in the use of new ecologically clean organic and mineral fertilizers are due on the one hand to the balanced formulas rich in organic matter, macro- and micro-elements, vitamins, humic acids and hormones and on the other - to the easily digestible form of nutrients. Our research with the biomineral fertilizer AgroArgentum Forte once again confirms the advantages of modern organic and mineral fertilizers. When treated with organic fertilizers - Humustim and Lumbricol, tested in gypsophila, potted species (carnation and chrysanthemum) and annual flowers (petunia and impatiens), a positive effect on plant growth and development was also observed (Atanassova and Nencheva, 2012; Atanassova and Zapryanova, 2013; Zapryanova and Atanassova, 2013). A positive impact was also reported in the study of the new complex mineral fertilizer HortiGrow on the overall habitus and the individual phases of the development of mini carnation, cyclamen and gypsophila (Atanasova, 2012; Sapundzhieva et al., 2001; Atanassova, 2013). The positive impact of ecologically friendly fertilizers on ornamental crops is indisputable proof not only for improving the growth and development of plants, but also for protecting human health and the environment.

CONCLUSIONS

From the obtained results for the influence of the biomineral fertilizer AgroArgentum Forte in three species of linden *Tilia cordata* Mill., *Tilia platyphyllos* Scop., *Tilia tomentosa* Moench. the following conclusions can be drawn:- Leaf treatment of plants with AgroArgentum Forte has a positive effect on the number and length of roots, the volume of the root system, the height and diameter of the stem, the number and size of leaves in linden.- The optimal concentration for foliar treatment of plants with the biomineral fertilizer is 0.9% solution.- Species specificity was observed with regard to the influence of the biomineral fertilizer AgroArgentum Forte, and it was found that a better effect of foliar treatment was reported in *Tilia cordata* Mill. and *Tilia tomentosa* Moench.

For nursery practice, a concentration of 1.2% solution of AgroArgentum Forte for foliar treatment of linden can be recommended, which also gives good results close to those of the optimal concentration (0.9%).

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