Indian Journal of Fundamental and Applied Life Sciences ISSN: 2231-6345 (Online)
An Online International Journal Available at http://www.cibtech.org/jls.htm
2012 Vol. 2 (1) January- March, pp. 127-132/Torkashvand et al.
Research Article

ZEOLITE: AN APPROPRIATE ALTERNATIVE TO PEAT IN THE GROWTH MEDIUM OF ORNAMENTAL PLANTS

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ABSTRACT
The possibility using zeolite as appropriate medium in the cultivation of ornamental plants was investigated by a completely randomized design in three replications in Export Terminal of Plant and Flower, Salmanshahr, Mazandaran, Iran. A 2:1 ratio of peat to perlite was used as control treatment and peat was replaced by 10, 20, 30, 40 and 50% v/v of zeolite. The chemical properties of these media including pH, EC, organic carbon, total nitrogen, C/N ratio; and available P, K, Ca, Mg and Na were measured. Growth indexes include stem height, leaf number, fresh and dry weight of shoot, fresh and dry weight of roots were measured in Dieffenbachia plant. Nutrients concentration of N, P, K, Ca, Mg, Fe, Mn and Zn were also measured. Results showed that the greatest dry weight of shoot (9.17 g) obtained in 10% treatment of zeolite. The highest height of stem obtained in control treatment, but the 40% zeolite treatment had not significant difference as compared with control. Effect of treatment on nitrogen, phosphorus, calcium, magnesium, and manganese was not significant at 5% level. Zeolite increased the potassium concentration of leaf in all levels that the greatest increase obtained at 20 and 40% zeoilte. The considerable increase in Fe concentration of leaf is observed at 10, 30 and 50% levels of zeolite.

Key Words: *Flower, Ornamental, Peat, Perlite, Zeolite*

INTRODUCTION
Optimum plant growth and economic continued availability are the first criterions for a commercial bed. Every commercial cultivation medium in addition to maintaining water, appropriate drainage and a suitable place to establish roots should be free from toxic substances, pests and diseases (Higaki and Imamura, 1985). One of the main production inputs for growing ornamental plants especially pot plants is appropriate cultivation medium. One of the main factors limiting exports of pot plants, lack of proper and standard cultivation bed in the country. The pot substrates and their compounds are a vital source for greenhouse industry (Padasht and Gholami, 2009).

Today, most plants with ornamental leaves are cultivated in soilless media which peat is as basic medium (Atieyh et al., 2000), but the use of peat is doubtful due to ecological damages to environmental and economic advantageous for ornamental plants producers. These factors caused those researchers think to beds with high quality and cheap instead of peat (Krumfolz et al., 2000). Natural zeolite mineral are often used to build new beds for planting and plant breeding, seed production and seedling, root cuttings, pot ornamentals plants etc. (Manolov et al. (2005). In recent years pay attention to the development of sustainable agriculture, using natural minerals as amendments are common to improve soil physical and chemical properties (Abdi et al, 2006).

The study of Perez et al. (2008) on olive plant showed that zeolites had a positive impact in reducing nitrate leaching, increase in soil water holding capacity, water use efficiency and a reduction in using fertilization. Increased use of zeolite had a significant effect on weight and amount of olive oil. Nabila et al. (2009) in the perlite-peat medium amended by zeolite reported that the need of plant for water and fertilizer decreased by about 29 percent without a reduction in plant growth and Kroton ornamental plant quality. Issa et al. (2001) found that Gerbera in a zeolite medium had a more growth than perlite medium. It has also been reported that the adding 10% clinoptilolite to sand soil used in grass and golf lands of Japan has caused to increase yield (Ferguson et al., 1987). Zeolites because of high cation exchange capacity can be used successfully in the cultivation of various crops such as cereals, forage crops, vegetables, grapes and fruit (Milosevic et al., 2009). The aim of this study is to evaluate the possibility using zeolite as a modifier in the growth medium of *Dieffenbachia amoena.*

