THE INFLUENCE OF FERTILIZATION AND OF CULTURE SUBSTRATE ON THE GROWTH AND DEVELOPMENT OF SOME DENDROLOGICAL SPECIES

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The paper presents experimental results regarding the study of some alternative substrate which may replace peat. Grape marc compost used in the first experimental year proved to be a favorable substrate for culture for woody ornamental plants, but which need studies to prove its suitability for long time culture of these plants. This way, during the second year on the some culture substrate made of: soil leaves compost +forestry compost + peat + grape marc compost with the ratio of 1:1:1:0.5, were monitored the growth and development of four dendrological species – *Tamarix tetrandra*, *Ligustrum ovalifolium* Aureum, *Chamaecyparis pisifera* Boulevard şi *Chamaecyparis lawsoniana* Stardust. Plants were fertilized during vegetation with Cöic solution in order to observe elements dynamics in the cultivated substrate and plants reactions to fertilization, needed and applied in most of the cases on traditional substrates during the 2nd year of culture.

Key words: woody ornamental species, grape marc compost, nutritive elements dynamics.

INTRODUCTION

The technology of containerized cultures determines obtaining quality ornamental woody plants in a short period of time as compared to classic technology due to the efficient control of the factors involved in plants growing and development[1].

An important issue for this technology is the culture substrates acquisition which involves, along with expensive acquisition costs (which raises the final costs of beneficiary plants) and the issue of reduction the use of natural soils resources in conformity with EU regulations.

The research theme aims to clarify a series of facts referring to elements dynamics in the cultivated substrate and plants reaction to fertilization, needed and applied in most cases on traditional substrates.

MATERIALS AND METHODS

The researches took place inside Green House of USAMV Bucharest. Young plants (2 years for deciduous shrubs and 5 years for coniferous) belonging to some different species – *Tamarix tetrandra*, *Ligustrum ovalifolium* Aureum, *Chamaecyparis pisifera* Boulevard and *Chamaecyparis lawsoniana* Stardust – were observed during growing period from development view point, on an substrate made of: soil leaves compost + forestry compost + peat + grape marc compost at a ratio of 1:1:1:0.5. Young seedlings (rooted cuttings) of these plants were planted on this substrate one year before the beginning of the experiment, the culture not being fertilized. So, in the second year of vegetation in containers, the plants were fertilized, on the same substrate with acidophilic Cöic solution for half of plants, the other half being unfertilized. The experimental scheme is shown in Table 1.

At the beginning of the vegetation, were done cuttings for the deciduous shrubs species – *Tamarix* and *Ligustrum*, the plants were left then to regrow. By the end of May the plants were measured and the next month fertilization begun. It was applied in June, July, and August.

The length and diameter of plants were monthly measured, during May–September. Also, plants and substrate samples were taken monthly for agrochemical analyses.

Agrochemical analyses of substrate samples aimed determining the following agrochemical parameters: pH, soluble salts content and nitrogen, phosphorus, potassium contents (soluble forms).

Plants samples were analyzed regarding total forms of nitrogen, phosphorus, potassium (Kjeldahl method) and dry substance content, and the results were in percents. The data were interpreted according to the work protocol and from the statistical point of view.

Table 1
Experimental schema

Variant		Species
A1	Unfertilized	*Tamarix tetrandra*
A2	Fertilized with 300ml Cöic solution	*Tamarix tetrandra*
A3	Unfertilized	*Ligustrum ovalifolium* Aureum
A4	Fertilized with 200ml Cöic solution	*Ligustrum ovalifolium* Aureum
A5	Unfertilized	*Chamaecyparis pisifera* Boulevard
A6	Fertilized with 300ml Cöic solution	*Chamaecyparis pisifera* Boulevard
A7	Unfertilized	*Chamaecyparis lawsoniana* Stardust
A8	Fertilized with 300ml Cöic solution	*Chamaecyparis lawsoniana* Stardust

RESULTS AND DISCUSSIONS

Macroelements concentration (N, P, K) in total forms found in the leaves of unfertilized and fertilized plants were analyzed monthly. The data regarding the total nitrogen (Fig. 1) show a lowering of its content towards autumn in the leaves of deciduous shrubs species. In *Tamarix*, nitrogen concentration in June in unfertilized plants was of 4.2% and in September of 2.8%. In *Ligustrum*, the overage value of N in unfertilized plants was of 3.4%, reducing towards autumn at 2.4%.

