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Research Article

INVESTIGATION USE OF MINERAL SUBSTRATES TO PROVIDE OPTIMUM SOIL MOISTURE

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ABSTRACT
Propagation and planting seedlings of tree and shrub species through cuttings method is much easier, more convenient and more economical than seed propagation methods. In the cuttings methods native plants creating large plants in a limited space, while maintaining the characteristics of the native plants. Creating optimum substrates for rooting is of particular importance in this method. The aim of this study was to investigate the application of inorganic substrates for optimal supply of media moisture of reproduced species of trees and shrubs in the landscape. The results showed that among the culture media use of Perlite, Zeolite, Vermiculite and Super Absorbent, due to have significant amounts of phosphorus, potassium, low density which reduces handling costs, high cation exchange capacity, high air and water retention capacity (above 70%) are more suitable for rooting cuttings of green area and are recommended.

Keyword: *Mineral Substrates, Soil Moisture, Tree Species, Shrub Species*

INTRODUCTION
Tree and shrub species used in the majority of urban green spaces such as parks, squares and boulevards, especially in the margins of the city and absolutely importance in controlling and reducing smoke and toxic agents resulting in a sterilized air (Parvanak and Chamheaidar, 2014). Propagation and planting of seedlings of these species by cuttings is much easier, more convenient and more economical than seed propagation (Khoshkhoe, 2004). In cuttings method, creating optimum substrates for rooting is of particular importance. An media substrate includes a large coarse minerals portion to raise the proportion of large pores filled with air, But existence of course minerals (such as sand and gravels), which have low water holding capacity and high deep water percolation, cause moisture which is the most important factor in rooting of cuttings, easily be drained. Water depletion could loss irrigation water resources and also reduces the physiological and metabolic processes which are effective in rooting of cuttings (Alan, 1994). Recently, the use of mineral substrates to increase and absorb the water holding capacity of the rooting environment of green area is taken into consideration (Huttermann *et al.*, 2007). Because these materials absorb hundreds of times their weight water and quickly become a high durable material, their use in plants rooting media with very few casualties attained a special place in the world (Parvanak and Chamheaidar, 2014). Their use in plants rooting media eliminates water stress and helps the adaptability of crops with the environment. The organic substrates in soil absorb water quickly and keep and increases absorption efficiency and irrigation intervals. The amount of this increase depends on the physical conditions of the medium, water consumption and plant type. Research results conducted by Jonce (2001) in investigation the use of four substrate of zeolite, perlite, sand and rock wool, showed that the lowest yield was in sand substrate. His present study was carried out to evaluate the use of mineral substrates in moisture supply optimal for rooting of cuttings used in landscaping.

MATERIALS AND METHODS
This study is based on library studies from the ISI papers, scientific research, doctoral dissertations, master thesis, books and results of research conducted by the authors in the field of exploring a variety of substrates was performed in propagation of some green area plants. First, we describe the concept of

growing media and steps that are effective in selecting a suitable culture medium. Then the variety of mineral substrates for propagation of green area plants is described.

RESULTS AND DISCUSSION

Mineral Substrates

Sand

The sand used for bedding media of plants including hard particles with a size of 0.5 to 2 mm. The use of lightweight materials such as perlite, gravel and Styrofoam coming to market that have similar characteristics to sand reduced its usage.The moisture holding capacity of sand is low and its aeration is small to moderate. Also the cation exchange capacity of sand is lowandis a completely inert material with very high stability.Sand is one of the heaviest materials with bulk density of 1.6 to 1.9 g cm^{-3}.The ratio of carbon to nitrogen of sand is zero (Baruah, 1998).

Gravel

Gravel particles have diameter of 0.05 to 2 mm.The rooting medium of gravel known as the most heavily environmental. Dry bulk density of the gravel is about 1.9 g cm^{-3}. Gravel has no food and cation exchange. Gravel is often used in combination with organic materials (Baruah, 1998).

Perlite

Perlite is a mineral with greyish white color that has volcanic origin (Figure 1).The composition of this material is aluminum, potassium and sodium silicate. The percentage of silicate, potassium and sodium are 73.06%, 4.5% and 3.65%, respectively (Martinez, and Abad. 1992). Each of the perlite particles surface enlarged when heated and empty holes it will tend to absorb water. Some chemical and physical properties of perlite are shown in Tables 1 and 2.

