THE EFFECT OF ADDITION OF DIFFERENT AMOUNTS OF NATURAL ZEOLITES ON THE CUCUMBER SEEDLINGS QUALITY

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ABSTRACT

In this work, the zeolitic tuffs, originally from Serbia, from three sites (Igroš, Vranjska Banja, Slanci) were used as a component of substrate in the vegetable seedlings production. The experiment was set in the pots and different amounts of zeolites (10, 20 and 30 % v/v) were added to the Terracult substrate (control). The Caman RZ hybrid cucumber was used as a growing culture. The following seedling quality parameters were examined: plant height, stem height, stem diameter, leaf number, fresh matter and total leaf area per plant.

Experiments showed a noticeable influence of zeolites' addition on seedlings parameters. The additions of different amounts of zeolites were consistently significant only for the variants with zeolite from Zlatokop. It is noticed that its higher content in the substrate mixture, reduced plant growth. The highest quality seedlings were obtained when substrate mixture contained 10 % of zeolite.

Keywords: zeolite, cucumber, seedlings, plant height, leaf area.

INTRODUCTION

Cucumber is grown in open field and in protected area (greenhous) conditions. Production could be done by direct sowing of seeds and through seedlings. The seedlings are produced under controlled conditions (protected space) up to the 3-5 leaf stage, after which the plants are planted in a permanent place. This method of production achieves early harvesting of fruits (early stage), saves expensive seeds and maximizes production capacity [1,2].

The main factors influencing successful production of vegetable seedlings are temperature, relative humidity, light, substrate, water content, nutrients in soil and substrate, as well as the vegetation space. Each plant species has specific requirements for these factors [3].The quality of the seedlings, as well as the length of its production cycle, depends right on these factors.

Mixtures usually contain certain materials, such as soil, manure, lumbrihumus, peat, sludge, etc. Peat mixtures (combination of white and black peat) are the most widely used. Depending on the type and method of its production, other materials such as fertilizers, perlite, zeolites, various clays, gels, etc. are added to substrate mixtures [4-7].

Zeolites are a group of aluminosilicate minerals. They have a rigid 3-dimensional, crystalline structure consisting of a network of interconnected tunnels and cages. The structure gives zeolites special properties like a high ion-exchange and the ability to act as molecular sieves.

Due to their special structure, physical and chemical properties, they have a very wide application in industry, agriculture and environmental protection. Agriculture is very significant, and potentially the largest consumer of natural zeolites, and zeolites are widely used in soil amelioration [8]. Compared with the normal soil, soil treated with zeolite, could increase infiltration by 7–30 % on gentle slope land and more than 35 % on steep slope land.

In addition, the treated soil could increase soil moisture by 0.4–1.8 % in the extreme drought condition and 5–15 % in general situation [9].

In our research, influence of substrates with addition of zeolites on quality of cucumber seedlings was measured through vegetative experiments.

EXPERIMENTAL

The experiment with pots was conducted in the greenhouse, at the Faculty of Agriculture, University of Belgrade, during spring 2019. The tests were performed on a Caman RZ hybrid cucumber (Netherlands) whose seeds were sown in pots with a diameter of 10.5 cm. The pots were filled with commercial Terracult TC 10 substrate (control), supplemented with various amounts of zeolite. The starting zeolitic materials used in this work were natural Serbian zeolitic tuffs from Zlatokop (Vranjska Banja - ZL), Igros (Brus - IG) and Slanci (Belgrade - SL). All zeolites contain mainly clinoptilolite [10]. The proportion of these zeolites in the commercial substrate ranged from 10 to 30 % v/v. Zeolite fractions up to 0.5 mm in diameter were used. All treatments were compared with a control with no addition of zeolite.

After the production of seedlings, which lasted 15 days (from sprouting), the following analyzes of the experimental plants were performed: plant height (cm), stem height (cm), stem diameter (mm), leaf number, fresh matter (g) and total leaf area per plant (cm^2). The scales, nonius, rulers and leaf area meter (CL 202 area meter, USA) were used for the analysis.

The obtained results were analysed according to the model of the one-factor analysis of variance, and the individual comparison of groups was performed by the subsequent LSD test ($p<0.05$ and $p<0.01$). The data were processed using various mathematical and statistical softwares (Excel 2010, DSAASTAT) and results are presented in the table 1.

