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EFFECT OF DIATOMITE ON GROWTH OF STRAWBERRY

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Abstract

Diatomite is a sedimentary rock primarily composed of the fossilized remains of unicellular fresh water plants known as Diatoms. However, its usage in horticulture is not common. It is mostly used as a filter material in industry. It is very finely porous, very low in density, and essentially chemically inert in most liquids and gases. These properties make diatomite an excellent growing media for horticultural applications. This study was carried out to characterize some physical and physico-chemical properties of diatomite and its potential use as a growing media for strawberry. For this aim two grades (2-4 mm (DE-I) and 4-8 mm (DE-II)) of diatomite and three amendment levels were used. Results obtained from this study have shown that diatomite is an effective amendment to improve water holding capacity of light textured soils. Among the substrates tested, the highest water retention capacity was obtained from 30% DE-I treatment.

Introduction

Among the cultural inputs involved in greenhouse crop production, perhaps the most important is the type of growing media used. Due to the shallow depth and limited volume of a container, growing media must provide the appropriate physical and chemical properties necessary for plant growth (Wilkerson, 2002). Since the growth medium relates to every cultural practice in the production stage, selection or formulation of medium is extremely important (Ingram *et al*., 2003).

Successful production of container-grown plants is dependent on the physical and chemical properties of the growing media selected. Therefore some critical physical and chemical properties need to be evaluated before making a media decision (Robbins & Evans, 2001; Riaz *et al*., 2008). Physical and chemical properties commonly measured for container media and media components include total pore space, water holding capacity, air space, bulk density, particle size distribution, pH, soluble salts, cation exchange capacity (CEC) and the carbon to nitrogen ratio (Ingram *et al*., 2003).

According to Csaba (1995) and Olympios (1999), substrates must have the following properties; inert, pH neutral, electrical conductivity (EC) within range of 0.5–3.0 dS m^{-1}, porous, low density, hydrophilic, free from grit, heavy metals and radioactive pollutants, applicable in natural form without need for processing, can be mined or produced by the industry, no decrease of physical properties during use, having a lifespan at least three years, easy to use, low cost, recyclable or destroyed without hazard, resistant to sterilized several times without structural quality change and pathogen free. These properties suggested us using diatomite as a growing media for horticultural applications.

Diatomite (Diatomaceous Earth or DE) is a sedimentary rock primarily composed of the fossilized remains of unicellular fresh water plants known as Diatoms. Diatomite is a chalk-like, soft, friable, earthy, very fine-grained, siliceous sedimentary rock, usually light in color. It is very finely porous, very low in density (floating on water at least until saturated), and essentially chemically inert in most liquids and gases (Anon., 2008).

Diatomite consists of approximately 90% Silicon dioxide, with the remainder of its being elemental minerals, which are essential for plant growth. All of these unique factors make diatomite an excellent horticultural grade medium for all growing applications.

The objective of this study was to characterize some physical and physico-chemical properties of diatomite and its potential use as a growing media for strawberry.

Materials and Methods

The experiment was laid out in a randomized design with two grades (2-4 mm (DE-I) and 4-8 mm (DE-II)) of diatomite and three amendment levels; 10% DE-I, 20% DE-I, 30% DE-I, 10% DE-II, 20% DE-II, 30% DE-II, and control (100% Soil), on a volume basis, with three replications.

The studies were done with an Ustorthents (Anon., 1992) sampled to a depth of 0-15 cm from agricultural fields in Erzurum province (39° 55′ N, 41° 61′ E) in Turkey. Soil was taken over an area of 10 ha using a grid sampling pattern. The soil was air-dried, well-mixed and crumbled to pass 8 mm (Fig. 1). For each treatment 2,250 g soil was transferred to polyethylene pots (15 cm diameter and 20 cm depth). Some physical and chemical properties of materials used in this study were given in Table 1.

Cull strawberry seedlings (stem diameter, <5 mm) belonging to the day-neutral cultivar of "fern" were planted. The experiment was carried out in a greenhouse with temperature control (18/24ºC, night/day). Irrigation was done with distilled water during the growing period (3 months), according to the water demand of plants. Stolons and flower clusters were removed throughout the growing season.

Moisture retention characteristics were determined in different tensions (pF 1, pF 2, pF 2.52, pF 3, and pF 4.18) using a membrane extractor (Soil Moisture, Santa Barbara, CA, USA) as described in Richards (1948, 1949). Pore size distribution was calculated from pF curve.

