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Researches Concerning the Use of Zeolites in the Culture Substrate of Tomatoes in Greenhouse Solarium Type

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Abstract. Obtaining good quality substrates is done by mixing some more organic and inorganic components, of which the most used, are: manure, garden soil, black or red peat and sand. Because of the biological vegetable culture concept, the comparative analyze, from the technological and economical point of view, of the substrate mixture components impact upon tomato plants' growth and development by using different organic and inorganic (volcanic tuffs) components with a high role in correcting and improving their physical-chemical features, it is imposed. By comparing the different culture substrate variants, very significant positive differences of production were obtained in variant a_3 (50% manure, 10% garden soil, 10% peat, 5% sand and 25% zeolite). In absolute values the average productions per fruiting clusters varied between 0.579 kg (b_7) and 1.035 kg (b_4).

Keywords: zeolite, substrate culture, tomatoes, quantity yield, polyethylene greenhouse

INTRODUCTION

The importance of tomatoes is crucial, because of the fact that these can be consumed fresh, as ingredients of tomato salads or of mixed salads, in vegetable soups, sauces, unfilled tomatoes etc., as well as industrially processed as natural juice, chilly juice, cans, sauces (Apahidean, Apahidean, 2004).

The nutritive mixture used for producing seedlings and for tomatoes' culture in bags or pots has to have the following features: a proper structure in order to assure the gases change with the atmosphere, to be light, a high porosity, permeable, a high capacity of water retention, abundance in nutrients and a low content of soluble salts, a pH between 6 and 6.5 and a high dab capacity in order to maintain the pH value (Indrea *et al.*, 2007).

Obtaining good quality substrates is done by mixing some more organic and inorganic components, of which the most used, are: manure, garden soil, black or red peat and sand.

Along the bases organic and inorganic components, there also can be used in mixtures some other components, such as: perlite, vermiculite, crushed volcanic tuffs and grind tree bark in proportion of 25-30% (Ciofu *et al.* 2003).

Because of the biological vegetable culture concept, the comparative analyze, from the technological and economical point of view, of the substrate mixture components impact upon tomato plants' growth and development by using different organic and inorganic (volcanic tuffs) components with a high role in correcting and improving their physical-chemical features, it is imposed (Stoian, 2005).

Volcanic tuffs, according to the content and the zeolite species present as secondary formats by debased volcanic glass, are classified upon the nomenclature of Aleksiev and

Djourova (1974) in zeolites (with a content higher than 50%), zeolite tuffs (25-50% zeolites), tuffs with zeolites (10-25% zeolites) and volcanic tuffs without zeolites (Monolov *et al.*, 2005).

MATERIALS AND METHODS

The experiment developed during 2011 at the Didactic and Research Base of the Faculty of Horticulture and Forestry, from B.U.A.S.V.M. Timişoara.

The biological material used in the experiment was represented by Venezia F_1 tomatoes hybrid.

The Volcanic tuff used in the experiment belongs to the group of polymineral zeolites, which is clinoptilolite-mordenite-natrolitic zeolites category, identified in Maramureş Hollow, the accumulation from Bârsana.

In order to show the impact of culture substrate composition upon the average production of each fruiting cluster we used the polyfactorial experiment model.

Factor A (culture substrate) with 5 gradations:

a_1 (Control) – 50% manure, 40% garden soil and 10% sand;

a_2 – 40% manure, 40% garden soil, 10% peat and 10% sand;

a_3 – 50% manure, 10% garden soil, 10% peat, 5% sand and 25% zeolite;

a_4 – 20% manure, 20% garden soil, 5% peat, 5% sand and 50% zeolite;

a_5 – 10% manure, 5% garden soil, 5% peat, 5% sand and 75% zeolite;

Factor B (the fruiting cluster) with 7 gradations.

At the maturity of consumption, there were made measurements on the weight of fruits on every fructification cluster of every plant and the weight of fruits on each plant.

The observations have been made using the current observation techniques, experimental data processing has been performed using statistical and mathematical methods and those data regarding the production were calculated and interpreted on the basis of variance analysis (Ciulca, 2002).