RESULTS AND DISCUSSION

The plant height represents the most significant and most frequent morphological feature used for evaluation of the seedling quality [4,11,12]. Substrates with a zeolite content of 30 %, have a depressed influence on the plant height. For IG and ZL zeolites this difference was also statistically significant. The highest plants were observed on substrate containing 20 % of IG zeolite and the lowest in substrate with 20% of SL zeolite (20.55 and 15.90 cm). Similar results were obtained for parameters of the height and thickness of the stem.

The average number of leaves for all treatments was 3.02. The highest number of leaves had plants grown on substrate with 10 % of ZL zeolite and the smallest on substrate with 30% of IG zeolite (4.33 and 2.0). In these treatments, statistical significance was only observed for the number of leaves relative to the control variant (3.33).

The fresh, green plant mass (overhead) in the control variant was 4.93 g had the lowest weight in the IG variant 30 % (2.93 g) and the highest in the ZL variant 10 % (6.94 g). Looking at substrates with the different amounts of the same zeolite, only a statistically significant decrease of this parameter was observed in substrate with the highest amount of IG zeolite. The substrates with zeolite ZL had the highest mass of fresh matter and the differences in treatments containing different amounts of zeolite ZL were not statistically significant.

The photosynthetic activity of plants is conditioned by the amount of chlorophyll and leaf mass. On average for all variants, the total leaf mass per plant was 99.16 cm^2. In terms of averages, the total leave mass was the highest in control (126.93 cm^2). This difference was statistically significant relative to all variants with IG and SL zeolites. Within the same zeolite, a positive, statistically significant effect was achieved with ZL zeolite. Here, the

zeolite content of 10% had a significant increase in leaf mass relative to the other two variants. Another significant influence on this parameter was registered in the IG variant where the highest zeolite content had a depressant effect.

Table 1. The effect of zeolite on the quality for cucumber seedlings

Supstrate	Plant height (cm)	Stem height (cm)	Stem diameter (mm)	Leaf number	Fresh matter (g)	Total leaf area per plant (cm^2)
Control	**18.13**	**7.73**	**4.71**	**3.33**	**4.93**	**126.93**
IG 10%	19.70	9.55	4.27	2.50	4.79	98.90
IG 20%	20.55	10.55	4.50	3.00	4.74	93.47
IG 30%	13.35	6.85	4.23	2.00	2.93	47.67
IG (average)	**17.87**	**8.98**	**4.33**	**2.50**	**4.15**	**80.01**
SL 10%	15.95	6.70	4.46	3.00	4.11	84.70
SL 20%	15.90	7.83	4.90	3.00	4.84	86.47
SL 30%	16.60	7.40	4.48	3.00	4.50	89.60
SL (average)	**16.15**	**7.31**	**4.61**	**3.00**	**4.48**	**86.92**
ZL 10%	20.30	10.53	4.82	4.33	6.94	146.43
ZL 20%	17.00	7.80	5.84	3.00	5.61	113.79
ZL 30%	17.73	8.50	5.60	3.00	5.84	103.68
ZL (average)	**18.34**	**8.94**	**5.42**	**3.44**	**6.13**	**121.30**
Average	**17.52**	**8.35**	**4.78**	**3.02**	**4.92**	**99.16**
LSD 0.05	2.65	1.58	0.94	0.52	1.63	31.3
LSD 0.01	3.61	2.15	1.28	0.7	2.22	42.7

CONCLUSION

Based on this research, it was concluded that there was a significant influence of the zeolite component in the substrate on the quality of cucumber seedlings produced in pots. The influence of the zeolitic tuff origin and its content in the substrate mixture on the investigated seedling traits was both positive and negative. Positive impact was recorded among all substrates within zeolitic tuff from Vranjska Banja, and the negative impact in substrates with tuffs originating from Igroš and Slanci. Such result is probably caused by different crystallographic and mineral composition of zeolitic tuffs, which is connected with its activity of substitution and absorption of nutrients. These aspects will be the subject of further research. A 10% substrate mixture of zeolites with a maximum diameter of 0.5 mm originating from Vranjska Banja may be recommended to the manufacturing practice.

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