Natural Resources and Sustainable Development
Volume 8, Issue 2, 2018
DOI: 10.31924/nrsd.v8i2.017

GROWTH INCREMENT OF JUVENILE ACER PLATANOIDES L. AND SOIL ORGANIC MATTER AFTER APPLICATION OF ORGANIC FERTILIZERS

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Abstract

The effect of fertilization with organic fertilizers (Siapton and Biohumus) on the growth of Acer platanoides L. saplings was investigated. Four variants were used: Variant V1 - "Siapton" - 1 ml per sapling; variant V2 - "Siapton" 50 ml per sapling; Variant V3 - "Siapton" 50 ml per sapling + 0.5 mg "Kristalon" dissolved in 500 ml of water; Variant V4 - Siapton " 50 ml per sapling + 50% Biohumus and Control (K) - non-fertilized variant. The growth of saplings by root collar diameter (RCD), diameter at breast height (BHD) and height (H) for two years after application of the fertilizers were measured. The best growth results have the saplings where the two organic fertilizers were applied - V4. The application of organic fertilization also improves the soil indicators - the total carbon content (Ct%) was increased, the proportion of "aggressive" fulvic acids was reduced and the ratio: carbon in humic acids / carbon in fulvic acids (Ch / Cf) were enhanced. This gives us reason to recommend organic fertilization in the cultivation of Acer platanoides L. saplings for the needs of forestry and urban planning.

Key words: Norway maple, saplings, fertilization, humus composition

INTRODUCTION

Norway maple (*Acer platanoides L.*) belongs to a family *Sapindaceae Juss*, genus *Acer L.*, section *Platanoidea*. It is fast-growing species, one of the most valued representatives of the genus, with its application for furniture, veneer and musical instruments (Pandeva, 2007; Nowak, Rowntee, 1990).

For Europe it is wide-spread, native species with an area of distribution from Scandinavia to Ural Mountains, at elevation from sea level to about 1800 m altitude. The species is attached to fresh, humid and moderately rich to rich habitats (Pandeva, Alexandrov, 2000; Pandeva, Glushkova, 2005; Tomov et al., 2014).

It loves shady exposure and deep, fertile, moist soils with pH 5.5 – 6.5 (Nowak, Rowntee, 1990; Pandeva, Alexandrov, 2000). To acid soils (pH<4), soils insufficiently enriched with nutrients and prolonged droughts the species is intolerant (Caudullo, de Rigo, 2016).

The longevity of the species is 120-150 years, but can reach up to 250 years (Praciak et al., 2013). It grows in mixed forest (deciduous or coniferous) individually or forming small groups of individuals mostly with Acer pseudoplatanus L. (Nowak, Rowntee, 1990).

Rubner (1953) says that the most favorable conditions for species to develops has Balkan Peninsula. In Bulgaria *Acer platanoides L*. occupies spaces in oak, beach, hornbeam and fir forests with altitude from 500 to 1500 m (Pandeva, Glushkova, 2005; Milev et al., 2004). There are 49 seed-production forest stands on the territory of the country. In dependence on soil conditions and climatic influences according to difference in habitats various phenological forms of Acer platanoides L. can be found (Pandeva, 2007).

Acer platanoides L. are used except for timber production, also as ornamental and street-side tree because of its beautiful crown and tolerance to urban conditions (sealings; contaminations etc.) (Caudullo, de Rigo, 2016). This requires some efforts in relation with growing of its saplings.

One of the best ways to be enhanced the resilience, growth and interception of young saplings is the use of fertilizers. By fertilization we can improve the soil quality and soil microbial activity; to increase total production of biomass and resilience towards air contamination, insects and diseases; to shorten the time for production of good saplings in the nurseries; to promote the interception and development of the young plantations (Donov, 1984; McCament, McCarthy, 2005; Kong et al., 2008; Baldi et al., 2014).

Using organic fertilizer, Zeng et al. (2007) founded that fertilized saplings had height about 1.5 time over control. But not in every case the effect of fertilization of trees is significant. There are results of marginal effects or a lack of any effects (Herendeen, 2007; Patterson, Dimov, 2013). Thus, Dakev and Badgov (1975) by using N-mineral fertilizer ascertained that treated and untreated saplings of *Acer platanoides* L. had approximately same weight. Is this will be true by using organic soil amendments?