RESULTS AND DISCUSSION

Productivity or production potential as fundamental trait of every plant – seen not only in terms of biology but also in economic way – should be analyzed and known thoroughly in all its aspects. Acknowledges of this are absolutely necessary in order to apply optimal solutions both in creation activity of new forms or hybrids, which refers to the improvement of plants, and in the activity of technological specialists that have the duty to cultivate them and to provide them with conditions that permit full expression of potential production (Savatti *et al.*, 2004).

In this sense, during the vegetation period there were made observations regarding quantity order, in the fruit weight on each fructification cluster (Berar *et al.*, 2010).

The experimental results obtained through the comparison of the nutritive substrate and the fruiting cluster variants are presented in tables 1 and 2.

Tab. 1

The influence of the culture substrate upon the average production of fruits/fruiting cluster
(Comparison of the nutritive substrate variants)

Culture substrate	Average production of fruits/fruiting cluster (kg)	Relative production of fruits/fruiting cluster (%)	Difference (kg)	Significance
a_2-a_1	0.761-0.684	111.25	0.077	*
a_3-a_1	1.021-0.684	149.26	0.337	***
a_4-a_1	0.783-0.684	114.47	0.099	**
a_5-a_1	0.593-0.684	86.69	- 0.091	00
a_3-a_2	1.021-0.761	134.16	0.260	***
a_4-a_2	0.783-0.761	102.89	0.022	-
a_5-a_2	0.593-0.761	77.92	- 0.168	000
a_4-a_3	0.783-1.021	76.68	- 0.238	000
a_5-a_3	0.593-1.021	58.08	- 0.428	000
a_5-a_4	0.593-0.783	75.73	- 0.190	000

$LSD_{5\%}$ = 0.051 kg $LSD_{1\%}$ = 0.079 kg $LSD_{0.1\%}$ = 0.125 kg

By analyzing the experimental results presented in table 1 there can be observed the following:

- very significant positive differences of the average production of fruits per fruiting cluster are obtained by comparing variant a_3 with variants a_2 and a_1;

- using the variant of nutritive mixture with 50% manure, 10% garden soil, 10% peat, 5% sand and 25% zeolite as a culture substrate gave production increase of 30-45%, for culture in greenhouse solarium type.

Tab. 2

The influence of the culture substrate upon the average production of fruits/fruiting cluster
(Comparison of the fruiting clusters)

Fruiting cluster	Average production of fruits/ fruiting cluster (kg)	Relative production of fruits/ fruiting cluster (%)	Difference (kg)	Significance	Fruiting cluster	Average production of fruits/ fruiting cluster (kg)	Relative production of fruits/ fruiting cluster (%)	Difference (kg)	Significance
b_2-b_1	0.811-0.613	132.30	0.198	***	b_4-b_3	1.035-0.947	109.29	0.088	*
b_3-b_1	0.947-0.613	154.48	0.334	***	b_5-b_3	0.883-0.947	93.24	- 0.064	-
b_4-b_1	1.035-0.613	168.84	0.422	***	b_6-b_3	0.751-0.947	79.30	- 0.196	000
b_5-b_1	0.883-0.613	144.04	0.270	***	b_7-b_3	0.579-0.947	61.14	- 0.368	000
b_6-b_1	0.751-0.613	122.51	0.138	**	b_5-b_4	0.883-1.025	86.14	- 0.142	00
b_7-b_1	0.579-0.613	94.45	- 0.034	-	b_6-b_4	0.751-1.025	73.25	- 0.274	000
b_3-b_2	0.947-0.811	116.76	0.136	**	b_7-b_4	0.579-1.025	56.48	- 0.446	000
b_4-b_2	1.035-0.811	127.62	0.224	***	b_6-b_5	0.751-0.883	85.05	- 0.132	00
b_5-b_2	0.883-0.811	108.87	0.072	-	b_7-b_5	0.579-0.883	65.57	- 0.304	000
b_6-b_2	0.751-0.811	92.60	- 0.060	-	b_7-b_6	0.579-0.751	77.09	- 0.172	000
b_7-b_2	0.579-0.811	71.39	- 0.232	000					

