Current Trends in Natural Sciences Vol. 4, Issue 7, pp. 23-31, 2015

Current Trends in Natural Sciences (on-line)
ISSN: 2284-953X
ISSN-L: 2284-9521

Current Trends in Natural Sciences (CD-Rom)
ISSN: 2284-9521
ISSN-L: 2284-9521

THE CULTURE OF *ASIMINA TRILOBA* (L.) DUNAL SEEDLINGS WITH A VIEW TOWARD THEIR DEVELOPMENT AS PLANTING MATERIAL

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Abstract
Asimina triloba (L.) Dunal, an exotic North American temperate-climate species, is little known or appreciated in Europe, especially in Romania. This work, with its goal of remodeling green spaces in Baia Mare by introducing the decorative species Asimina triloba (L.) Dunal, proposes to test seedlings of the species in forced cultivation for producing vigorous dendrological material in a reduced time frame. Thus, in the course of experiments that took place from January to May 2014, the ecological valences of Asimina triloba were measured. The pedoclimatic conditions experienced were favorable to the growth and development of the plant in question.

Keywords: Asimina triloba, physiological features, photosynthesis intensity, ornamental value.

1. INTRODUCTION

The species *Asimina triloba* (L.) Dunal is cultivated with a decorative purpose in twenty-six American states, centered in the South but going from northern Florida to Western Nebraska and to Southern Ontario in Canada (Kral, 1960; Young and Yavitt, 1987; Callaway, 1990; Callway, 1993). Its elevated potential for use in landscaping derives from its ornamental qualities (Sargent, 1890 cit. by Layne, 1996). It can be cultivated in extended plantations, in private gardens and in public parks (Finneseseth and Layne, 1998).

The species' ornamental value comes from the fact that flowers bloom in early spring before leaves appear, from its shape, from the dimensions and colors of its leaves and from the appearance of its fruits.

The floral decor of *Asimina triloba* (L.) Dunal is improved by the way the carmine-colored flowers are arranged on the twigs. They appear in groups of three or more per twig, and have petals of 1.5-3 cm in diameter. Another important decorative characteristic is the candelabra-shaped crown.

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ISSN-L: 2284-9521

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The leaves also intensify the tree's ornamental character (Hunter, 1989). The leaves' decorative aspect is maintained throughout the period of vegetation. Spring, the leaves are light green; in summer, they turn dark green to golden; while in autumn, they are an intense red.

In autumn, the decorative effect of *Asimina triloba* (L.) Dunal trees is enhanced by the shapes and arrangement of fruits at the year-old stem bases. These reach dimensions of 5-15 cm, with a seed ratio of 8-24% (Layne, 1996).

These ornamental characteristics, taken together, recommend the *Asimina triloba* (L.) Dunal plant as "an integrating component of the aesthetic landscape" (Layne, 1996) with a high decorative potential. Given this, the plant is frequently found in floral arrangements in the United States (Szilagyi et al., 2014).

In Romania, *Asimina triloba* (L.) Dunal was first mentioned fifty years ago in Pianu de Sus village, Alba County. The species was also recorded 25-35 years ago at the Dimitrie Brândza Botanical Garden in Bucharest. In the past twenty years, numerous studies into the pomology of *Asimina triloba* (L.) Dunal have been performed (Cepoiu et al., 2004). It has been grown both as a bush of 3-7 m (Stănică & Cepoiu, 2003) and as a conical or globe-shaped tree of 5-10 m. It was also observed that *Asimina triloba* (L.) Dunal has a behavior similar to that found in its native regions (Cepoiu et al., 2003).

At 8 km west of Baia Mare (NW Romania), in Lăpuşel Commune, a planting of *Asimina triloba* (L.) Dunal was established in 2002, including 15 saplings. This began yielding abundant fruits in autumn 2007, while the seeds collected represent the basis for experiments undertaken at Baia Mare in 2014.