As can be seen, the water holding capacity, cation exchange capacity, bulk density and nutrient of perlite is very low. The permeability, aeration and stability of pearlite are high. The capillary activity is very high so being able to hold water 3 to 4 times of its weight (Shahinrokhsar *et al.*, 2010). Particles typically with a diameter of 1.5 to 3 mm are used in horticulture. One of the advantages of using perlite in rooting is that perlite is capable of rise water by capillary to the root and provide humid environment to them (Khoshkhoe, 2004).

Figure 1: Schematic perlite

Table 1: Physical properties of perlite

EC dS.m^{-1}	pH	Air porosity %	Water holding %	Porosity %	Bulk density gr.cm^{-3}	Substrate
0.07	7.5	28	36	84	1.88	perlite

Table 2: Chemical properties of perlite

CEC Cmol.kg^{-1}	Fe Mg.kg^{-1}	Zn	Cu	Mn	Mg	Ca	K	Substrate
11	4	0.9	0.5	1	25	25	30	perlite

Rock Wool

Rock wool can be achieved of melting 60% diabase, 20% limestone and 20% coal pellets at 1600 ° C. Rock wool can be used for rooting of cuttings, as growth bed in potsor applied in combination with other media, such as peat or soil. 95% of the volume form of dry rock wool contains air and only 5% of that is fiber. Rock wool is excellent moisture retention and has good aeration. Its pH is neutral to slightly alkalinebut has little effect on substrate pH. Rock wool has a very good stability and be sterilized during heating. The ratio of carbon to nitrogen is zero. Rock wool cannot be over-watered (Angelis, 2001). Plants in the bed with Rock wool can better benefit nutrients relative to peat or soil. Another advantage of using rock wool, is its neutral, sterile and easy to manage.This substrate can used for the cultivation of ornamental plants such as roses, orchids and shoots of plants.

Leca

Leca can be achieved from an expanded special type of clay in industrial rotary kiln at temperatures around 1200 ° C. Leca aggregates due to numerous properties such as high porosity, free from pests, non-compactness, long life, high permeability, the ability to retrieve and reuse, proper drainage and lightness known as one of the world's best roots preservatives (Table 3). It is also a matter of planting trees along streets and walkways, grass land (parks and sports fields) and in hydroponics. Its bulk density is moderate to high and ratio of carbon to nitrogen is zero (Mohamadi, 1998; Shahinrokhsar *et al.*, 2010).

Table 3: Some physical and chemical properties Leca

ǫ EC dS.m^{-1}	pH	Air porosity %	Water holding %	Porosity mm	Bulk density gr.cm^{-3}	Substrate
3.25	7.8	42	16	<12.5	7.98	Leca

Pumis

Pumice is a volcanic material which made of aluminum silicate (Figure 2). It contains small amounts of potassium and sodium. Its aeration is good and the material is sterile.

Figure 2: Schematic Pumis

It is recommended to use size of 3-6 mm for propagation. Pumice mix with peat moss at a ratio of 1: 1 and 2: 1 is a suitable medium for plant (Tzortzakis and Economakis, 2008).

Zeolite and Vermiculite

Vermiculite and zeolite are hydrated aluminosilicate minerals along with some inert material used as bedding medium for rooting of cuttings (Figure 3 and 4). Zeolite due to absorption and high cation exchange and vermiculite for high water retention capacity are used in the rooting media. Some chemical properties of zeolite and vermiculite are indicated in Table 4 (Abad *et al*., 2002; Saberei, 2013).