In current work we are looking for some positive effects on the saplings increments of *Acer platanoides L*. and on the soil organic matter composition in relation with the use of organic fertilizers.

For this purpose, we use organic amendment “Siapton” which is a new product for Bulgarian market.

MATERIAL AND METHOD

The experience was set in 2016 on Smolnitsa (Vertisols - FAO 2006) with an organic carbon content of 3.93%, a total nitrogen content of 0.12 % and a pH of 6.42. Seedlings (*Acer platanoides L.*) were planted in the last week of March 2016 in 7 rows of 7 pieces or a total of 49 saplings.

The fertilization is done with a liquid organic fertilizer with biostimulating action "Siapton", developed on the basis of natural hydralized proteins. It is recommended for foliar and soil application. The

organic fertilizer is specialized in increasing yield and quality of production and activating crop defenses in stressful environment situations. In combination with "Siapton" was used "Kristalone" mineral fertilizer containing N, P, K, Mg and other microelements. Also, the organic amendment was used in combination with another organic fertilizer "Biohumus" made of red California worm. The Experiment Scheme (Table 1) is composed of five variants with 9 items each:

Table 1

Scheme of the experiment with fertilization of saplings Acer platanoides L.

43 7-1	**44** 7-2	**45** 7-3	**46** 7-4	**47** 7-5	**48** 7-6	**49** 7-7
36 6-1	**37** 6-2	**38** 6-3	**39** 6-4	**40** 6-5	**41** 6-6	**42** 6-7
29 5-1	**30** 5-2	**31** 5-3	**32** 5-4	**33** 5-5	**34** 5-6	**35** 5-7
22 4-1	**23** 4-2	**24** 4-3	**25** 4-4	**26** 4-5	**27** 4-6	**28** 4-7
15 3-1	**16** 3-2	**17** 3-3	**18** 3-4	**19** 3-5	**20** 3-6	**21** 3-7
8 2-1	**9** 2-2	**10** 2-3	**11** 2-4	**12** 2-5	**13** 2-6	**14** 2-7
1 1-1	**2** 1-2	**3** 1-3	**4** 1-4	**5** 1-5	**6** 1-6	**7** 1-7

1. Control (K) – non-fertilized saplings - (saplings 1-7 and 7-49)
2. Variant V1 - "Siapton" - 1 ml per sapling (saplings 29-43; 31-45; 33-47)
3. Variant V2 - "Siapton" 50 ml per sapling (saplings 30-44; 32-46; 34-48)
3. Variant V3 - "Siapton" 50 ml per sapling + 0.5 mg "Kristalon" dissolved in 500 ml of water (saplings 8-22; 10-24; 12-26)
4. Variant V4 - "Siapton" 50 ml pere sapling + 50% of Biohumus (saplings 9-23; 11-25; 13-27)

"Siapton" was applied to the soil, twice during the vegetation period: 08.06.2016 and 28.06.2016. Each month during the vegetation period with digital caliper were measured RCD1 / RCD2 - two perpendicular root collar diameters; DBH1 / DBH2 - two perpendicular diameters at breast height (1.30m). The height (H) of each sapling was measured too, using a digital rod. The arithmetic mean values were calculated.

Soil samples were taken after 1.5 year of fertilizers application – on October 2017 in depth 0-10cm. There was applied the method of Kononova – Balchikova (1961) for determining the soil humus composition. This method comprises the following steps: total content of humic and fulvic acids with a mixed solution of 0.1N $Na_4P_2O_7$ and 0.1M NaOH; free and bound to the sesquioxides (R_2O_3) with 0.1M NaOH; aggressive fulvic acids with 0.05M H_2SO_4. The soil-to-solution ratio is 1:20 for all three extracts.

RESULTS AND DISCUSSION

The measured mean values of RCD, DBH and H by months in the two years after fertilizers application are shown in figures. Figure 1 and 2 show the RCD increments per 2016 and 2017 respectively, figures 3 and 4 show

DBH increment for 2016 and 2017 respectively, and figures 5 and 6 give the increment of H for the same years.

