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VEGETABLE GROWING ON EXPANDED CLAY

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ABSTRACT – Vegetable growing on expanded clay
As soilless gardening is becoming more popular, the broadening of knowledge on growing media with low environmental burden is continuously of interest. In the experiment we investigated the applicability of Liapor Hydro clay pebble products in greenhouse production of sweet pepper, tomato, eggplant and cucumber, using rockwool as the control medium (sweet pepper, tomato, eggplant) and peat-perlite mix (cucumber). The volume of substrate per plant was 5 liters in the case of pepper and tomato, 10 liters in the case of cucumber and 7.5 or 15 liters in the case of eggplant. Experimental results demonstrate the suitability of expanded clay as growing medium for the soilless greenhouse production of all four vegetables. In the case of eggplant, results relative to growing medium quantity, showing that the greater root volume produces greater yields, are an indication of the importance of making the choice of the volume in accordance with the growing medium.

Keywords: cucumber, eggplant, Liapor, sweet pepper, tomato

INTRODUCTION

An ever greater number of farms are compelled to change their production technology as a result of the monocultural production system characteristic in greenhouse vegetable growing, of the spread of soil-born pathogens and root-knot nematodes and of the unfavorable changes in the physical and chemical properties of soils (TERBE, PAP, 2008). The area of soilless production is ever greater in the whole world. Owing to the great number of new plant physiology knowledge applicable also in the practice of production, to the ever deeper knowledge of substrates and to technical inventions the annual growth of this production system can be estimated to be approximately 5% (VERDONCK, 2007).
Expanded clay has been used in horticultural production since 1936 (RAVIV ET AL., 2002), but the large-scale production in expanded clay pellets started in 1950 in Switzerland (FISCHER, MEINKEN, 1991).
Clay pellets are divided in several size ranges between 1 and 20 mm, but in the case of a few products also the 10-30 mm fraction is known (VERDONCK ET AL., 1980). According to shape, distinction is made between whole (round) balls and crushed clay pellets, but types containing a mixture of the two are also known (SLEZÁK, PAP, 2008), though generally the shapes close to sphere are in use (VERDONCK, 2007).
In the early 90s IMRE carried out a series of experiments with pepper on the substrates of production systems isolated from the soil. Based on the results of the experiments he concluded that expanded clay was suitable for cultivation if accompanied with the elaboration of a suitable fertigation system (IMRE, 1993, 1994). Italian researchers gathered favorable experiences with the use of the product in the size range of 2-4 mm in greenhouse tomato production in expanded clay pebbles (CALABRETTA ET AL., 1994). In greenhouse cucumber cultivation, in the two-year experiment of BÖHME (1995) expanded clay pellets produced higher yields compared to rockwool, while used in the second year produced ones significantly lower.

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At the Department of Vegetable and Mushroom Growing of Corvinus University of Budapest the research of substrates has great traditions. The present publication is a summary of some of technology development researches on production in expanded clay pellets (Liapor Hydro 4/8, Liapor Hydro 4/8 KK) and a synthesis of the results.

MATERIAL AND METHOD

We studied the applicability of Liapor Hydro clay pebble products in hydroponic production of **sweet pepper**, using rockwool for control medium. In the treatments containing the clay pellets, the white plastic bags serving for covering the rockwool slabs were filled with 15 liters of clay pellets. In plant nutrition, we used the formula and nutrient solution concentration recommended for rockwool pepper production. Irrigation frequency and length were set to accord with plant development. The fruits were divided into the following quality categories: extra ((>100 g), 1st class (80-100 g), 2nd class (60-80 g), 3rd class (40-60 g), substandard and tiny fruits (including the strongly deformed or blotched ones, mainly with Ca deficiency, and the ones under 40 grams).

In greenhouse **tomato** production we also used the plastic bag cultivation, with rockwool control. In irrigation and fertigation, for all three treatments we used the formula and nutrient solution concentration recommended for rockwool tomato cultivation, with as many as 15-20 irrigations per day. As the nutrient solution amount optimal for rockwool grown plants proved to be insufficient for the plants planted in expanded clay pellets, two additional drippers were pricked into each bag filled with the clay pellets, into the part between the rockwool cubes. At the pickings the number and total weight of the fruits collected from the 12 plants were registered.