This reaction is normal and occurs due to metabolism and nitrogen resorption in September. Resorption of nutrients before leaves fall is one of the conservation processes in woody plants with deciduous leaves. Through this process N and P losses are lowered when leaves fall, and these essential elements would be used in spring to form new leaves, flowers and later fruits and seeds[2, 3, 4, 5].

In studied species of coniferae – *Chamaecyparis pisifera* Boulevard and *Chamaecyparis lawsoniana* Stardust – the lowering of the total N content is less intense. In *Chamaecyparis* Boulevard the leaves of unfertilized plants had 2.8% N in June and 2.3% in September, and in *Chamaecyparis* Stardust 2.2%, in June and 2.1% in September.

Comparing total nitrogen values in the leaves of unfertilized plants with the fertilized ones, one may see different reactions of species[6]. The total nitrogen in *Tamarix* fertilized plants leaves has almost the same values as the ones in unfertilized leaves. The monthly fertilization with Cöic solution seems not to modify N metabolism of this species.

In *Ligustrum* one may notice considerable differences between nitrogen content in fertilized and unfertilized plants. After the first fertilization – in June, one may see that the next month the values of the total nitrogen in unfertilized plants are higher (3.13%) as compared with the fertilized ones (2.24%).

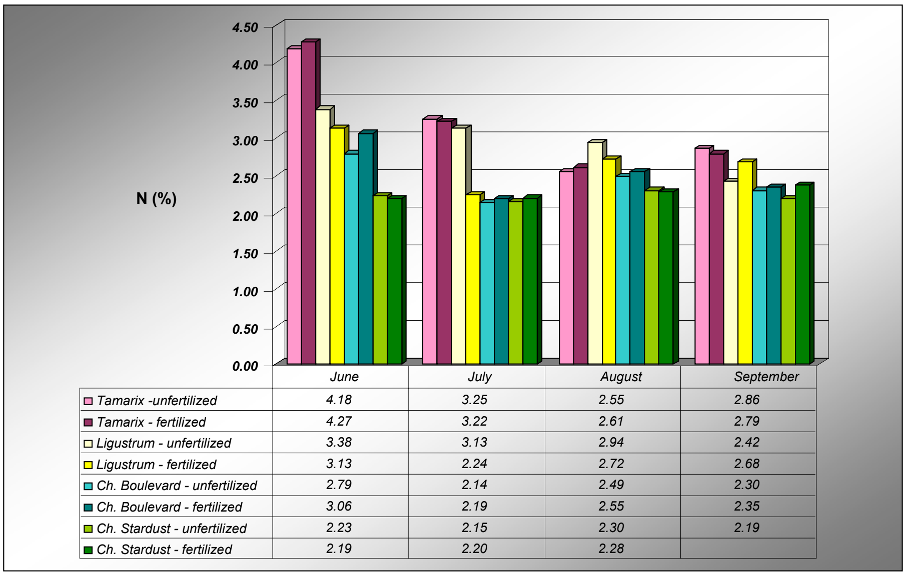


Fig. 1. The total nitrogen content in leaves.

