RESEARCHES CONCERNING THE INFLUENCE OF CULTIVATION AND TECHNOLOGY SYSTEMS UPON GROWTH AND DEVELOPMENT OF THUJA OCCIDENTALIS L. PYRAMIDALIS AND THUJA OCCIDENTALIS L. GLOBOSA CULTIVARS

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Abstract

Growth of Thuja occidentalis Pyramidalis and occidentalis Globosa cultivars expressed in stem height is more vigorous in plants cultivated in containers than in the field due to more favorable thermal regime in the substrate and due to the better water and nutrients intake regime.

The cultivation in nursery containers enhances growth with 47.5% in Thuja occidentalis Pyramidalis and 36.6% in Thuja occidentalis Globosa compared to the cultivation in nursery soil.

Keywords: *Thuja occidentalis Pyramidalis, occidentalis Globosa, fallow* soil, peat, garden soil, urban waste compost, organic fertilizers, containers, plant height

INTRODUCTION

The establishment of new aesthetic green environments, maintenance and modernization of old green spaces is a never ending and continuously evolving preoccupation (Vlad, 2007).

Thuja spp. (fam. Cupressaceae) is a component of the vegetation planted in green spaces, with several positive traits such as favorable influence upon microclimate, noise reduction, maintenance of high air humidity, dampening of temperature oscillations, high quantities of dust particles interception, contributing to the improvement of air quality, the prevention and diminution of the environmental pollution (Iliescu, 2004).

The cultivars of Thuja occidentalis In Romania are not widespread due to probably, lack of planting material.

The presented researches concerning the influence of cultivation and technology systems on the rapid growth and development of young T. occidentalis plants aimed new technological solutions in the production of plant material and the improvement of old technologies being developed in the private nursery from the locality Leş, Bihor County, North-Western Romania.

The preoccupation for aesthetic and useful settings became imperative in the context of urban and industrial expansion and traffic intensification (Mattern, 2006).

It became clear that specialists in urban green spaces face the imperative of diversification of woody ornamental plants as well as the improved knowledge on this plants, to assemble them in accordance with multifunctional purposes according to the principle of sustainable aesthetics, to elaborate and promote in practice modern methods and approaches in the production of planting material, to organize and monitor green spaces (Verd, 2007).

Green spaces are essential parts of the modern urbanism. The urbanism and territory management are important factors in the improvement of life quality, in this context, green spaces playing a central role (Florincescu, 1999).

The urbanism deals with such issues as housing, comercial spaces, schools and cultural settings, health and industrial settings, communication routes as well as the repartition, design and management of green spaces within urban and periurban areas (Maillet, 2003).

Green spaces represent also an indicator of the civilization level reached by a nation being at optimal development in prosperous societies (Krüssmann, 2011).

Wold Health Organization states that every inhabitant of an urban area needs 50m2 of urban greenery and 300 m2 of extra-urban green zone to build optimal conditions for human life and activity (Muja, 1994).

Species of the genus Thuja are resilient under noxious conditions characterizing street neighborhood and industrial areas (due to dust, smog, hazardous gases such as sulphur dioxide, arsenic based compounds, chlorine compounds, traffic gases and heat radiation of the asphalt pavements). (Dajoz, 1995).

In the dendrological nursery, technologies are differentiated according to planting substrate and cultivation site (Hay, 2002).

Classical methods make use of the nursery soil and the production of the planting material is performed directly into the fields. The results depend in great extent on the possibility to maintain and enhance soil fertility (Vlad, 2007). Another method employed in the production of planting material consists in the use of containers with horticultural soil mixtures or other substrates such as mineral or synthetic substrates (soil-less cultures) (Habhouse, 2007).

The method is applied in two alternatives:

1. Container culture from the beginning until delivery
2. Cultivation in field and transfer to containers at least one season before the delivery.

The method regarLSDess to the alternative, presents advantages and disadvantages. Main advantages are:

• The elimination of field maintenance works.

• Roots develop in a reduced soil volume surrounding the leading root making possible the plantation in the final substrate such as green spaces, at any time of the year. (Herwing, 2000).