In the case of **eggplant**, using the same plant spacing, the plastic bags with a filling length of 1 meter were planted with one or two plants because of the 66 cm spacing (2 plastic bags were planted with 3 plants). As a result, in the analyses, separate investigations could be carried out on the effect of 7.5 and 15 liters root volume per plant. In the experiment the two different 4/8 size expanded clay pellets were compared with rockwool in an irrigation-fertigation system for rockwool grown plants. Each plant was considered to be a separate plot. As yield results of the plants were different with the two planting types, their results were compared separately and also the effect of the growing media volume was studied.

Experiment on greenhouse **cucumber** production was set up in Mórahalom (South Hungary) in a plastic tunnel of Filclair type. Prior to planting, 10-10 buckets were filled with expanded clay pellets in the plastic tunnel, and further 10 buckets filled with peat containing soil mix were assigned to be control plots. Irrigation and fertigation were carried out in accordance with the requirements of the plants planted in peat containing soil mix (2-10 times a day). Two pickings per week were carried out and at the pickings, divided into classes we measured the number and total weight of the fruits collected from the 10 plants on each plot.
Detailed technological parameters of the experiments are reported in *Table 1.*

Table 1: Technological data of trials

Species			Sweet pepper	Tomato	Eggplant	Cucumber
Location of trials			Budapest, Corvinus Univ.	Szentes	Budapest, Corvinus Univ.	Mórahalom
Variety			Hó	Annet	Madonna	Ceres
Site of trials			plastic greenhouse of Filclair type	10 m long plastic tunnel	plastic greenhouse of Filclair type	plastic greenhouse of Filclair type
Method of cultivation			plastic bag	plastic bag	plastic bag	container
Expanded clay product tested			H4/8KK	H4/8, H4/8KK,	H4/8, H4/8KK,	H4/8, H4/8KK
Control substrate			rockwool	rockwool	rockwool	90% peat + 10% perlite
Seedling growing medium			rockwool	rockwool	rockwool	peat
Date of planting			March 30th	Feb 28th	May 9th	Feb 23rd
Plant density			4 plants/m^2	3.8 plants/m^2	2 plants/m^2	1.95 plants/m^2
Pickings	date	first	May 17th	Apr 26th	June 17th	Apr 5th
		last	Oct18th	June 12th	Oct 16th	July 27th
	number (total/early)		15 / 1-5.	7 / 1-3.	18 / 1-5.	33 / 1-11.

RESULTS

Sweet pepper

The higher total yields were characteristic to the plots with expanded clay pellets (*Table 2*), though no statistical difference was detectable between the two media and almost all over the growing season the best result was produced by the rockwool. The proportion of substandard fruits was very low in all of the treatments.

Table 2: Sweet pepper yields with plastic bag cultivation

Treatment	Yield weight [kg/m^2]				Fruit number [fruits/m^2]			
	Total	Early	Extra + 1st class	Subst.*	Total	Early	Extra + 1st class	Subst.*
H4/8KK	18.36	3.85	9.66	0.28	231.20	53.67	90.53	4.13
Rockwool	17.76	4.05	9.97	0.64	216.01	51.94	93.84	8.58

*Substandard

Tomato

The yields of the plants grown in rockwool were approximately 0.76 kg higher per m^2 than those of the plants grown in expanded clay (*Table 3*). Of the two different expanded clay pellet types the H4/8KK produced somewhat better results than the H4/8. In the case of the former the fruiting graph had almost the same pattern as that of the plants grown in rockwool.

Table 3: Tomato yields [kg/m^2]

Treatment	Total	Early
H4/8	26.82	8.52
H4/8KK	27.04	11.65
Rockwool	28.09	12.41

Eggplant

Considering total yields it can be seen (*Table 4*) that in the case of planting one plant per slab the rockwool was the most favorable but the treatment H4/8 was only slightly inferior. The H4/8KK on the other hand produced yields that were almost 30% inferior (5.18 kg) to that produced by the rockwool. When two plants were planted on the same slab, the difference between the three treatments was less than 0.30 kg. In the case of the rockwool and the expanded clay H4/8 the greater root volume per plant was significantly superior to the smaller one.