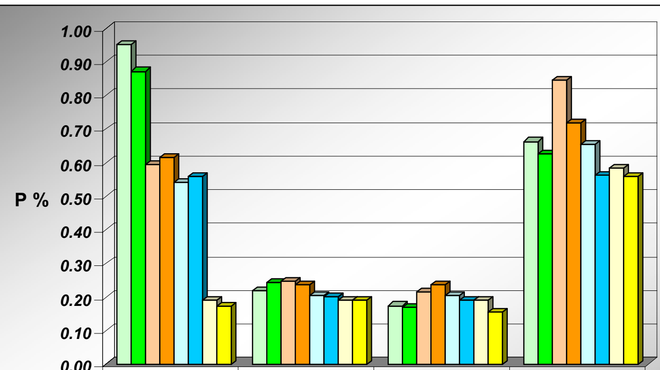
Almost similar values in fertilized and unfertilized plants were found in coniferous, proving the fact that the used substrate, rich in organic components – peat, forestry compost, grape marc, had during the second year of culture enough N reserves for plants growth, not needing fertilizations of the plants during vegetation[7,8].

The total content in phosphorus in fertilized and unfertilized leaves of the four studied species is presented in Figure 2.

The analyses show a decrease of the total content in P in the leaves in July and August. The coniferous species had the lowest values of the phosphorus in this period.

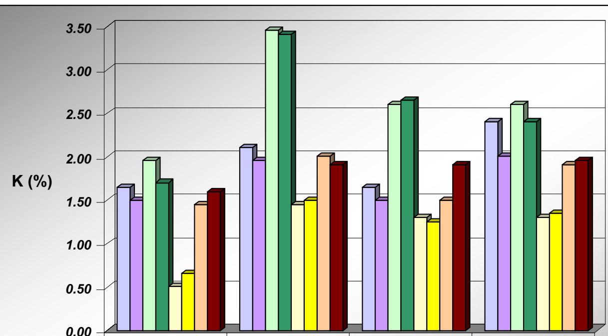
This high phosphorus consumption of the plants is explained through plants attempt to adapt to the high temperature and low humidity. One may notice that the fertilized plants had the same reaction as the unfertilized ones, the values of the phosphorus in the samples being almost the same. In September, the total phosphorus values in leaves show a general tendency of the species which had a higher content in unfertilized plants as compared to those fertilized.

As regarding total potassium (Fig. 3) in leaves one can see a difference of this element content in the unfertilized plants as compared with the fertilized ones in all species.



	June	July	August	September
Tamarix - unfertilized	0.95	0.22	0.17	0.66
Tamarix -fertilized	0.87	0.24	0.17	0.63
Ligustrum - unfertilized	0.59	0.25	0.21	0.84
Ligustrum -fertilized	0.61	0.24	0.24	0.72
Ch. Boulevard - unfertilized	0.54	0.20	0.20	0.65
Ch. Boulevard -fertilized	0.56	0.20	0.19	0.56
Ch. Stardust - unfertilized	0.19	0.19	0.19	0.58
Ch. Stardust -fertilized				

Fig. 2. The total phosphorus content in leaves.



	June	July	August	September
Tamarix - unfertilized	1.65	2.10	1.65	2.40
Tamarix - fertilized	1.50	1.95	1.50	2.00
Ligustrum - unfertilized	1.95	3.45	2.60	2.60
Ligustrum - fertilized	1.70	3.40	2.65	2.40
Ch. Boulevard - unfertilized	0.50	1.45	1.30	1.30
Ch. Boulevard - fertilized	0.65	1.50	1.25	1.35
Ch. Stardust - unfertilized	1.45	2.00	1.50	1.90
Ch. Stardust - fertilized	1.60	1.90	1.90	1.95

Fig. 3. The total potassium content in leaves.

One may notice the fact that the deciduous shrubs species – *Tamarix* and *Ligustrum* had higher potassium values in unfertilized leaves plants, and in coniferae – *Chamaecyparis Boulevard* and *Chamaecyparis Stardust*, in those of the fertilized plants. The concentration differences of potassium in the samples taken from unfertilized plants and those from the fertilized ones were small.

The results of the analyses done in June, before applying of fertilization are presented in Table 2.

