STUDY CONCERNING THE BALANCE OF CALCIUM AND MAGNESIUM INTO SUBSTRATES MADE FROM RECYCLABLE ORGANIC WASTE

STUDIUL PRIVIND BILANŢUL CALCIULUI ŞI MAGNEZUILUI ÎN SUBSTRATURI DE CULTURĂ ALCĂTUITE DIN DEŞEURI ORGANICE RECICLABILE

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Abstract:*The recycling and revaluation of some organic waste (forestry compost, leaves compost, peat and marc compost) as non-polluting substrates in horticulture impose the study of their properties and agrochemical characterization in order to establish their adaptability for ornamental plants cultivation. Besides the principal nutritive elements (nitrogen, phosphorous, potassium) that are absolutely indispensable for plants growth and development, calcium and magnesium have an important role not only for plants nutrition but also for the physico-chemical proprieties of substrates such as stability, structure and base saturation. The research involved 4 substrate receipts in which the marc compost was in different proportions and the other 3 compounds (forestry compost, peat and leaves compost) in equal quantities. The substrate columns were percolated with distillated water and Coïc nutritive solution to establish the percent of calcium and magnesium dislocated, retained in substrate and leached in percolate. The results were correlated with the substrates' pH and sum of exchangeable base cations. The exchangeable forms of calcium and magnesium were extracted with ammonium acetate, $AcNH_4$, 0.5M, pH=4.65, ratio 1:3 v/v, Găbriels and Verdonck method.*

Rezumat. *Reciclarea şi revalorificarea în agricultura a unor deşuri organice (compost forestier, pământ de frunze, turbă şi compost de tescovină) sub forma de substraturi nepoluante folosite în special în horticultură, impune studierea proprietăţilor şi caracterizarea lor agrochimică în vederea pretabilităţii lor pentru cultivarea plantelor dendrofloricole. Pe lângă elementele nutritive esenţiale (azot, fosfor, potasiu), absolute indispensabile creşterii şi dezvoltării plantelor, Ca şi Mg joacă un rol important atât în nutriţie cât şi în definirea unor proprietăţi fizico-chimice, cum ar fi stabilitatea substratului, structura lui şi gradul de saturaţie în baze. Cercetările s-au efectuat la 4 reţete de substrat în care compostul de tescovină a fost introdus în cantităţi variabile, celelalte trei component de baza fiind participante în cantităţi egale. Pentru stabilirea procentuală a formelor de Ca şi Mg dizlocat, nedizlocat şi cel regăsit în percolat, substraturile au fost percolate pe coloane cu H_2O distilată şi cu soluţie nutritivă Coïc, iar datele obţinute au fost corelate cu pH şi S_B din substraturi. Extracţia formelor schimbabile de Ca şi Mg s-a efectuat prin metoda Găbriels şi Verdonck în acetat de amoniu 0,5M, pH = 4,65 raport 1:3 v/v.*

Due to the existence of a multitude of organic and mineral compounds and the various proportions in which those can participate for a substrate, the number of recipes is very big. Because each ornamental species have specific requirements concerning the substrate proprieties, it is essential to study the substrates before to recommend them to a culture (Van der Boon, 1982).

Substrates' physical and chemical proprieties are determinate and establish by a series of studies that contain elements of fundamental research such as: solubility, mobility, retention of some anions and cations into the substrate (Davidescu et al., 2002, Anstett, A., 1976). If these aspects were elucidated for the soils in the past century, they still remain unknown for the substrates (Carrión et al., 2005), because their study started just two decades ago, as soon as the ornamentals production was extended to containerized culture.

MATERIAL AND METHOD

The organic compounds used for the substrates variants were the following: forestry compost, leaves compost, peat and grape marc compost (waste from wine production). The proportions among components that composed the substrates are presented in table 1:

Table 1

The organic substrates formula

Variant	Components ratio			
	Forestry compost	Leaves compost	Peat	Marc compost
V1	1	1	1	0,5
V2	1	1	1	1
V3	1	1	1	2
V4	1	1	1	3

The agrochemical characterization of the components was made after the determination of pH, total soluble salts content, soluble forms of: nitrate, ammonium, phosphorous, potassium, calcium, magnesium and total forms of nitrogen, phosphorous and potassium (table 2).

Table 2

The agrochemical characteristis of the substrates variants

Variant	pH	Total soluble salts contents %	P-PO_4^{3-} ppm	N-NO_3^- ppm	N-NH_4^+ ppm	Ca^{2+} ppm	Mg^{2+} ppm	K^+ ppm	Na^+ ppm	N_{total} %	P_{total} %	K_{total} %
V1	6.55	0.45728	2.8	1175	28	1132.53	168.34	250	45	1.9834	0.320	0.70
V2	6.74	0.38080	urme	980	23	448.93	88.70	295	40	1.9928	0.325	0.65
V3	7.35	0.28704	44.20	632	37	91.82	10.60	275	23	2.1056	0.336	0.95
V4	7.89	0.16864	82.00	693	46	40.81	5.89	170	15	2.5098	0.358	1.05

The cation exchange in substrate variants was studied using the percolation on glass columns procedure (Madjar R. et al., 2007). The columns of 3 cm in diameter and 25 cm height were filled with 20 cm substrate variants (V1, V2, V3, V4) sustained by glass wool on the base of the columns. In order to establish the nutritive ions exchange, after the saturation of the substrates with distillate water, these were percolated with water or acidophil nutritive Coïc solution.