• Selling and planting all year round.

• The transfer from containers to final destination is stress free and plants continue to grow and develop.

• Pest or pathogen damaged plants can be isolated.

• It is possible to monitor environmental factors, therefore the growth is rapid and uniform (Hessayon, 2003).

• Avoidance of negative effects as a consequence of improper soil use (Krüssmann, 1996).

• Unsold plants can be maintained in containers for one or more vegetation seasons without compromising their vitality.

The main disadvantages are:

• The initial investment in containers and soils which is recuperated with time (Hiecke, 2001) which can vary in length.

• The necessity of manipulation of environmental factors especially the water and the nutrients (Vlad, 2008).

• The necessity of qualified labor for such cultures (Hendekerk, 2000).

• The cultivation of plants on peat and moss substrates is practiced in countries rich in this type of resources (Vlad, 2010)

In the nurseries where such methods are applied, the terrain is perfectly leveled in order to ensure the uniform repartition of water and fertilizers: the terrain must be protected against strong winds which can bend the plants, produce the deformation of crowns or overthrow the containers (Hartman, 1995).

The site where containers are placed is covered with black foil or canvas and the containers are aligned in rows of 1.0-1.5m wide and length according to the needs. Rows are separated by paths of 0.5-0.6m wide which are necessary for the maintenance works (Moore, 2000).

The containers are made of plastic, baked clay, black polystyrene foil, bitumen impregnated burlap, peat etc. (Vlad, 2007). Container dimensions expressed in volume units, especially in liters differs as function of root system (Harris, 1996). The shape of containers also differs, with circular or square cross section; the vertical wall usually makes an angle of 5 degrees with the perpendicular line traced from one extreme point (Zaharia, 1993).

At the bottom of containers, at 5-10 cm from the base, on lateral walls holes are drilled in order to eliminate water excess (Thome, 2006).

The preparation of appropriate substrate mixtures covering the plant demands implies the knowledge of physical and chemical characteristics of each component, and the participation proportion of each component must be determined as function of these indicators (Vlad, 2009).

The number of varieties and cultivars within the genus Thuja are numerous: many of them have special use for hedges, groups or isolated trees. Taking into account the high demand in Oradea area for ornamental plants, we pursued the study of cultivars Pyramidalis and Globosa of Thuja occidentalis.

Thuja occidentalis Pyramidalis is characterized by its upright stem, reddish-brown bark and conical crown. Branchlets are flattened, distributed obliquely or horizontally in fan-shaped sprays, deep green on the upper surface and light green on the reverse (Zaharia, 2003). The flat, scaly leaves are disposed on opposite sides; those which are on lateral position are raft shaped and cover completely the shoot. The lateral leaves present round resiniferous glands near the tips

Thuja occidentalis Globosa presents golden leaves during the summer and yellow-orange during the winter, showing globular aspect.

MATERIAL AND METHODS

The researches concerning the influence of the cultivation system and technology on growth and development of *Thuja occidentalis* plants were organized during 2012-2014 as two factorial block experiments with 4 levels of factor A and two levels of factor B.

The factor A consisted in the cultivation system:

- A_1- containers with soil mixture consisting of 60% fallow soil, 20% garden soil, 20% peat;
- A_2 – containers with composted urban waste
- A_3- field with organic fertilizers
- A_4 - field unfertilized with organic fertilizers;

The factor B was represented by the employed cultivar:

- B_1 - *Thuja occidentalis* Pyramidalis
- B_2- *Thuja occidentalis* Globosa

Factor combination resulted in 8 treatment groups in systematic blocks, with four repetitions (table 1). There were 240 plants in containers per plot. The area of the experimental block in the field was established at 1920 m^2 and of the experimental plot, at 120 m^2. There were 240 plants per experimental block, corresponding to 20000 plants/ha.

Planting in the nursery was performed in the spring of 2012 The mineral content of the soil and of the employed substrata is summarized in table 2. Table data show that the nursery soil was optimally supplied with

macroelements due to high humus content. Soil mixtures from variant I and II and the compost resulted from urban waste (variants III and IV) were optimally supplied with macroelements.