After one year after the ornamental plants cultivation, all four species, without fertilization, the content in nitrogen, nitric form, of the soil samples characterized them as having a low or a moderate content in this element. Yet, the substrates were well fed with ammonium nitrogen form, the values being of 17.5 ppm N-NH_4 in A4 and A6 variants and 52.0 ppm in A2 variant.

As regards phosphorus and potassium, the analyses indicated a normal level of the substrates before fertilization.

The data were statistically interpreted for each species, in order to release the need for fertilization during the second year of culture on the same substrate, and the results are presented in Tables 3, 4, 5 and 6.

For *Tamarix tetrandra*, negative correlations very significant ones, are noticed (Table 3) between the content in potassium of the substrate and plants development. These correlations indicate the fact that any decrease of the potassium in substrate has direct effects on height ($r = 0.9567$) and plant diameter ($r = –0.9316$).

Also, positive correlations, distinctively significant were established between the total content in N in plant and N content ($r = –0.8358$) and potassium ($r = 0.9181$) in substrate. It results that no significant correlations can be made between the total content in phosphorus and potassium in plant and N, P, K, Ca, Mg, Na content in substrate.

In *Ligustrum ovalifolium* Aureum the statistic analysis (Table 4) shows that the variation of the content in substrate influences the height and diameter of plants. Negative correlations, very significant were established between plants height and phosphorus and potassium concentration from substrate and between diameter and ammonium nitrogen concentration, and potassium. At the same time, for this species can be seen that plant growth (height and diameter) in negatively influenced by the Na content increase in substrate (negative correlations, very significant between plants height and content in Na and correlations distinctively significant between plants diameter and Na content).

Table 2

N, P, K, Ca, Mg and Na values – soluble forms – of substrates before fertilization

Variant	**NO_3**	**NH_4**	**PO_4**	**K**	**Ca**	**Mg**	**Na**
	ppm	ppm	ppm	ppm	ppm	ppm	ppm
A1 Tamarix – unfertilized	18.5	21.0	23.2	160	204.06	40.22	57
A2 Tamarix – fertilized 300 ml	8.5	52.0	20.8	112	163.21	39.29	80
A3 Ligustrum – unfertilized	6.5	20.0	23.0	89	142.84	34.51	40
A4 Ligustrum – fertilized 200 ml	1.0	17.5	19.2	92	163.24	34.54	40
A5 Ch.Bulevard – unfertilized	10.5	22.5	23.2	91	153.04	30.83	40
A6 Ch.Bulevard – fertilized 300 ml	6.5	17.5	27.4	80	173.45	32.92	47
A7 Ch.Stardust – unfertilized	12.0	27.5	16.0	80	153.04	22.80	39
A8 Ch Stardust – fertilized 300 ml	12.0	23.0	11.0	140	122.43	20.49	35

Table 3

Statistic correlations for *Tamarix tetrandra*

	Height	**Diameter**	**N**	**P**	**K**
NO_3	-0.8701**	-0.8358**	0.8465**	0.5847	-0.4051
NH_4	-0.7409*	-0.6536	0.6023	0.3316	-0.5786
PO_4	-0.8622**	-0.7713*	0.7873*	0.2007	-0.3225
K	**-0.9567***	**-0.9316***	0.9181**	0.6050	-0.4723
Ca	-0.0194	-0.0927	0.0834	0.4398	-0.2754
Mg	-0.7787*	-0.7421*	0.7345*	0.6743	-0.6953
Na	-0.4903	-0.4067	0.2784	0.0752	-0.5442

* $P< 0.05$; ** $P< 0.01$; *** $P< 0.001$

Table 4

Statistic correlations for *Ligustrum ovalifolium Aureum*

	Height	Diameter	N	P	K
NO_3	-0.5750	-0.4228	-0.0076	-0.3807	0.2838
NH_4	-0.8902**	**-0.9592*** **	0.7146*	0.2487	-0.6479
PO_4	**-0.9398*** **	-0.9119**	0.6391	-0.0007	-0.2260
K	**-0.9737*** **	**-0.9852*** **	0.6643	0.0273	-0.3557
Ca	0.5593	0.3846	-0.0862	0.5180	-0.6219
Mg	-0.4236	-0.4086	0.6056	-0.5527	-0.1303
Na	**-0.9412*** **	-0.8982**	0.6819	-0.1167	-0.4797