Constantly, the volume of the collected percolate solution was measured and then the percolate rate was determinate. After the percolation of water and Coïc solution, the content of the exchangeable calcium and magnesium was analyzed in the collected percolate. Also, the substrates were studied after the percolation of the solutions applied. The exchangeable calcium and magnesium forms were determinate in ammonium acetate

$AcNH_4$, 0.5 M, pH = 4.65, ratio 1/3 (Gäbriels and Verdonck, 1991).

RESULTS AND DISCUSSIONS

For a normal growing of plants, it is necessary a calcium saturation over 45% from the total exchangeable bases and over 20% Ca from the sum of exchangeable cations.

Comparing the calcium content in different types of soils (2438 ppm in typical grey soil, 4840 ppm in typical clay-illuvial chernozem soil, 3458 ppm reddish brown mollic soil, 1004 ppm typical podzol soil) with our variants of substrates, we observed a very high content of exchangeable calcium, varying between 9590.8 ppm (V3) and 14692.3 ppm (V4).

Table 3

The balance of calcium exchangeable in substrate variants

Variant	Ca, ppm				
	Exchangeable in substrate at the beginning of experiment	Exchangeable in substrate after the percolation with distillate water	In percolate water	Exchangeable in substrate after the percolation with nutritive solution Coïc	In percolate Coïc
V1	12957.80	1397	85.70	767	186.72
V2	10713.10	1530	60.19	795	99.99
V3	9590.80	1122	20.40	683	29.58
V4	14692.30	877	7.14	591	30.61

The exchangeable Ca content in substrates was comparable with the values of the typical rendzina soil (12058 ppm) and the eubazic brown mollic soil (12298 ppm). The presence of peat and grape marc compost in substrates explain their high content in calcium, considering that the typical peat moss soil can attain 22158 ppm exchangeable Ca. After the percolation of substrates with water, undislocated calcium represented 93.98% at V4 and 85.15% at V2 and in resulted percolate, the percent of calcium was very low of 0.048% (V4) and 0.66% at V1.

Table 4

Exchangeable Ca (%) dislocated, undislocated forms and Ca in percolate with distillate water leaching on recyclable organic waste columns substrate

Variant	Ca (%)			
	Exchangeable total dislocated	Exchangeable undislocated	Exchangeable in substrate after percolation	In percolate (water solution)
V1	11.44	88.55	10.78	0.660
V2	14.81	85.15	14.28	0.560
V3	11.91	88.09	11.69	0.210
V4	6.01	93.98	5.96	0.048

After the percolation with nutritive Coïc solution, undislocated calcium represented 95.76% (V4) and 91.64% (V2). The calcium percent from Coïc percolate was low, between 0.2% (V4) and 1.44% (V1).

Table 5

Exchangeable Ca (%) dislocated, undislocated forms and Ca in percolate with Coïc nutritive solution leaching on recyclable organic waste columns substrate

Variant	Ca(%)			
	Exchangeable total dislocated	Exchangeable undislocated	Exchangeable in substrate after percolation	In percolate (Coïc solution)
V1	7.36	92.63	5.91	1.44
V2	8.35	91.64	7.42	0.93
V3	7.42	92.57	7.12	0.30
V4	4.23	95.76	4.02	0.20

Table 6

The balance of magnesium exchangeable in substrate variants

Variant	Mg, ppm				
	Exchangeable in substrate at the beginning of experiment	Exchangeable in substrate after the percolation with distillate water	In percolate water	Exchangeable in substrate after the percolation with nutritive solution Coïc	In percolate Coïc
V1	475.11	519.33	13.19	244.72	45.29
V2	421.29	534.78	11.29	281.65	35.48
V3	541.82	497.98	4.01	311.84	11.64
V4	492.72	457.06	1.55	348.01	5.04

In the substrates, the content of magnesium varied between 541.82 ppm (V3) and 421.29 ppm (V2), these values being superior of some soils such as typical cambic chernozem (55.08 ppm exchangeable Mg), cambic chernozemic soil (156 ppm) or reddish brown luvic soil (201.6 ppm exchangeable Mg). The biggest saturation with Mg was remarked at substrate V4 that included two parts of grape marc compost. After the substrates percolation with water in V1 and V2, 109.30%, respectively 126.93% exchangeable Mg was founded. In substrate variant 3 and 4 the exchangeable Mg represented 91.90%, respectively 92.76% from total magnesium dislocated. With nutritive Coïc solution was dislocated at the percolation 59.70% exchangeable Mg in V3 and 75.27% exchangeable Mg in V2. From total exchangeable Mg dislocated, into the substrates were found the following percents: 51.50% atV1, 57.55% atV3, 66.85% atV2 and 70.63% atV4.