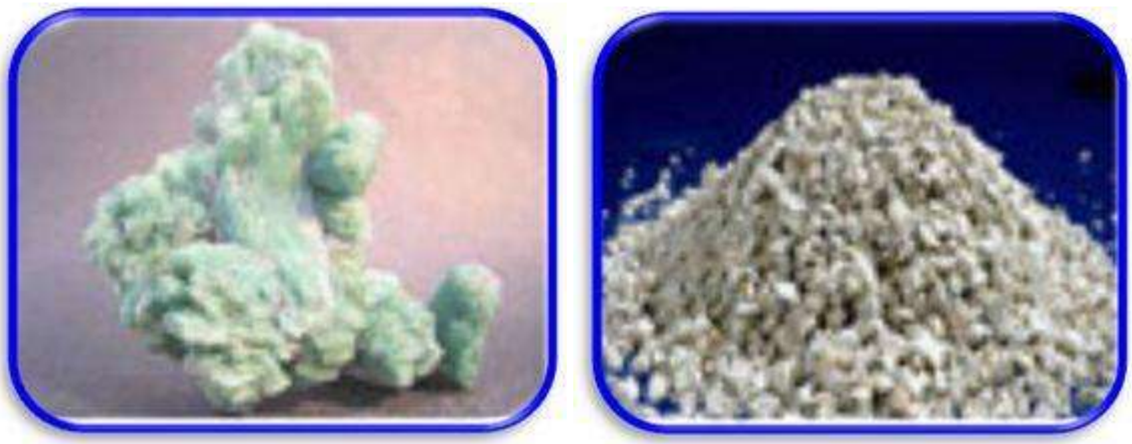

Figure 3: Schematic zeolite

Figure 4: Schematic zeolite

Table 4: Some physical and chemical properties zeolite and Vermiculite

CEC	Fe	Zn	Cu	Mn	Mg	Ca	K	EC	pH	Substrate
Cmol.kg^{-1}	**Mg.kg^{-1}**							**dS.m^{-1}**		
174	3	0.8	0.4	4	300	2000	4300	0.18	9.7	Zeolite
26	16	11	0.8	17	70	1000	50	0.15	7.7	Vermiculite

Styrofoam

The substance is a white synthetic product. Styrofoam packaging has many voids that are filled with air and improves aeration of root growth environment. Like perlite is a good substitute for sand and does not absorb water like it. CEC is not significant. This material is neutral and therefore has no effect on the root medium pH. The lightest material that can be used in substrates and small particles that become floating on the surface of the substrate with excessive irrigation. The water holding capacity of styrofoam is low, its cation exchange capacity is very small, and have high stability, very low bulk density and carbon to nitrogen ratio equal to zero. Appropriate size for use in the growth media is 0.3 to 1.3 cm. Light weight and durable nature of Styrofoam caused it as a material for the substrates to grow houseplants (Khoshkhoe, 2004; Tzortzakis and Economakis, 2008).

Superabsorbent

Superabsorbent are hydrophilic polymer gels that consist of much smaller molecules that bind considerable number monomers (Zohoriyan-Mehr, 2006). Superabsorbents are not toxic and are degraded by microorganisms in the soil after 4 to 7 years, depending on the type of superabsorbent. The superabsorbents are odorless, color less, has an acidity (pH) neutral, non-pollutant in soil, surface water and groundwater and plant tissues (Parvanak and Chamheidar, 2014). Some properties of superabsorbent are shown in Table 5. Using of superabsorbents in greenery, flowers and houseplants, preparation and transplanting of seedlings, plantation and farm land is recommended by researchers and professionals in the world of agriculture (Peterson, 2002; Zohoriyan-Mehr, 2006; Allahyarei *et al.*, 2013; Parvanak and Chamheidar, 2014).

1) Efficient use of irrigation water (50% irrigation water saving)
2) Reduction the number of irrigation to 50%
3) Reductionthe cost of irrigation
4) Faster and better root growth and food storage
5) Prevention of rapid fertilizer leaching and pollution of groundwater

Table 5: Some physical and chemical characteristics of superabsorbent

Entry	Properties	Characterization of superabsorbent
1	Appearance	White polyhedral
2	Moisture content (%)	5-7
3	Odor and toxicity	none
4	Particle density (g cm^{-3})	1.4-1.5
5	The practical capacity of water absorption (g g^{-1})	300
6	Solubility in water	Insoluble
7	The pH of the aqueous solution	6-7
8	The mean particle size (µm)	50-350

Parvanak and Chamheidar (2014) investigated the effect of four Tarawat superabsorbent levels (zero (control), 0.15, 0.3 and 0.6% w/w) and four irrigation intervals (1,2,3, and 4 days) on the amount of available water and rooting of cuttings indices of *Berberis davidi*, *Nerium oleander*, *Rosa Sp*, *Juniperus exelsa and Pyracantha coccinea*. Results showed that application of 0.3% of the hydrogel can be used in rooting of cuttings of *Juniperus exelsa*, *Nerium oleander*and *Rosa Sp* and 15% in *Berberis davidi* and *Pyracantha coccinea* with 2 days irrigation intervals also produced cuttings with rooting convenient, saving 50 percent on limited water supplies for irrigation and other costs relative to expected daily irrigation (Figure 5).

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Figure 5: A) The impact of non-application and B) the use of Tarawat superabsorbent on the expansion and retention of moisture in the sandy beds of *Berberis davidi, Nerium oleander, Rosa Sp, Juniperus exelsa and Pyracantha coccinea* cutting

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