The phases in nursery terrain preparations included;

- Basic fertilization with 30t/ha of manure for variants V and VI, 200kg/ha of ammonium nitrate, 200kg/ha potassium sulphate and 200kg/ha superphosphate for all field cultivation variants.
- Plowing at 25-28 cm deep during the autumn of 2011.
- Disking during the spring of 2012.
- Planting at 31st March.

The container planting was performed in the interval 25-29 March 2012. 40/40 cm plastic containers were employed.

Maintenance works consisted in:

- Periodical weeding for weed elimination and soil aeration improvement using nursery tiller and Wolf tools resembling dibbles used for containers.
- Drop watering in the field and hose watering of the containers, covering 65% of the active humidity interval. Watering norm as calculated to ensure the wetting of 40 cm top soil layer, considering the depth root bulk. During the first two years from the culture initiation, we employed lower watering norms, wetting the top 20 cm of soil and in the second year, the top 30 cm of soil. Tensiometers were employed to establish the moment to start the watering, one for each variant.
- In order to cover completely the balanced mineral nutrition, every 10-12 days mineral content and concentration were analyzed together with pH of the soil in the field and in the containers, applying consequently the needed corrections.
- Phase fertilizations with complex chemical fertilizers were applied as function of laboratory analyses of the nursery and container soil.
- No treatments against pests and pathogens were needed.

Table 1.

Experimental variants, Leş, 2012-2014

Variants	Cultivation system	Cultivar
I	A_1 – containers with fallow soil 60%, garden soil 20%, peat 20%	B_1 – Thuja occidentalis Pyramidalis
II	A_1 – containers with fallow soil60%, garden soil 20%, peat 20%	B_2 – Thuja occidentalis Globosa
III	A_2 – containers with compost from urban waste	B_1 – Thuja occidentalis Pyramidalis
IV	A_2 – containers with compost from urban waste	B_2 – Thuja occidentalis Globosa
V	A_3 – field fertilized with organic fertilizers	B_1 – Thuja occidentalis Pyramidalis
VI	A_3 – field fertilized with organic fertilizers	B_2 – Thuja occidentalis Globosa
VII	A_4 – unfertilized soil (with organic fertilizers)	B_1 – Thuja occidentalis Pyramidalis
VIII	A_4 – unfertilized soil (with organic fertilizers)	B_2 – Thuja occidentalis Globosa

Table 2.

Mean mineral content of nursery soil and container substrates at the beginning of the experiments

Substrate	Water extracted content (1;5) in mg/100 g soil (substrate)						pH
	N	P_2O_5	K_2O	CaO	MgO	Mineral residue	
Nursery soil	14	10	24	36	12	0.23	6.6
Fallow soil 60%+garden soil 20%+peat 20%	19	12	29	47	15	0.37	6.5
Urban waste compost	21	13	32	51	14	0.42	6.9

RESULTS AND DISCUSSION

The researches concerning the influence of the cultivation system and technology on growth and development of *Thuja occidentalis* plants were organized during 2012-2014 as two factorial block experiments with 4 levels of factor A and two levels of factor B.

The factor A consisted in the cultivation system:

- A_1- containers with soil mixture consisting of 60% fallow soil, 20% garden soil, 20% peat;
- A_2 – containers with composted urban waste
- A_3- field with organic fertilizers
- A_4 - field unfertilized with organic fertilizers;

The factor B was represented by the employed cultivar:

- B_1 - *Thuja occidentalis* Pyramidalis
- B_2- *Thuja occidentalis* Globosa

Factor combination resulted in 8 treatment groups in systematic blocks, with four repetitions (table 1). There were 240 plants in containers per plot. The area of the experimental block in the field was established at 1920 m^2 and of the experimental plot, at 120 m^2. There were 240 plants per experimental block, corresponding to 20000 plants/ha.