Saplings begin their growth from different diameters and height values. However, in the first year there was a slowdown in the growth of the control compared to the growth rates of fertilized saplings. Much more obvious is the difference in the rate of growth between the non-fertilized and the fertilized saplings in the second year after fertilization (2017).

Long-lasting effects of fertilization have been established with sharper differences in the more distant period of fertilizers application - in the second year. Particularly strong is the effect of fertilization if we present the results in annual growth, calculated as the difference between the values of diameters and heights in the beginning and the end of 2016 and respectively in the beginning and the end of 2017.

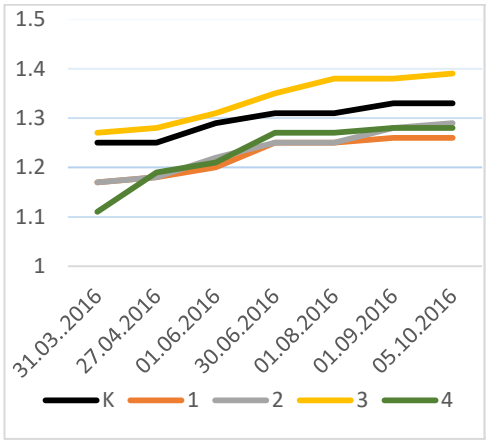

Fig. 1. Mean RCD (cm) -2016

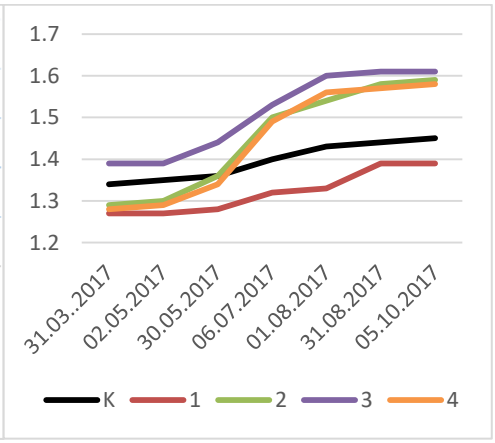

Fig. 2. Mean RCD (cm) -2017

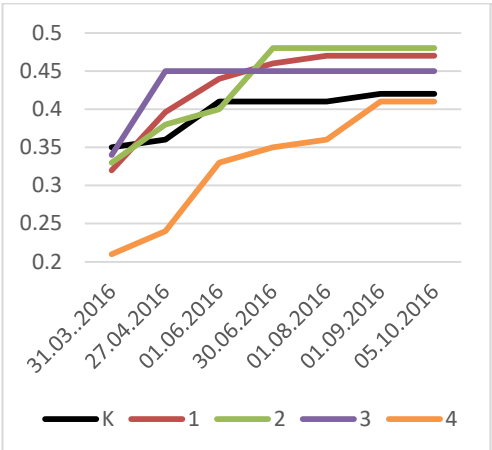

Fig. 3. Mean DBH (cm) -2016

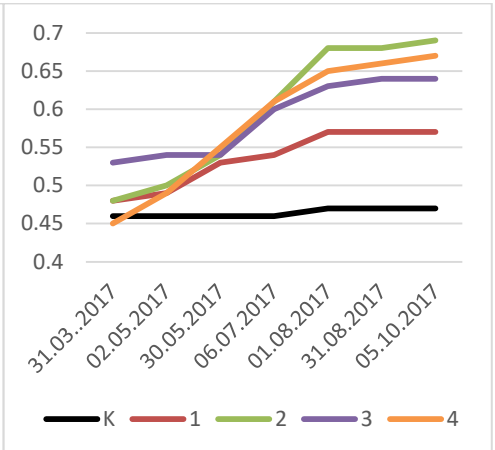

Fig. 4. Mean DBH (cm) -2017

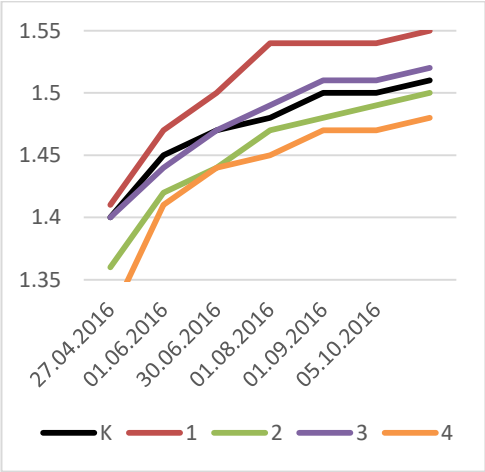

Fig. 5. Mean H(cm) -2016

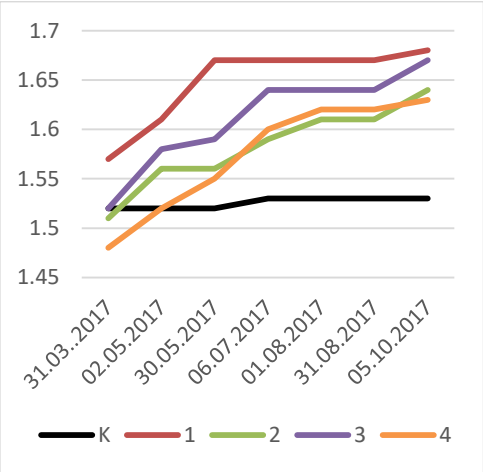

Fig. 6. Mean H (cm) -2017

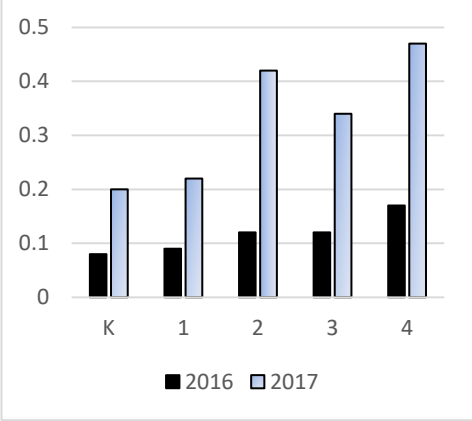

Fig. 7. Anual RCD (cm) increment

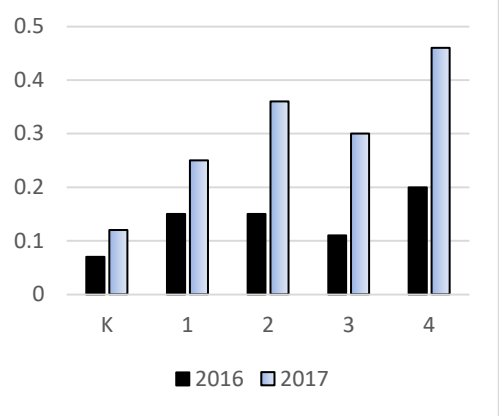