The conditioning of pedoclimatic factors in the soil-plant relation has been scientifically demonstrated (Laasimer, 1965; Chertov, 1981; Kolli, 1987; Ibanez et al., 1998; Fisher et al., 2002; Targulian and Krasilnikov, 2007; Bazilevich and Titljanova, 2008; Paal et al., 2011, Köster and Kõlli, 2013). Moreover, the qualities of the soil determine its state of favorability with direct influences on the development of the vegetation, of the floral composition and in maintaining biodiversity. In this context, Baia Mare is characterized by the following types of soil: argillic soil, cambisols and andisols. The majority of soil types in this area are strongly acidic, even holoacidic, and are thus very vulnerable to pollution from heavy metals and SO_2 (Miloiu, 2008). Situated at a meeting point between valleys, hills and mountains, Baia Mare has a varied flora, characteristic of these relief types. Favorable conditions for thermophilic vegetation have been created on southerly slopes around Baia Mare. Average summer temperatures are 19.5˚C, in winter dropping to -2.8˚C, while the annual average is 9.8˚C. Frost is present on 100-120 days per year. The Baia Mare depression is characterized by a high frequency of precipitation (annual averages of 976 mm), (Environmental Status Report, Maramureş County, 2008). The are is characterized by atmospheric calm. Temperature and precipitation conditions recorded at 194 m altitude are favorable for the development of exotic species: *Castanea sativa*, *Cryptomeria japonica*, *Cedrus atlantica*, *Paulownia tomentosa* (Bolea and Chira, 2009). It should be noted that these conditions fulfill the ecological demands of the reference plant.

Upcoming research will investigate transplantation into pedoclimatic conditions particular to Baia Mare and monitorization of *Asimina triloba* (L.) Dunal saplings tested under experimental conditions.

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2. MATERIALS AND METHODS

In January-May 2014, biofactorial experiments were organized at the Plant Physiology Laboratory of the Baia Mare North University. The study's subjects consisted of year-old *Asimina triloba* (L.) Dunal saplings, planted in equally-sized and shaped pots. Three culture substances (**Factor A**) were applied; these were different in their physical and chemical components. A second experimental factor (**Factor B**) was analyzed; this was represented by phasic fertilization.

The experiments are based on nine variants, their reference point being the **V1**-witness variant. The nine experimental variants were applied based on the two experimental factors (**Factors A and B**). Thus, the following combinations were obtained: $\mathbf{V_1}$-F_1S_1, $\mathbf{V_2}$-F_1S_2, $\mathbf{V_3}$-F_1S_3, $\mathbf{V_4}$-F_2S_1, $\mathbf{V_5}$-F_2S_2, $\mathbf{V_6}$-F_2S_3, $\mathbf{V_7}$-F_3S_1, $\mathbf{V_8}$-F_3S_2 and $\mathbf{V_9}$-F_3S_3.

The *Asimina triloba* (L.) Dunal saplings grouped into variants $\mathbf{V_1}$, $\mathbf{V_2}$ and $\mathbf{V_3}$ represent the unfertilized planting material tested on the three culture substrates. Regarding the compositions of variants $\mathbf{V_4}$, $\mathbf{V_5}$ and $\mathbf{V_6}$, these form the planting material that was fertilized for four weeks, divided into the same three culture substrates.

The sapling groups belonging to variants $\mathbf{V_7}$, $\mathbf{V_8}$ and $\mathbf{V_9}$ represent planting material fertilized for eight weeks divided among the three culture substrates.

Phasic fertilization took place once a week at an interval of seven days.

Likewise, the pedoclimatic conditions in which the plant material was tested were recorded. Thus, daily tests (9:13:17) were done for five months (January-May 2014) for the following environmental factors: air and soil humidity and temperature. Aside from these observations, the intensity of photosynthesis was determined using the same methods. Furthermore, the following decorative parameters were biometricized: differences in growth of width; leaf size (length and width). Data regarding the vegetal evolution of *Asimina triloba* (L.) Dunal saplings were gathered once every 14 days (bimonthly) for the duration of the experiments (January-May 2014).