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- In order to cover completely the balanced mineral nutrition, every 10-12 days mineral content and concentration were analyzed together with pH of the soil in the field and in the containers, applying consequently the needed corrections.
- Phase fertilizations with complex chemical fertilizers were applied as function of laboratory analyses of the nursery and container soil.
- No treatments against pests and pathogens were needed.

Table 3.

Experimental variants, Leş, 2012-2014

Variants	Cultivation system	Cultivar
I	A_1 – containers with fallow soil 60%, garden soil 20%, peat 20%	B_1 – Thuja occidentalis Pyramidalis
II	A_1 – containers with fallow soil60%, garden soil 20%, peat 20%	B_2 – Thuja occidentalis Globosa
III	A_2 – containers with compost from urban waste	B_1 – Thuja occidentalis Pyramidalis
IV	A_2 – containers with compost from urban waste	B_2 – Thuja occidentalis Globosa
V	A_3 – field fertilized with organic fertilizers	B_1 – Thuja occidentalis Pyramidalis
VI	A_3 – field fertilized with organic fertilizers	B_2 – Thuja occidentalis Globosa
VII	A_4 – unfertilized soil (with organic fertilizers)	B_1 – Thuja occidentalis Pyramidalis
VIII	A_4 – unfertilized soil (with organic fertilizers)	B_2 – Thuja occidentalis Globosa

Table 4.

Mean mineral content of nursery soil and container substrates at the beginning of the experiments

Substrate	Water extracted content (1;5) in mg/100 g soil (substrate)						pH
	N	P_2O_5	K_2O	CaO	MgO	Mineral residue	
Nursery soil	14	10	24	36	12	0.23	6.6
Fallow soil 60%+garden soil 20%+peat 20%	19	12	29	47	15	0.37	6.5
Urban waste compost	21	13	32	51	14	0.42	6.9

Table 5.

Crown circumference of Thuja occidentalis cultivars in experimental plots, Leş, Bihor County, 2012-2014

No	Variant	Cultivar	Crown circumference(cm)							
			Start	2012		2013		2014		Mean
			31 III	10 VII	15 XII	12 VII	17 XII	15 VII	16 XII	
1	Containers with soil mixture (60% fallow soil, 20% garden soil and 20% peat)	Thuja occidentalis Pyramidalis	45.3	9.8	11.0	10.7	11.5	9.2	10.1	20.76
2	Containers with soil mixture (60% fallow soil, 20% garden soil and 20% peat)	Thuja occidentalis Globosa	53.1	1.0	17.1	11.9	13.2	4.0	6.1	17.76
3	Containers with urban waste compost	Thuja occidentalis Pyramidalis	47.2	10.1	11.4	11.6	18.0	7.6	9.8	22.76
4	Containers with urban waste compost	Thuja occidentalis Globosa	48.1	1.5	17.3	13.5	4.2	6.5		17.73
5	nursery field with organic fertilizers	Thuja occidentalis Pyramidalis	57.0	11.1	11.3	14.1	17.2	13.2	14.8	27.23
6	nursery field with organic fertilizers	Thuja occidentalis Globosa	52.2	9.5	10.4	13.6	19.2	9.6	12.9	25.06
7	Unfertilized nursery soil (with organic fertilizers)	Thuja occidentalis Pyramidalis	51.2	11.0	10.8	14.0	16.8	10.1	12.6	25.10
8	Unfertilized nursery soil (with organic fertilizers)	Thuja occidentalis Globosa	46.1	9.8	9.2	13.8	17.3	8.1	10.5	22.90

Table 6.