Table 4: Eggplant yields

Treatment	Total	Early	Marketable	Substandard
Yield weight [kg/m^2]				
1 plant / plastic bag				
H4/8	17.70^{aA}	3.56^{abA}	13.85^{abA}	3.85^{aA}
H4/8KK	12.61^{bA}	2.45^{bA}	10.48^{bA}	2.13^{aB}
Rockwool	17.96^{aA}	5.26^{aA}	15.35^{aA}	2.61^{aA}
2 plants / plastic bag				
H4/8	13.70^{aB}	4.59^{aA}	9.97^{aB}	3.73^{aA}
H4/8KK	13.76^{aA}	2.71^{aA}	9.97^{aA}	3.79^{aA}
Rockwool	13.68^{aB}	3.85^{aA}	10.80^{aB}	2.88^{aA}
Two factor variance analysis results				
Planting method	$p<0.05$	-	$p<0.05$	-
Growing medium	$p<0.05$	$p<0.05$	$p<0.05$	-
Planting method x growing medium	$p<0.05$	-	-	-
Fruit number [fruits/m^2]				
1 plant / plastic bag				
H4/8	62.00^{aA}	20.00^{abA}	40.00^{abA}	22.00^{aA}
H4/8KK	39.00^{bA}	12.00^{bA}	29.00^{bA}	10.00^{bB}
Rockwool	54.00^{aA}	22.00^{aA}	42.00^{aA}	12.00^{abA}
2 plants / plastic bag				
H4/8	48.80^{aB}	20.00^{aA}	29.80^{aA}	19.00^{aA}
H4/8KK	49.50^{aA}	16.50^{aA}	29.30^{aA}	20.20^{aA}
Rockwool	50.00^{aA}	19.50^{aA}	34.50^{aB}	15.50^{aA}
Two factor variance analysis results				
Planting method	-	-	-	-
Growing medium	$p<0.05$	$p<0.05$	-	$p<0.05$
Planting method x growing medium	$p<0.05$	-	-	-

Note: The different small letters next to the numbers in the columns indicate the statistical difference at $p<0.05$ level of the effect of the media, and the capitals that of the planting method (root volume)

In terms of total fruit number the two planting methods showed difference again. In the investigation of the plants grown singularly the best result was produced by the expanded clay H4/8, while in the case of planting in pairs the rockwool. In the case of the former the H4/8KK treatment produced an almost 40% lower result than the H4/8, while a result between the two was reached in the rockwool. In the second case the lowest number of fruits were harvested from the plants of the treatment H4/8, but it was only 13% inferior to the rockwool. Comparing the two planting methods, significant difference occurred only in the case of the medium H4/8, for the advantage of the greater root volume.
The level of the Ca-deficient, damp and soft (substandard) fruits was relatively high in each treatment, but the planting of two plants per bag (i.e. the lower root volume per plant) resulted in a higher proportion of substandard fruits.

Cucumber

The highest numbers of fruits were produced by the plants planted in the peat containing mix, though the yield weight of the plants grown in the expanded clay pellets was only 15-20% lower and their fruit number only 10-12% lower (*Table 5*). In terms of the total yields no significant difference was found between the two different expanded clay types. Considering the qualitative distribution of fruits it can be seen that the proportion of the 1st class fruits (over 90%) was very favorable in each treatment.

Table 5: Cucumber yields

Treatment	Yield weight [kg/m^2]			Fruit number [fruits/m^2]		
	Total	Early	1st class	Total	Early	1st class
H4/8	18.40	7.16	17.25	49.45	19.18	44.93
H4/8KK	17.59	7.32	16.19	47.95	19.59	42.88
Peat + Perlite	21.58	8.81	20.36	54.66	23.15	50.14

CONCLUSIONS

Experimental results show the suitability of expanded clay pellets for root medium in the soilless greenhouse production of sweet pepper, tomato, eggplant and cucumber. With the refinement of the irrigation-fertigation system probably the yields of each species can be increased. In the case of the eggplant the results on the amount of the growing medium, according to which the greater root volume increases yields, show that choosing the volume in accordance with the substrate can also have great significance.

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