<u>The culture factors analyzed in the experiments were:</u>

-Factor A, culture substrate (**S**):

- $\mathbf{S_1}$ - substrate I: potting soil 75%, sand 25% (3:1);
- $\mathbf{S_2}$ - substrate II:potting soil 50%, manure 25%, sand 25% (2:1:1);
- $\mathbf{S_3}$ - substrate III:potting soil 25%, sphagnum moss 25%, manure 25%, sand 25% (1:1:1:1).

-Factor B, fertilization (**F**): Fertilizer: 15N-30P-15K-2.5MgO-trace elements,

- $\mathbf{F_1}$ - unfertilized;
- $\mathbf{F_2}$ - fertilized for 4 weeks;
- $\mathbf{F_3}$ -fertilized for 8 weeks.

The quantity of fertilizer administered was 4.24 gr/plant.

The statistical analysis of the data was accomplished using standard statistical methods (Pearson correlation coefficient and regression analysis), with the aid of SPSS 17 (Statistical Package for the Social Sciences) (Howit and Cramer, 2006, 2011).

3. RESULTS AND DISCUSSIONS

The organization of experiments between January and May 2014 had as its objective the determination of the combined and independent influence of the effect of applying the fertilizer 15 N-30 P-15 K 2.5 MgO-trace elements, for four weeks, respectively eight weeks, and the effect of the culture substrate on the vegetal evolution of *Asimina triloba* (L.) Dunal plants arising from seeds germinated in 2013.

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The cumulative influence of the two experimental factors was analyzed: the fertilizer factor (**F_1** - unfertilized; **F_2** - fertilized 4 weeks; **F_3** - fertilized 8 weeks) and the culture substrate factor (**S_1** - substrate I: potting soil: sand (3:1); **S_2** - substrate II: potting soil, manure, sand (2:1:1); **S_3** - substrate III: potting soil, sphagnum moss, manure, sand (1:1:1:1) on the following decorative parameters: sapling height, length and width of *Asimina triloba* (L.) Dunal leaves.

Thus, nine experimental variants were obtained: **V_1**-F_1S_1, **V_2**-F_1S_2, **V_3**-F_1S_3, **V_4**-F_2S_1, **V_5**-F_2S_2, **V_6**-F_2S_3, **V_7**-F_3S_1, **V_8**-F_3S_2 and **V_9**.-F_3S_3. Together, these form our object of study, and are divided into three blocs (Table 1).

Table 1. Identifying predictors favorable to the development of decorative parameters

Experimental factor: F-fertilizer, S –culture substrate		Unstandardized Coefficients		Standardized Coefficients	t	Significance
Model	**Variants**	**B**	**Std. Error**	**Beta**		
1	**(Constant)**	65.239	3.914	-	16.669	000
	F_1S_1	-19.223	3.845	-641	-5.000	000
	F_1S_2	-8.683	2.259	-493	-3.844	001
	F_1S_3	-6.549	2.177	-386	-3.009	006
2	**(Constant)**	74.865	4.180	-	17.909	000
	F_1S_1	-22.691	3.257	-757	-6.966	000
	F_1S_2	-10.618	1.905	-603	-5.574	000
	F_1S_3	-8.448	1.839	-498	-4.594	000
	F_2S_1	-5.763	1.686	-369	-3.417	003
	F_2S_2	-3.867	1.567	-267	-2.467	023
	F_2S_3	-1.935	1.353	-155	-1.431	168
3	**(Constant)**	55.103	5.919	-	9.309	000
	F_1S_1	-15.573	3.001	-520	-5.189	000
	F_1S_2	-6.646	1.726	-377	-3.851	001
	F_1S_3	-4.550	1.675	-268	-2.716	015
	F_2S_1	-2.325	1.516	-149	-1.534	144
	F_2S_2	-.555	1.427	-038	-389	702
	F_2S_3	1.020	1.246	082	818	424
	F_3S_1	2.336	1.234	184	1.893	075
	F_3S_2	3.299	1.048	311	3.148	006
	F_3S_3	4.912	1.138	426	4.315	000

a Dependent Variable: Decorative parameters

In attempting to determine the most favorable variant in terms of developing decorative parameters (sapling height, length and width of *Asimina triloba* (L.) Dunal leaves), we performed a multiple hierarchical regression (Table 1).