Growth of Thuja occidentalis cultivars in experimental plots, Leş, Bihor County, 2012-2014

No	Variant	Cultivar	growth(cm)							
			Start	2012		2013		2014		Mean
			31 III	10 VII	15 XII	12 VII	17 XII	15 VII	16 XII	
1	Containers with soil mixture (60% fallow soil, 20% garden soil and 20% peat)	Thuja occidentalis Pyramidalis	21.0	10.2	26.4	14.1	15.3	20.5	13.0	33.16
2	Containers with soil mixture (60% fallow soil, 20% garden soil and 20% peat)	Thuja occidentalis Globosa	16.1	5.0	14.2	7.4	9.0	7.3	8.1	17.00
3	Containers with urban waste compost	Thuja occidentalis Pyramidalis	22.0	21.3	26.1	21.2	20.7	25.4	22.4	45.70
4	Containers with urban waste compost	Thuja occidentalis Globosa	16.3	9.0	15.3	16.0	12.2	20.4	18.0	30.80
5	nursery field with organic fertilizers	Thuja occidentalis Pyramidalis	20.0	10.5	11.3	14.1	17.2	13.2	14.8	27.23
6	nursery field with organic fertilizers	Thuja occidentalis Globosa	15.2	6.4	9.0	7.3	6.1	8.3	6.0	14.36
7	Unfertilized nursery soil (with organic fertilizers)	Thuja occidentalis Pyramidalis	21.4	7.3	16.0	10.2	8.0	19.1	7.6	22.73
8	Unfertilized nursery soil (with organic fertilizers)	Thuja occidentalis Globosa	16.2	3.5	6.0	7.2	5.3	7.0	5.0	11.33

Table 7.

Stem circumference of Thuja occidentalis cultivars in experimental plots, Leş, Bihor County 2012-2014

No	Variant	Cultivar	Stem circumference(cm)							
			Start	2012		2013		2014		Mean
			31 III	10 VII	15 XII	12 VII	17 XII	15 VII	16 XII	
1	Containers with soil mixture (60% fallow soil, 20% garden soil and 20% peat)	Thuja occidentalis Pyramidalis	5.2	1.3	1.4	1.3	1.2	0.5	0.8	2.16
2	Containers with soil mixture (60% fallow soil, 20% garden soil and 20% peat)	Thuja occidentalis Globosa	3.7	1.1	1.3	1.3	1.0	0.9	0.5	2.03
3	Containers with urban waste compost	Thuja occidentalis Pyramidalis	5.5	1.2	1.6	1.1	1.2	0.6	1.2	2.30
4	Containers with urban waste compost	Thuja occidentalis Globosa	3.6	1.2	1.6	1.2	1.1	0.5	1.1	2.20
5	nursery field with organic fertilizers	Thuja occidentalis Pyramidalis	5.8	1.3	1.8	1.4	1.5	0.7	1.2	2.63
6	nursery field with organic fertilizers	Thuja occidentalis Globosa	3.9	1.6	2.0	1.1	1.3	0.7	1.1	2.60
7	Unfertilized nursery soil (with organic fertilizers)	Thuja occidentalis Pyramidalis	5.6	1.3	1.7	1.1	1.6	0.6	0.6	2.30
8	Unfertilized nursery soil (with organic fertilizers)	Thuja occidentalis Globosa	4.1	1.6	1.2	1.1	1.4	0.5	0.6	2.13

Table 8

Experimental results with regard to plant growth in *Thuja occidentalis* Pyramidalis, 2012-2014, Leş, Bihor County

No	Variants	Plant height		±D	Significance of the difference
		Absolute (cm)	Relative %		
1	Containers with soil mixture (60% fallow soil, 20% garden soil and 20% peat)	33.16	145.8	10.43	**
2	Containers with urban waste compost	45.70	201.0	22.97	*******
3	nursery field with organic fertilizers	30.80	135.5	8.07	*
4	Unfertilized nursery soil (with organic fertilizers)	22.73	100	-	-

Table 9.

Experimental results with regard to plant growth in Thuja occidentalis Globosa, 2012-2014, Leş, Bihor County

No	Variants	Plant height		±D	Significance of the difference
		Absolute (cm)	Relative %		
1	Containers with soil mixture (60% fallow soil, 20% garden soil and 20% peat)	17.0	150.0	5.67	***
2	Containers with urban waste compost	18.10	**159.7**	**6.77**	*******
3	nursery field with organic fertilizers	14.36	126.7	3.03	*
4	Unfertilized nursery soil (with organic fertilizers)	11.33	100	-	-

Table 10.