MATERIALS AND METHODS

To verify the impact of zeolite on the growth of ornamental plants, a study was conducted at the export terminal of flower and plant, Salmanshahr, Mazandaran province, Iran. In a completely randomized design, the possibility of replacing peat by six levels of zeolite was investigated including:

1. Control: a 2:1 ratio of peat-perlite,
2. 10% zeolite: 10% of peat was replaced by zeolite,
3. 20% zeolite: 20% of peat was replaced by zeolite,
4. 30% zeolite: 30% of peat was replaced by zeolite,
5. 40% zeolite: 40% of peat was replaced by zeolite,
6. 60% zeolite: 50% of peat was replaced by zeolite.

The chemical properties of these media including pH, EC, organic carbon, total nitrogen, C/N ratio; and available P, K, Ca, Mg and Na were measured. Every treatment applied in three replicates and was selected as the test plant. 108 cuttings of *Dieffenbachia amoena* were prepared in July 2010 so that all seedling of plant were the same size. First all cutting were disinfected by fungicides (Mancozeb) and were planted on leaf litter pots that after one month were fully rooted. The used peat was provided from the German SAB company that was purchased as a ready. After preparing media, the rooted cutting of *Dieffenbachia amoena* was transferred to 4 liters pots. Stem height were measured after four months of experiment initiation. The shoots were cut after four months; fresh and dry weight of shoot and leaves numbers was measured at the end of experiment. The fresh and dry weight of roots was also measured. In every pot, an extraction of dry shoot was prepared and in extraction, phosphorus by spectrophotometry method and potassium by flame photometry, calcium, magnesium, iron, manganese and zinc by atomic absorption were measured. Total nitrogen of shoots was measured by Kjeldal method (Jackson, 1967; Houba et al., 1989). MSTATC software was used for variance analysis of data by Least Significant Difference (LSD) test.

RESULTS

The amount of nitrogen has decreased in the beds with increasing zeolite. Adding zeolite to beds substrates caused to decrease the available phosphorus proportional to the used zeolite. Unlike nitrogen and phosphorus, potassium content in the different zeolite treatment has increased considerably compared to the control so that the maximum potassium (218.6 mg/kg) was observed in 20% zeolite bed and the lowest amount of potassium (50 mg/kg) in control bed. This considerable increase is also observed in available calcium of beds containing zeolite than in the control.

The use of zeolite in substrates decreased available Mg and the largest decrease was observed in 20% zeolite medium. Zeolite reduced the C/N ratio so that this ration in 20% zeolite treatment, 2.35 times was less than in the control. The pH increased in zeolite treatments and the highest increase (1.7 units) was observed in 50% zeolite. It should be noted that the EC has also increased under this treatment (50% zeolite) approximately 2 dS/m in compared to the control.

The ANOVA results (Table 2) showed that the effect of treatments on all growth factors was significant at one percent level. Table 3 showed the effect of treatment on the growth of *Dieffenbachia amoena.* The zeolite treatments at the amounts of 20 and 50% increased the leaf number, but these increases were not significant. The greatest dry weight of shoot (9.17 g) was related to 10% treatment of zeolite. The 20% zeolite treatment also showed a significant increase in shoot dry weight than in the control, but other treatments of zeolite decreased shoot dry weight than control, significantly. The highest height of stem obtained in control treatment, but the 40% zeolite treatment had not significant difference as compared with control. The root dry weight decreased in 10, 30 and 40% zeolite treatments than in the control, but the 20 and 50% zeolite treatments had not significant difference in compared with control.