Fig. 8. Anual DBH (cm) increment

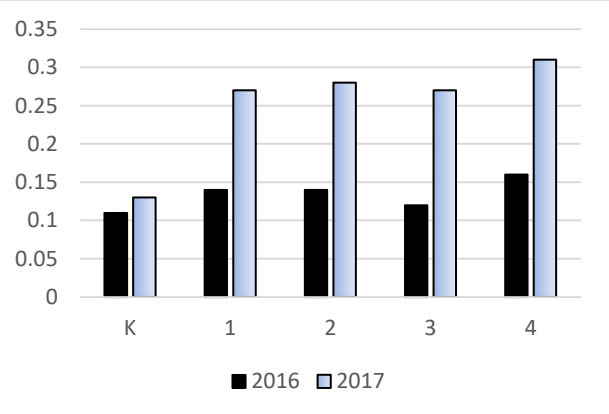

Fig. 9. Mean H (cm) increment

It is established in all measurements bigger increment of RCD, DBH and H for the saplings that are fertilized compared to the saplings of the control. The growth of saplings of Variant 1 (V1) is comparatively less where we applied lower dose of the Siapton organic improver (1ml per sapling). It is obvious that the dose is important in the use of organic fertilizers and that at lower doses the effect is less significant. More over, at very low doses, the effect of fertilization can be reduced to zero - that is, lacking effect. That found Rieske et al. (2003) using very low doses of N-mineral fertilizer on the growth of American chestnut saplings. It should be noted that the best effect on BHD and height was observed with the use of "Siapton" in a larger dose (Variant 2) and especially when using a combination of 2 organic fertilizers (Siapton + Biohumus). Namely when using the combination of two organic fertilizers (Variant 4) that the diameters and height increments are the best. This confirms our hypothesis that organic fertilization has a positive effect on the growth of saplings of *Acer platanoides L.*

We have also analyzed the composition of humus 1 year after application of fertilization. The results are given in table 2.