Analysis of variance was performed by SPSS Statistical Package (SPSS 13.0, SPSS Science, Chicago, IL) using GLM. Mean differences were considered significant if $p \leq 0.05$ (Duncan's Multiple Range Test).

Results and Discussion

Moisture retention characteristics of media's used in the experiment given in Table 2. Application of diatomite increased water holding capacity in all of the tensions tested. Among the diatomite substrates, the highest water retention capacity was obtained from 30% DE-I treatment. Although 30% of DE-I and DE-II is similar, DE-I is much more effective in water retention, which can be due to increase in surface area. The expandable structure of diatomite also increased water retention capacity. Higher water retention capacity at low tensions is important for optimal plant growth (Sahin *et al*., 1997). While diatomite application had no effect on wilting point (pF 4.18), it increased field capacity (pF 2.52) of soils significantly. Therefore, available water increased with diatomite application. This shows that diatomite can be used in light textured soils to improve water retention capacity.

Pore size of media is a critical physical property which affects water and nutrition absorption by root system (Caron & Nkongolo, 1999). The proper portion of macro pores to micro pores is necessary for drainage, water retention capacity and sufficient gas exchange (Abd El-Hady & El-Dardiry, 2006). Increasing diatomite in mixture increased meso, micro and ultra pores, which are important for plant water requirements (Fig. 2). However, it also increased macro pores which are desired for optimum plant growth and root distribution.

Table 1. Some physical and chemical properties of soil and diatomite.

Parameters	Soil	Diatomite (DE)
Clay (%)	14.44	-
Silt (%)	32.64	-
Sand (%)	52.92	-
Texture class	**Sandy loam (SL)**	**-**
Bulk density (g cm^{-3})	1.29	0.41 (2-4 mm) 0.41 (4-8 mm)
Particle density	2.59	2.21
Porosity (%)	50.19	81.45 (2-4 mm) 81.45 (4-8 mm)
pH*	7.96	8.55
Electrical conductivity* (dS m^{-1})	0.21	0.46
Cation exchange capacity (CEC) (me 100 gr^{-1})	32.52	22.21
Organic matter (%)	1.59	-
$CaCO_3$ (%)	0.80	1.20

* Determined in 1:2.5 (soil: water) extract

Table 2. Moisture retention characteristics of media's used in the experiment (P_v).

Treatments	pF 1	pF 2	pF 2.52	pF 3	pF 4.18	AW*
10 % DE-I	36.02ab	31.47	30.04ab	28.67abc	11.15	18.90abc
20 % DE-I	36.24ab	32.73	30.83a	29.55ab	10.69	20.14ab
30 % DE-I	37.00a	33.15	31.48a	30.33a	10.66	20,82a
10 % DE-II	33.88c	31.23	28.87b	27.69c	11.21	17,66cd
20 % DE-II	35.70b	32.37	29.03b	28.55bc	10.91	18,13bcd
30 % DE-II	36.95a	32.65	31.11a	29.71ab	10.82	20,30ab
Control	32.52d	27.74	26.57c	25.73d	10.64	15,93d
P	<0.05	ns	<0.05	<0.05	ns	<0.05

*Available water

Table 3. Effects of media on vegetative parameters of strawberry.

Treatments	Root number	Root lenght (cm)	Root weight (g)		Leaf area (cm^2)	Stem diameter (cm)
			Fresh	Dry		
10 % DE-I	30.00ab	22.95a	22.39	4.80	80.46ab	11.15
20 % DE-I	32.50ab	22.65a	19.44	3.92	68.90b	11.50
30 % DE-I	34.50a	24.30a	19.35	4.01	87.88a	11.65
10 % DE-II	18.50c	16.35c	17.79	2.94	72.19b	11.35
20 % DE-II	33.00ab	20.50ab	21.17	4.59	69.24b	11.30
30 % DE-II	31.00ab	22.35a	19.44	4.62	78.26ab	11.35
Control	28.50b	17.85bc	13.89	3.39	69.99b	11.00
P	<0.05	<0.05	ns	ns	<0.05	ns

Addition of diatomite to substrate increased development of cull strawberry seedlings (Table 3). Root number and length and leaf area increased significantly with diatomite addition. Primer root number is directly affected by soil moisture in the upper layer. Increase in primer root number and length can be due to increase in water holding capacity and pore size distribution of media. Leaf area is important for photosynthetic efficiency. It not only affects plant development but also yield capacity. Increase of leaf area is especially desired in plants with low canopy, such as fern cv. Diatomite application increased leaf area. The highest results were gained from 30% DE-I treatment.