Table 1: Some chemical properties of growth media

Media	N (%)	P ($mgkg^{-1}$)	K ($mgkg^{-1}$)	Ca ($mgkg^{-1}$)	Mg ($mgkg^{-1}$)	Na ($mgkg^{-1}$)	OC (%)	C/N ratio	pH (1:5)	EC (dSm^{-1}) (1:5)
Control (peat/perlite 2:1)	0.8	26.3	50.0	7.6	81.3	276.0	37.6	47.0	5.8	1.41
Zeolite 10%	0.73	13.5	129.9	44.0	76.8	306.4	20.3	27.8	6.7	1.48
Zeolite 20%	0.63	10.4	218.6	22.8	34.8	284.5	12.6	20.0	6.4	1.64
Zeolite 30%	0.50	7.2	163.2	26.0	37.5	284.5	11.7	23.4	7.1	1.87
Zeolite 40%	0.35	7.3	180.0	28.0	52.3	324.4	10.5	30.0	7.3	2.16
Zeolite 50%	0.50	4.3	168.2	24.8	43.2	370.0	10.7	21.4	7.5	2.42

Table 2: The ANOVA results of treatments effect on the growth of *Dieffenbachia amoena*

Variation Resource	d.f	Mean Squared					
		Root fresh Weight (g)	Root dry Weight (g)	Stem Height (cm)	Shoot fresh Weight (g)	Shoot dry Weight (g)	Leaf number
Treatments (zeolite levels)	5	13.7**	34.4**	2.3**	159.3**	18.56**	0.6**
Error	24	54.3	0.09	0.2	7.2	0.24	0.1

Table 3: The effect of treatment on the growth of *Dieffenbachia amoena*

Treatments	Leaf number	Shoot dry Weight (g)	Shoot fresh Weight (g)	Stem Height (cm)	Root dry Weight (g)	Root fresh Weight (g)
control	2.6 a	8.14 b*	62.9 a	9.7 a	10.7 a	103.4 a
10% Zeolite	2.5 a	9.17 a	63.1 a	9.0 b	9.6 c	91.4 b
20% Zeolite	2.8 a	8.85 a	56.6 b	9.0 b	10.6 a	99.1 ab
30% Zeolite	2.4 b	6.02 d	57.4 b	8.3 c	8.9 d	79.1 c
40%Zeolite	1.9 b	4.65 e	49.5 c	9.2 ab	8.7 d	77.9 c
50% Zeolite	2.9 a	6.86 c	61.0 a	8.0 c	10.0 b	97.3 ab

**LSD (least significant difference) shows the significant difference (ρ = 0.05) among the different treatments.*
Values followed by the same letters in each column are not significantly different at the 0.05 level (least significant difference).

Table 4: The ANOVA results of treatments effect on the nutrients concentration of *Dieffenbachia amoena* leaves

Variation Resource	d.f	Mean Squared							
		N	P	K	Ca	Mg	Fe	Mn	Zn
Treatments (zeolite levels)	5	0.08 ^{ns}	0.01^{ns}	3.12**	0.07^{ns}	0.02^{ns}	249561.0 **	1823.9^{ns}	5613.5*
Error	24	0.15	0.03	0.25	0.06	0.04	138.39	923.2	2085.5

Table 5: The effect of treatments on the nutrients concentration of *Dieffenbachia amoena* leaves

Treatment	N (%)	P (%)	K (%)	Ca (%)	Mg (%)	Fe (mgkg^{-1})	Mn (mgkg^{-1})	Zn (mgkg^{-1})
control	2.9 a	0.45 a	3.4 c	1.38 a	0.65 a	696.2 c	270.26 a	284.8 a
10% Zeolite	2.9 a	0.43 a	4.2 b	1.56 a	0.57 a	1160.0 a	270.24 a	216.8 b
20% Zeolite	3.0 a	0.52 a	5.1 a	1.37 a	0.73 a	931.5 b	270.30 a	224.2 b
30% Zeolite	2.7 a	0.42 a	5.0 a	1.48 a	0.71 a	1118.0 a	270.28 a	223.8 b
40% Zeolite	3.0 a	0.55 a	5.3 a	1.30 a	0.73 a	719.5 c	270.20 a	197.2 b
50% Zeolite	3.0 a	0.51 a	4.9 a	1.58 a	0.64 a	1084.0 a	270.20 a	249.9 ab

The ANOVA results (Table 4) showed that the effect of treatments on potassium and iron concentration of leaf at 5% and zinc at 1% level was significant. Effect of treatment on nitrogen, phosphorus, calcium, magnesium, and manganese was not significant at 5% level. Zeolite increased the potassium concentration of leaf in all levels that the greatest increase obtained at 20 and 40% zeoilte. The considerable increase in Fe concentration of leaf is observed at 10, 30 and 50% levels of zeolite. A decrease in Zn concentration is observed zeolite treatments but this decrease was not significant in 50% zeolite treatment.