The variables introduced in the last block (3) (F_1S_1, F_1S_2, F_1S_3, F_2S_1, F_2S_2, F_2S_3, F_3S_1, F_3S_2, F_3S_3) justify to a degree of 86 % (R2 = 0.86) the influence exercised by the experimental factors upon the decorative parameters compared to block 2 and block 1, which justify the influence to a smaller degree (73 % and 59 %, respectively) (R2 = 0.73; R2 = 0.59).

Analyzing the data in block 3 reveals that variant **V_9** - F_3S_3 (B = 4.91) most influences the evolution of decorative parameters for *Asimina triloba* (L.) Dunal, followed by variant **V_8** – F_3S_2 (B = 3.30) and by variant **V_7**-F_3S_1 (B = 2.33). In a similar vein, we observed that the following experimental variants: **V_1**–F_1S_1 (B = -15.57), **V_2**-F_1S_2 (B = -7.65), **V_3**-F_1S_3 (B = -4.55), **V_4**-F_2S_1 (B = -2.33) and

Current Trends in Natural Sciences (on-line)
ISSN: 2284-953X
ISSN-L: 2284-9521

Current Trends in Natural Sciences (CD-Rom)
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ISSN-L: 2284-9521

V_5-F_2S_2 (B = -0.56) negatively influence the vegetative evolution of the decorative characteristics studied (sapling height, length and width of leaves) under the combined influence of the experimental factors.

We observed that the variant **V_6**-F_2S_3 (B = 1.02) exercises a positive but weaker influence on the decorative parameters.In order to determine the unilateral effect of the fertilization factor (**F**) upon the growth in height of saplings, we grouped the results obtained from our research based on the gradations in the fertilizer factor (Table 2) and the culture substrate factor (**S**) (Table 3). The values recorded in the tables (Tables 2 and 3) represent the differences in growth obtained by measuring seedlings belonging to the same variant.

Analyzing the results regarding the unilateral influence of the fertilizer factor (**F**), we found differences in height growth between the initial values (January) and the final ones (May), of between 3.2 cm (control group - **F_1**) and 9.1 cm (group **F_3**), which indicates a percentage growth of between 87.5 % and 184.3 %, as against the control (**F_1**-unfertilized).

Table 2. Experimental results regarding the growth in height of Asimina triloba (L.) Dunal plants under the influence of fertilizer

Experimental factor: F-fertilizer	Diference in grouth (cm)	% compared to control (Mt)	± d	Significance
F_1 (V_1+V_2 +V_3)- Mt	3.2	-	-	-
F_2 (V_4+V_5+V_6)	6.0	187.5	2.8	***
F_3 (V_7+V_8+V_9)	9.1	284.3	5.9	***
F media	6.1	190.6	2.9	
DL 5%			**1.56**	
DL 1%			**1.83**	
DL 0.1%			**2.52**	

Taking as a starting point the value of the control (F1-unfertilized), the growths recorded under the influence of the fertilizer factor are positive and statistically confirmed with a high degree of confidence. The same cannot be said when the results are grouped according to gradations in the culture substrate (**S**) factor (Table 3).

Table 3. Experimental results regarding the growth in height of Asimina triloba (L.) Dunal plants under the influence of culture substrate

Experimental factor: S – culture substrat	Diference in grouth (cm)	% compared to control (Mt)	± d	Significance
S_1 (V_1+V_4 +V_7)- Mt	5.9	-	-	
S_2 (V_2+V_5+V_8)	5.8	98.3	-0.1	-
S_3 (V_3+V_6+V_9)	6.6	111.8	0.7	-
S media	6.1	103.3	0.2	
DL 5%			**1.38**	
DL 1%			**1.67**	
DL 0.1%			**2.26**	

The differences between the variants **S_2**, **S_3** and **S_1** - the control group, are no longer statistically visible. Measured against the control value (**S_1**- control group), we observed that the growth

Current Trends in Natural Sciences (on-line)
ISSN: 2284-953X
ISSN-L: 2284-9521

Current Trends in Natural Sciences (CD-Rom)
ISSN: 2284-9521
ISSN-L: 2284-9521

differences between the values of the sapling heights obtained at the beginning and at the end of the study are not positive within the group obtained after graduating $\mathbf{S_2}$ (Table 3).