The amount of total carbon was increased 1 year after application of fertilization in variants with organic fertilization: V2 (the variant with higher doses Siapton) and V4 (combination Siapton + Biohum). Particularly high is the increase of the total carbon in V4, where the soil from average humic as it is in K (Ct = 3.8%) has turned into humic soil (Ct = 5.04 %).

The humus consists of humic acids and fulvic acids. Humic acids are the more stable part of the organic matter in the soil, which part represents the carbon that is sequestered in soil. Humic acids are long-chain carbon compounds that are difficult to move and decompose. On the contrary, fulvic acids are shor-chain carbon compounds and more easily decomposable.

They move easily into soil with run-off and are comparatively mobile compounds. The most mobile are the so-called "Aggressive" fulvic acids that we extracted with 0.1N H2SO4. The humic acid fraction is higher in K and V1 (low doses of Siapton), but this is also due to the higher amount of total C extracted with the pyrophosphate extract (10 %).

However, the amount of the fulvic acids (0.24%) in K and especially the "aggressive" fulvic acids (0.13%) - the most unstable part of the soil organic matter, is also higher in K. The fact that K has the worst humus composition in the soil is best demonstrated in the calculation of the ratio of humic / fulvic acids (Ch / Cf). The lowest is this ratio (0.58) in K, indicating that the fulvic acids occupy the highest share in the soil organic matter in these soil (K).

Table 2

Humus composition

Sample Plot	Humus (%)	Total C (%)	Organic carbon, (%), extracted with 0.1M $Na_4P_2O_7$+0.1M NaOH						Ch/Cf	Organic carbon, (%) fraction of Humic Acids		Non-Extractible carbon, (%) (Crest)		"Aggressive" Fulvic Acids - Extracted with 0.1N H_2SO_4 (%)	
			C - total		C, (%) - Humic Acids		C, (%) - Fulvic Acids								
Number of the column	1	2	3	%	4	%	5	%	6	7	8	9	%	10	%
										Free or bounded with R2O3- Extracted with 0.1 N NaOH	Bounded with Ca				
K	6.72	3.90	0.38	10	0.14	4	0.24	6	0.58	100	0.00	2.40	96	0.13	3
V1	6.83	3.96	0.33	8	0.15	4	0.18	5	0.82	100	0.00	3.63	92	0.12	3
V2	7.76	4.50	0.38	8	0.16	3	0.22	5	0.70	100	0.00	4.12	92	0.11	2
V3	5.17	3.00	0.31	10	0.14	5	0.17	6	0.81	100	0.00	2.69	90	0.11	4
V4	8.69	5.04	0.22	4	0.12	2	0.10	2	1.14	100	0.00	4.82	96	0.11	2

PS. The % is calculated to the weight of soil sample, but the % in columns (Number of the column) is calculated to the amount of the total carbon in soil sample

The soils of the different variants also have a Ch / Cf < 1 ratio, which also shows the fulvic-type humus of these soils. But in V4 where there is a combination of two organic fertilizers, the ratio Ch / Cf > 1 (1.14) and here we have a humus type of humus on this soil in the superficial horizons.

CONCLUSIONS

The use of organic fertilizers - "Siapton" and "Biohumus" is beneficial for the growth of the saplings of *Acer platanoides* L. Saplings grow significantly better than the non-fertilized variants (control). The diameters (root collar diameter and diameter at breast height) and height increments in variants with the use of organic fertilizers are the best. The humus composition is also improved by the application of organic fertilizers. The ratio Ch / Cf is increased. This gives us the basis for recommendation of the use of organic fertilizers in growing *Acer platanoides* L. for the purpose of forestry or urban planning.

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Received: November 23, 2018
Revised: November 28, 2018