$LSD_{5\%}$ = 0.081 kg $LSD_{1\%}$ = 0.117 kg $LSD_{0.1\%}$ = 0.150 kg

Analyzing the experimental results presented in table 2 concerning the comparison of the average production obtained in each fruiting cluster there can be observed the following:

- very significant positive differences are obtained by comparing fruiting clusters 2-5 with 1, respectively fruiting cluster 4 with 2;

- in absolute values the average productions per fruiting clusters varied between 0.579 kg (b_7) and 1.035 kg (b_4).

The experimental results obtained through the comparison of the nutritive substrate variants for each fruiting cluster variants are presented in table 3.

Tab. 3

The influence of the culture substrate upon the average production of fruits/fruiting cluster
(Comparison of the nutritive substrate variants for each fruiting clusters)

Mixture of facts	Average production of fruits/ fruiting cluster (kg)	Relative production of fruits/ fruiting cluster (%)	Difference (kg)	Significance	Mixture of facts	Average production of fruits/ fruiting cluster (kg)	Relative production of fruits/ fruiting cluster (%)	Difference (kg)	Significance
a_2b_1-a_1b_1	0.680-0.658	103.34	0.022	-	a_4b_4-a_2b_4	0.901-0.995	90.55	- 0.094	0
a_3b_1-a_1b_1	0.813-0.658	123.55	0.155	***	a_5b_4-a_2b_4	0.812-0.995	81.60	- 0.183	000
a_4b_1-a_1b_1	0.695-0.658	105.62	0.037	-	a_4b_4-a_3b_4	0.901-1.027	87.73	- 0.126	00
a_5b_1-a_1b_1	0.597-0.658	90.72	- 0.061	-	a_5b_4-a_3b_4	0.812-1.027	79.06	- 0.215	000
a_3b_1-a_2b_1	0.813-0.680	119.55	0.133	**	a_5b_4-a_4b_4	0.812-0.901	90.12	- 0.089	00
a_4b_1-a_2b_1	0.695-0.680	102.20	0.015	-	a_2b_5-a_1b_5	0.819-0.785	104.33	0.034	-
a_5b_1-a_2b_1	0.597-0.680	87.79	- 0.083	0	a_3b_5-a_1b_5	0.949-0.785	120.89	0.164	***
a_4b_1-a_3b_1	0.695-0.813	85.48	- 0.118	00	a_4b_5-a_1b_5	0.831-0.785	105.85	0.046	-
a_5b_1-a_3b_1	0.597-0.813	73.43	- 0.216	000	a_5b_5-a_1b_5	0.735-0.785	93.63	- 0.050	-
a_5b_1-a_4b_1	0.597-0.695	85.89	- 0.098	00	a_3b_5-a_2b_5	0.949-0.819	115.87	0.130	**
a_2b_2-a_1b_2	0.783-0.757	103.43	0.026	-	a_4b_5-a_2b_5	0.831-0.819	101.46	0.012	-
a_3b_2-a_1b_2	0.914-0.757	120.73	0.157	***	a_5b_5-a_2b_5	0.735-0.819	89.74	- 0.084	0
a_4b_2-a_1b_2	0.791-0.757	104.49	0.034	-	a_4b_5-a_3b_5	0.831-0.949	87.56	- 0.118	00
a_5b_2-a_1b_2	0.682-0.757	90.09	- 0.075	0	a_5b_5-a_3b_5	0.735-0.949	77.44	- 0.214	000
a_3b_2-a_2b_2	0.914-0.783	116.73	0.131	**	a_5b_5-a_4b_5	0.735-0.831	88.44	- 0.096	0
a_4b_2-a_2b_2	0.791-0.783	101.02	0.008	-	a_2b_6-a_1b_6	0.752-0.757	99.33	- 0.005	-
a_5b_2-a_2b_2	0.682-0.783	87.10	- 0.101	0	a_3b_6-a_1b_6	0.878-0.757	115.98	0.121	**
a_4b_2-a_3b_2	0.791-0.914	86-54	- 0.123	00	a_4b_6-a_1b_6	0.765-0.757	101.05	0.008	-