DISCUSSION

Chemical properties of the substrate should be considered, because they have a great impact on plant quality. Chemical properties directly influence on the solubility and maintenance of nutrients (Robert et al, 2005). Zeolite is used as an adsorbent for reducing nitrogen transformation (Hung and Petrovic, 1992). Because nitrogen and phosphorus are the part of organic matter copmound, so increasing the amount of zeolite in the growth medium to reduce these nutrients. These results are consistent with the results of Mahboub Khomami (2011) in replacement of peat by zeoilte in *ficus benjamin* medium. Zeolite can be recognized as a source of plant available potassium because of significant amounts of potassium in its compound (Williams and Nelson, 1997). Challinor et al. (1995) by the use of zeolite in medium, concluded that zeolite have the high absorption power for ammonium and potassium and its exchange. With increasing amounts of zeolite in the growth media, pH increased, so that the highest pH value (7.5) was observed in 50% zeolite. Adding zeolite usually increases soil pH (Perez et al, 2008). The results showed that the EC is also proportionally increased compared to controls that is consistent with the studies of Mahboub Khomami (2011).

Increase in stem diameter by Zeolite in this experiment is consistent with the results of Song et al. (2004). They demonstrated that stem diameter, leaf area and seedling dry weight of pepper increased with increasing amounts of zeolite. It seems that the higher rations of 20% zeolite because of the greater C/N ratio, EC and pH caused to decrease the growth of plant. This represents an optimum use of zeolite to achieve maximum yield. It is predicted to differentiate this optimum in different crops. Munir et al (2004) stated that zeolite as slow-release fertilizer decreases the contamination of groundwater and leaching losses by the absorption and trapping nutrients. Fotouhi Ghazvini et al., (2007) reported that a mixture of zeolite and perlite at the growth medium of strawberry caused to increase yield due to high water holding capacity and supplying nutrients.

Potassium concentration of leaf significantly increased in media. Zeolite can absorb potassium and reduces leaching of this nutrient of the growth medium, and then releases it gradually as available to plants. Off course, concentrations variations in the most cases don't follow from the values of these elements in cultivation beds. The increase in potassium concentration of leaf is consistent with Gul et al. (2005) studies that showed the use of zeolite at the growth medium of lettuce with perlite tend to increase in plant growth, nitrogen and potassium of plant tissue and decrease in leaching K. It has been proved that zeolite has a potential in attracting potassium of fertilizers. The added clinoptilolite to a pot cultivation bed of Chrysanthemum has served as a slow-release fertilizer and tend to same growth of plant due to the use of Hoagland nutrient solution (Mumpton, 1999). Regards that nutrients concentration in the plant organs are imposed of different factors such as plant growth, ionic competition and deposition, so, sometimes it is impossible to use nutrients concentration in plant as reliable parameter in assessing plant growth. Impact of nutrients dilution in resulting further yield is also sometimes led to confusion.

Conclusion

It should be regarded that using zeolite don't created a clear difference in plant growth as compared with control, but it is important that can be appropriate alternative for peat because it provides suitable environ for plant growth same peat. Thus, zeolite had a significant effect on potassium concentration in growth media and plant leaves. Since potassium plays an important role in osmotic balance, activating enzymes, photosynthesis, protein synthesis, cell growth and development and material transfer in the vascular, the use of zeolites is important in this respect. It is proposed to do the researches on applied and economic aspects of zeolite with respect to the crops yield.

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