Following the evolution of decorative parameters for *Asimina triloba* (L.) Dunal saplings, leaf length was also biometrized, together with plant height. Growth differences obtained following graduation of the fertilizer factor, compared with the group labeled the control, show positive values. These are statistically confirmed and considered distinctly positive and significant (Table 4).

Table 4. Experimental results regarding the growth in length of Asimina triloba (L.) Dunal plants under the influence of fertilizer

Experimental factor: F-fertilizer	Diference in grouth (cm)	% compared to control (Mt)	± d	Significance
F_1 (V_1+V_2 +V_3)- Mt	5.4	-	-	-
F_2 (V_4+V_5+V_6)	7.3	135.1	1.9	**
F_3 (V_7+V_8+V_9)	7.2	133.3	1.8	**
F media	6.7	124.0	1.3	

DL 5%	1.32
DL 1%	1.78
DL 0.1%	2.12

Analyzing the unilateral influence of the culture substrate factor upon the growth in length of *Asimina triloba* (L.) Dunal leaves, we observed that variants $\mathbf{S_2}$ and $\mathbf{S_3}$ have elevated values compared to $\mathbf{S_1}$-control variant and are statistically confirmed (Table 5).

Growth differences in the variants pertaining to **S2** are very positively significant, as opposed to the results obtained for group **S3,** which are merely distinctly positively significant and close together (Table 5). Alongside leaf length, we also measured their width in order to determine their growth under the influence of the experimental factors studied.

Table 5. Experimental results regarding the growth in length of Asimina triloba (L.) Dunal plants under the influence of culture substrate

Experimental factor: S – culture substrat	Diference in growth (cm)	% compared to control (Mt)	± d	Significance
S_1 (V_1+V_4 +V_7)- Mt	5.1	-	-	
S_2 (V_2+V5+V_8)	7.8	152.9	2.7	***
S_3 (V_3+V_6+V_9)	6.8	133.3	1.7	* (*)
S media	6.6	129.4	1.5	

DL 5%	1.32
DL 1%	1.78
DL 0.1%	2.12

When grouping the data obtained after graduating the fertilizer factor, we find that the leaves of *Asimina triloba* (L.) Dunal saplings display significant growth in width compared to the control group only in the case of $\mathbf{F_3}$.

The differences pertaining to $\mathbf{F_2}$ are not statistically confirmed, being insignificant (Table 6). Regarding the cumulative influence of the culture substrate factor, the leaves of *Asimina triloba* (L.) Dunal saplings have elevated width values compared to the control group, and the differences are both positive and statistically confirmed (Table 7).

Current Trends in Natural Sciences (on-line)
ISSN: 2284-953X
ISSN-L: 2284-9521

Current Trends in Natural Sciences (CD-Rom)
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Table 6. Experimental results regarding the growth in width of Asimina triloba (L.) Dunal plants under the influence of fertilizer

Experimental factor: F-fertilizer	Diference in grouth (cm)	% compared to control (Mt)	± d	Significance
F_1 (V_1+V_2 +V_3)- Mt	3.0	-	-	-
F_2 (V_4+V_5+V_6)	3.2	106.6	0.2	-
F_3 (V_7+V_8+V_9)	3.7	123.3	0.7	*
F media	3.3	110.0	0.3	
DL 5%			**0.67**	
DL 1%			**1.04**	
DL 0.1%			**1.25**	

Regarding gradations for S_2, the differences are very closely distinctly significative and are very positively significant for the gradations pertaining to S3 (Table 7).