* $P< 0.05$; ** $P< 0.01$; *** $P< 0.001$

Table 5

Statistic correlations for *Chamaecyparis pisifera Boulevard*

	Height	Diameter	N	P	K
NO_3	-0.8809**	-0.8443**	0.3694	-0.1786	-0.0812
NH_4	-0.8174*	-0.7162*	0.7661*	0.3764	-0.6410
PO_4	**-0.9477*** **	-0.8488**	0.5802	0.0552	-0.2945
K	-0.8625**	-0.8705**	0.5069	0.1715	-0.3211
Ca	0.2528	0.0360	0.5938	0.3652	-0.7551*
Mg	-0.3717	-0.3992	0.2925	-0.2714	-0.0064
Na	-0.2003	-0.2653	0.5500	0.6441	-0.6940

* $P< 0.05$; ** $P< 0.01$; *** $P< 0.001$

Table 6

Statistic correlations for *Chamaecyparis lawsoniana Stardust*

	Height	Diameter	N	P	K
NO_3	-0.4762	-0.9197**	-0.5926	-0.6374	-0.3592
NH_4	-0.6361	-0.8896**	-0.3918	-0.4811	-0.6267
PO_4	-0.2790	-0.6955	-0.3335	-0.8140*	-0.1690
K	-0.4923	-0.8438**	-0.3877	-0.4276	-0.5778
Ca	-0.0876	0.1059	0.5489	-0.1527	-0.3676
Mg	0.0773	0.0074	0.1323	-0.6422	0.0425
Na	-0.4435	-0.3906	-0.0560	0.0402	-0.4259

* $P< 0.05$; ** $P< 0.01$; *** $P< 0.001$

A low number of correlations very significant are seen in *Chamaecyparis pisifera* Boulevard species (Table 5). The low content in phosphorus in substrate determines in this species also a smaller height ($r = –0.9477$). Also, variation of the nitrogen and potassium content in substrate determines modifications in plants growth.

In *Chamaecyparis lawsoniana Stardust* species were not established significant correlations for plants height and macroelements content in the substrate (Table 6). The variation of the content in nitrogen and potassium in the substrate influenced plants diameter.

As the other coniferous species – *Chamaecyparis pisifera* Boulevard one may notice the fact that does not exist significant correlations between the content in nitrogen, phosphorus and potassium in the plant and in the substrate. Also, the calcium, magnesium, and sodium did not influence the growth and development of plants in a significant manner.

CONCLUSIONS

1. From the obtained data, one may conclude that the used substrate in the containerized culture of *Tamarix tetrandra*, *Ligustrum ovalifolium* Aureum, *Chamaecyparis pisifera Boulevard* and *Chamaecyparis lawsoniana* Stardust, made of leaves compost, forestry compost, peat and grape marc compost (ratio 1:1:1:0.5), does not need fertilization during the second year of culture for the ornamental plants.

2. The differences in height and diameter of the unfertilized plants as compared to the fertilized were small one for all studies species.

3. The fertilized plants, *Chamaecyparis pisifera* Boulevard species, had smaller heights then the unfertilized ones after the first fertilization (June).

4. The small differences of the nitrogen, phosphorus and potassium content – total forms – between the fertilized and unfertilized plants were found in all studies species (2–3.5%).

5. The soil reaction and the content in soluble salts did not significantly modify after Cöic solution fertilization. These results were explained through a buffer reaction of the used substrate for the containerized culture of some woody ornamental species.

6. At the end of vegetation period – September – one noticed a decrease of the nutritive elements content in substrates, which indicates the fact that the using the same substrates during the 3rd year of containerized production of these plants, fertilizations are necessary.

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