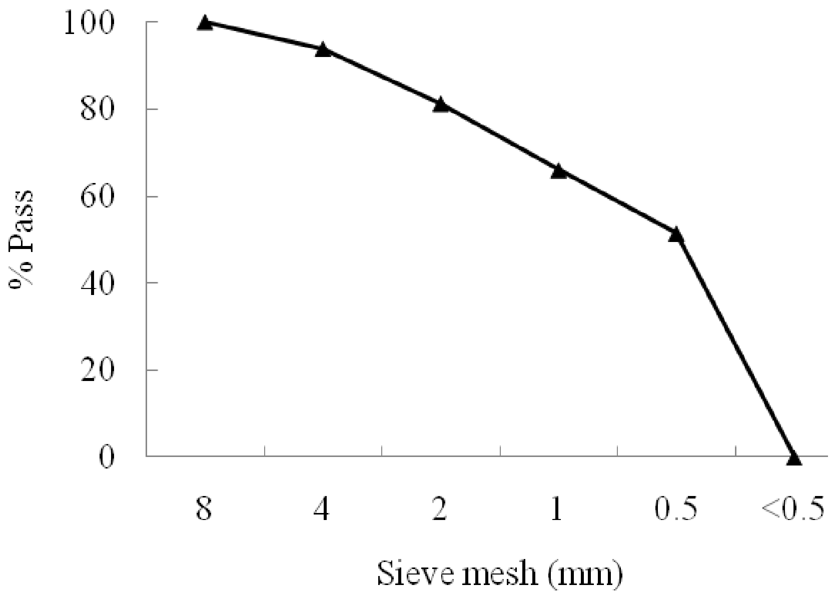

Fig. 1. Particle size distribution of soil.

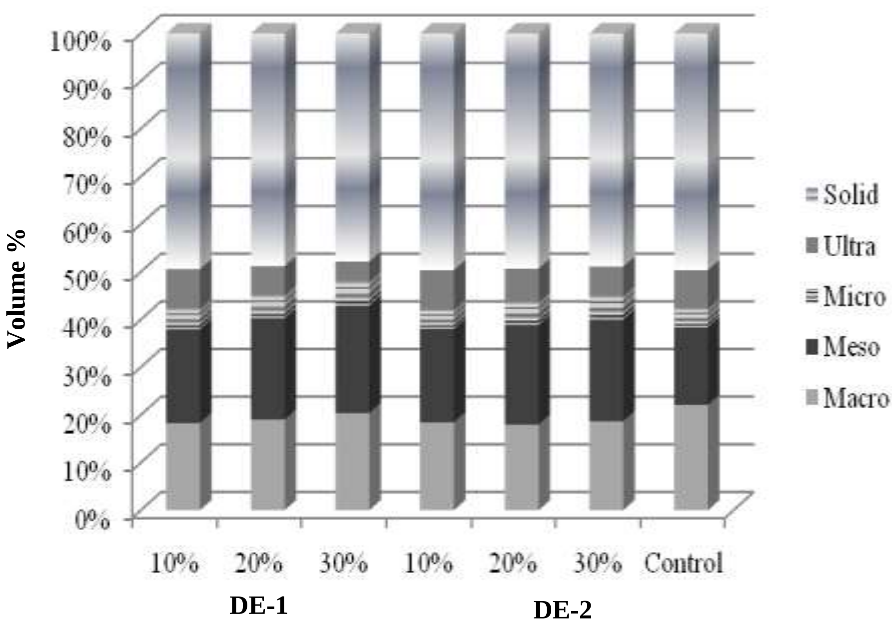

Fig. 2. Pore size distribution of media's used in the experiment.

Conclusion

Results obtained from this study have shown that diatomite is an effective amendment to improve water holding capacity of light textured soils. Among the substrates tested, the highest water retention capacity was obtained from 30% DE-I treatment. As DE-II application has also increased water retention capacity, it was not much more effective as DE-I due to surface area. Use of diatomite as substrate not only improved hydro-physical properties of soil but also vegetative parameters of strawberry. As a conclusion it can be said that, use of diatomite as a growing media not only improves water holding capacity but also minimize leaching.

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