Table 7. Experimental results regarding the growth in width of Asimina triloba (L.) Dunal plants under the influence of culture substrate

Experimental factor: S – culture substrat	Diference in grouth (cm)	% compared to control (Mt)	± d	Significance
S_1 (V_1+V_4 +V_7)- Mt	2.2	-	-	
S_2 (V_2+V5+V8)	3.4	154.5	1.2	**(*)
S_3 (V3+V6+V9)	4.4	200.0	2.2	***
S media	3.3	150.0	1.1	
DL 5%			**0.67**	
DL 1%			**1.04**	
DL 0.1%			**1.25**	

For the duration of the experiments, the average air temperature (deciles I-VI) was between 21 and 22˚C, while the average culture substrate temperature ranged between 20 and 21˚C. Relative air humidity was between 40 and 49 %, while in the soil, it was between 32 and 40 %. Photosynthesis intensity in the plants studied varied between 43 and 55 %.

After monitoring the photosynthesis process, we measured the degree to which pedoclimatic conditions (humidity and temperature of the air and soil) under which the dendrologic material of *Asimina triloba* (L.) Dunal was tested influenced the plants' vegetal evolution. Thus, we determined the Pearson correlation coefficient (Table 8).

Analyzing the results obtained after correlating conditions in a controlled environment and the intensity of photosynthesis, we observed that atmospheric humidity ($\mathbf{H_A}$) was the factor that most influenced the process of photosynthesis ($r = 0.82$, $DF = 4$, $p < 0.05$), followed by soil humidity ($\mathbf{H_S}$) ($r = 0.54$, $DF = 4$, $p < 0.05$). Likewise, we observed that the temperature factor exerts a negative influence on the photosynthesis process ($\mathbf{T_S}$ – $r = -0.26$, $DF = 4$, $p = 0.05$; $\mathbf{T_A}$ – $r = -0.45$, $DF = 4$, $p < 0.05$). These results confirm studies performed on the intensity of plant photosynthesis in North America, revealing a physiological behavior identical to that of the reference species (Ainsworth, Davey, Hymus, Drake, Long, 2002; Crummer, K., 2003).

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Table 8. Correlation between the environmental conditions and the process of photosynthesis In Asimina triloba (L.) Dunal for the duration of the experiments

Correlations		**Soill**		**Atmosphere**	
		Temperature (T_S)	**Humidity (U_S)**	**Temperature (T_A)**	**Humidity (U_A)**
Photosynthesis (F)	**Pearson correlation**	-258	544	-446	815
	Sig. (2 tailed)	05	035	037	048
	N	6	6	6	6

*** Correlation is significant at the 0.05 level (2-tailed).**

In the future, we plan to transplant *Asimina triloba* (L.) Dunal saplings tested in the pedoclimatic conditions of Baia Mare. We will be mindful of the fact that introducing non-native species into a new habitat can, in time, endanger the local ecological equilibrium (Mack, Simberloff, Lonsdale, Evans, Clout, Bazzaz, 2000; Lovett, Canham, Arthur, Weathers, Fitzhugh, 2006; Preda-Godeanu, 2013). Thus, we propose, together with Szilagyi and Marian (2011), that the eventual introduction of the species into public species be accompanied by permanent monitoring of the following parameters: morphological, anatomical, ecophysiological and phenological characteristics, as well as allelopathic behavior.

4. CONCLUSIONS

In synthesizing the results obtained, we can affirm that*Asimina triloba* (L.) Dunal saplings are influenced by the culture substrate (**S**) experimental factor in leaf growth. Likewise, *Asimina triloba* (L.) Dunal saplings show height growth following the application of fertilizer. We note that fertilizer applied for eight weeks spurs a more intense growth (**F_3**).

Regarding the vegetal evolution of decorative characteristics under the influence of experimental factors (**F** and **S**), favorable results were recorded for the following variants, listed in decreasing order based on the cumulative effect: **V_9**-F_3S_3 , **V_8**–F_3S_2 and **V_7**-F_3S_1.

In the event of applying a forced culture for year-old *Asimina triloba* (L.) Dunal saplings, we recommend placing pots in a controlled climate and applying fertilizer for eight weeks in the conditions of the experiment (**F_3S_3**).

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ISSN-L: 2284-9521

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ISSN-L: 2284-9521

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