Table 7

Exchangeable Ca (%) dislocated, undislocated forms and Ca in percolate with distillate water leaching on recyclable organic waste columns substrate

Variant	Mg (%)			
	Exchangeable total dislocated	Exchangeable undislocated	Exchangeable in substrate after percolation	In percolate (water solution)
V1	112.08	-	109.30	2.77
V2	129.61	-	126.93	2.67
V3	92.64	7.35	91.90	0.74
V4	93.07	6.92	92.76	0.31

Table 8

Exchangeable Ca (%) dislocated, undislocated forms and Ca in percolate with Coïc nutritive solution leaching on recyclable organic waste columns substrate

Variant	Mg (%)			
	Exchangeable total dislocated	Exchangeable undislocated	Exchangeable in substrate after percolation	In percolate (Coïc solution)
V1	61.04	38.96	51.50	9.53
V2	75.27	24.73	66.85	8.42
V3	59.70	40.30	57.55	0.30
V4	7.65	28.35	70.63	1.02

Table 9

Sum of Exchangeable Bases (SB) Σ (Na, K, Ca, Mg), me/100 g substrate

Variant	Na me/100g substrate	K me/100g substrate	Ca me/100g substrate	Mg me/100g substrate	Σ(Na,K, Ca,Mg)= SB me/100g substrate	pH
V1	0.136	4.487	64.65	3.89	73.163	6.55
V2	0.130	5.064	53.45	3.45	62.094	6.74
V3	0.141	9.487	47.85	4.44	61.918	7.35
V4	0.152	10.064	73.31	4.03	87.550	7.89

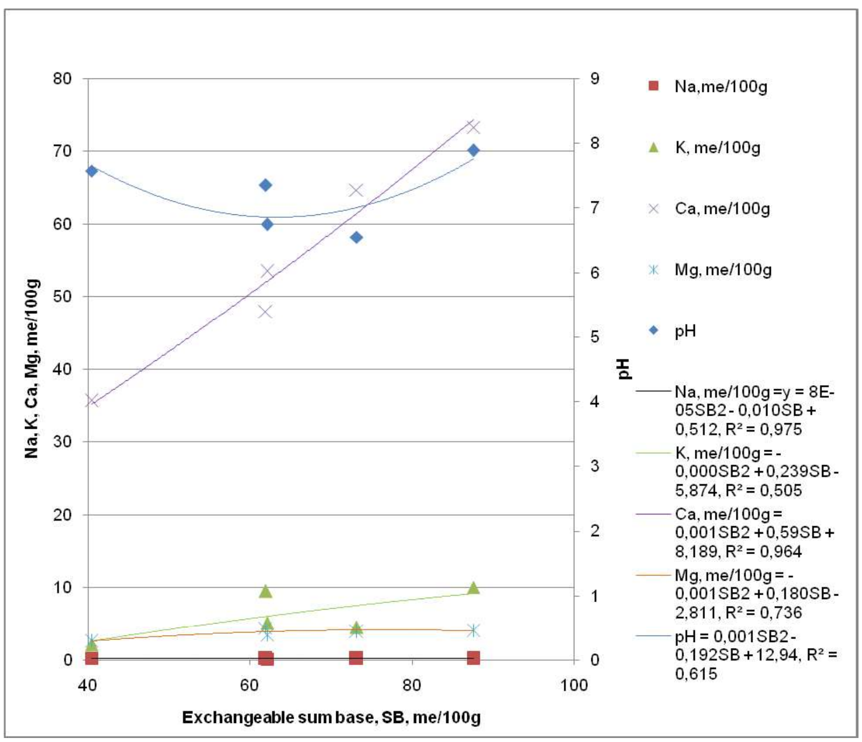

Fig.1 - Correlation between exchangeable sum base SB (me/100g) and Na, K, Ca, Mg and pH

Table 10

The percent of monovalent (Na + K) and bivalent (Ca + Mg) ions from the sum of the exchangeable bases in substrates

Variant	Σ (Na,K, Ca,Mg)	% (Na + K)	% (Ca+Mg)
V1	73.163	6.31	93.68
V2	62.094	8.36	91.63
V3	61.918	15.54	84.45
V4	87.550	11.66	88.33

Correlation between SB, the content in exchangeable cations and substrate pH (fig. 1) indicate that only in the case of Na and Ca the correlation is distinct significant in experimental substrate variants.

CONCLUSIONS

The retention and extraction on substrate was different for the studied ions.

Higher quantities of P, K, Mg and Na in percolate were found in the case of nutritive Coïc solution substrate percolation.

Calcium was retained better by the organic components of the substrates; the undislocated Ca was found of 78.65% after water percolation and 89.10% after nutritive Coïc solution percolation.

Lab simulation of irrigation (water percolation) conducted us to the conclusion that in container plant culture leaching phenomena of nutrients comes out after frequently watering of plants.

Lab simulation of fertilizations with nutritive solution determine different reactions of the ions in the substrate, phenomena which have to be considered in containerized plant technology where the nutrients supply must be correlated with species requirements.

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