Experimental results regarding the influence of the cultural system on plant growth in Thuja occidentalis Pyramidalis, Leş, Bihor County, 2012-2014

Variant	Plant height		±D	Significance of the difference
	Absolute (cm)	Relative %		
Container culture	39.4	147.5	12.7	***
Field culture	26.7	100	-	-

LSD – 5% -3.91
LSD – 1% - 5.58
LSD – 0.1% - 8.80

Table 11.

Experimental results regarding the influence of the cultural system on plant growth in Thuja occidentalis Globosa, Leş, Bihor County, 2012-2014

Variant	Plant height		±D	Significance of the difference
	Absolute (cm)	Relative %		
Container culture	17.55	136.6	4.71	***
Field culture	12.84	100	-	-

LSD – 5% -2.45
LSD – 1% - 3.44
LSD – 0.1% - 4.82

Table 12.

Experimental results regarding the influence of the cultivation system on crown circumference in Thuja occidentalis Pyramidalis plants, Leş, Bihor County, 2012-2014

Variant	Crown circumference		±D	Significance of the difference
	Absolute (cm)	Relative %		
Container culture	21.7	100	-	-
Field culture	26.1	120.2	4.3	**

LSD – 5% -2.65
LSD – 1% - 3.97
LSD – 0.1% - 5.96

Table 13

Experimental results regarding the influence of the cultivation system on crown circumference in *Thuja occidentalis* Globosa plants, Leş, Bihor County, 2012-2014

Variant	Crown circumference		±D	Significance of the difference
	Absolute (cm)	Relative %		
Container culture	18.24	100	-	-
Field culture	23.98	131.4	5.7	**

LSD – 5% -3.51
LSD – 1% - 5.26
LSD – 0.1% - 7.89

CONCLUSIONS

Plant growth expressed in terms of stem height is more vigorous in container cultivated plants as compared to field cultivated plants, due to the more favorable thermal regime and also due to better nutrient and water supply.

- Thuja occidentalis Pyramidalis plants grow taller with 101% (139 cm) in the variant of container cultivated plants with urban waste compost, with 46.8% (99 cm) in the variant of container cultivated plants on soil mixture containing 60% fallow soil, 20% garden soil and 20% peat and with 35.5%(92 cm) in the variant of plants cultivated in nursery soil with organic fertilizers compared to plants cultivated in unfertilized soil (68 cm).
- Urban waste compost has a positive influence on plant growth as compared to plants cultivated on soil mixture (60% fallow soil, 20% garden soil and 20% peat).
- T. occidentalis Globosa grows taller with 59.7% (54.3 cm) in urban waste compost container cultivated variant, with 50% (51 cm) in soil mixture (60% fallow soil, 20% garden soil and 20% peat) container cultivated variant and with 26.7% (43 cm) in organically fertilized nursery field cultivated plants variant as compared to the witness, unfertilized nursery field (34 cm).
- Factors that influence at the greatest extent plant growth are soil organic fertilization followed by the culture system.

- Container cultivation ensures a growth gain of 47.5% in Thuja occidentalis Pyramidalis and 36.6% in Thuja occidentalis Globosa compared to field culture.
- Thuja occidentalis Pyramidalis shows grate growth gain compared to Thuja occidentalis Globosa due to the fact that the later cultivar displays a globular shape.
- Crown and stem circumference in Thuja occidentalis Pyramidalis and Globosa are larger in field cultivated variants compared to those cultivated in containers.
- Crown and stem circumference are larger with 20.25 and 10.7% respectively in Thuja occidentalis Pyramidalis and with 31.4%, 12.35 respectively in Thuja occidentalis Globosa in field culture compared to container culture.
- Organic fertilization ensures growth gain with 35.5%, of which 8.4% corresponds to crown circumference and 14.3% to stem circumference in Thuja occidentalis Pyramidalis, in Thuja occidentalis Globosa the gain is of 26.75 of which 9.45 corresponds to crown circumference and 22.5 to stem circumference compared to unfertilized culture.

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