a_5b_2-a_3b_2	0.682-0.914	74.61	- 0.232	000	a_5b_6-a_1b_6	0.669-0.757	88.37	- 0.088	0
a_5b_2-a_4b_2	0.682-0.791	86.21	- 0.109	00	a_3b_6-a_2b_6	0.878-0.752	116.75	0.126	**
a_2b_3-a_1b_3	0.845-0.855	98.83	- 0.010	-	a_4b_6-a_2b_6	0.765-0.752	101.72	0.013	-
a_3b_3-a_1b_3	0.980-0.855	114.61	0.125	**	a_5b_6-a_2b_6	0.669-0.752	88.96	- 0.083	0
a_4b_3-a_1b_3	0.861-0.855	100.70	0.006	-	a_4b_6-a_3b_6	0.765-0.878	87.12	- 0.113	00
a_5b_3-a_1b_3	0.763-0.855	89.23	- 0.092	0	a_5b_6-a_3b_6	0.669-0.878	76.19	- 0.209	000
a_3b_3-a_2b_3	0.980-0.845	115.97	0.135	**	a_5b_6-a_4b_6	0.669-0.765	87.45	- 0.096	000
a_4b_3-a_2b_3	0.861-0.845	101.89	0.016	-	a_2b_1-a_1b_1	0.663-0.653	101.53	0.010	-
a_5b_3-a_2b_3	0.763-0.845	90.29	- 0.082	0	a_3b_1-a_1b_1	0.793-0.653	121.43	0.140	**
a_4b_3-a_3b_3	0.861-0.980	87.85	- 0.119	00	a_4b_1-a_1b_1	0.678-0.653	103.82	0.025	-
a_5b_3-a_3b_3	0.763-0.980	77.85	- 0.217	000	a_5b_1-a_1b_1	0.577-0.653	88.36	- 0.076	0
a_5b_3-a_4b_3	0.763-0.861	88.61	- 0.098	0	a_3b_1-a_2b_1	0.793-0.663	119.60	0.130	*
a_2b_4-a_1b_4	0.995-0.895	111.17	0.100	*	a_4b_1-a_2b_1	0.678-0.663	102.26	0.015	-
a_3b_4-a_1b_4	1.027-0.895	114.74	0.132	**	a_5b_1-a_2b_1	0.577-0.663	87.02	- 0.086	0
a_4b_4-a_1b_4	0.901-0.895	100.67	0.06	-	a_4b_1-a_3b_1	0.678-0.793	85.49	- 0.115	00
a_5b_4-a_1b_4	0.812-0.895	90.72	- 0.083	0	a_5b_1-a_3b_1	0.577-0.793	72.76	- 0.216	000
a_3b_4-a_2b_4	1.027-0.995	103.21	0.032	-	a_5b_1-a_4b_1	0.577-0.678	85.10	- 0.101	0

$LSD_{5\%}$ = 0.072 kg $LSD_{1\%}$ = 0.103 kg $LSD_{0.1\%}$ = 0.147 kg

The comparative analysis of the experimental results presented in table 3 show very significant differences of production of fruits/ fruiting cluster when compared with variant a_3 with variants a_1, for the first three fruiting cluster.

CONCLUSIONS

According to the experimental obtained results concerning the influence of culture substrate upon the average production on fruiting clusters of tomatoes cultivated in greenhouses, we can take the following conclusions:

- using the zeolite in soil mixtures represents an alternative to the classical nutritive substrate, composed of those three or four bases organic and inorganic components;
- by comparing the different culture substrate variants, very significant positive differences of production were obtained in variant a_3 (50% manure, 10% garden soil, 10% peat, 5% sand and 25% zeolite);
- introducing zeolite in the composition of the culture substrate of tomatoes cultivated in greenhouses contributes to the obtaining of superior average productions per fruiting cluster compared to the classical variants;
- the production differences obtained in case of using 25% zeolite in the substrate composition are of 30-45%.

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