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# EFFECT OF PUMICE AMENDMENT ON PHYSICAL SOIL PROPERTIES AND STRAWBERRY PLANT GROWTH

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## ABSTRACT

We report the results of a research carried out in Turkey in 2004 to determine the effectiveness of different levels of pumice amendments to soil using strawberry plants. Two grades (2-4 mm and 4-8 mm) of pumice were added to soil and three amendment levels (15%, 30% and 45% by volume) were applied. Finally 6 different growing media types were formulated. The amount of moisture retained at different tensions and distribution of pore size of these growing media were determined. Some plant properties such as the number of leaves, leaf area, fresh and dry root weight, most developed root length and increasing fresh weight of day-notr strawberry plants cv. Fern grown on these media were determined. The best plant growth was observed on media including 4-8 mm pumice grade and 45% pumice amendment ratio with soil.

**KEYWORDS: Pore size distribution; soil-pumice mixture media; strawberry plant growth; water retention**

## INTRODUCTION

The production of greenhouse crops involves a number of cultural inputs. Among these, perhaps the most important is the type of growing media used. Due to the relatively shallow depth and limited volume of a container, growing media must be amended to provide the appropriate physical and chemical properties necessary for plant growth [17].

The most important physical properties of a growing media for suitability are good aeration and drainage, and optimum water retention capacity [2]. To improve the physical properties of soils and promote plant growth, soil conditioners can be used [12]. Soil amends have been suggested for use in soils to alleviate soil compaction, increase available water and aeration. Soil compaction changes porosity by generally reducing total porosity and macropore space and increasing micropore space. The relative balance of air and water within a soil's pore space is critical to plant growth [1, 3]. Porosity can be functionally divided into three parts - total porosity, aeration porosity (macropores) and water holding porosity (micropores) [11]. The macropores (>100 μm diameter) supply drainage and aeration, the mesopores (100-30 μm diameter) supply water conductivity, and the micropores (30-3 μm diameter) supply water retention [7]. The water retained in ultramicropores (<3 μm diameter) is unavailable for plant use [6]. The porosity is generally determining the shape of the moisture characteristics curve (pF curve) which reflects pore size distribution [13, 14, 15, 16].

Pumice has been used to a large extent as a plant growing media and it lightens the soil, makes tillage easier, improves soil aeration and holds water. Pumice mixed with soil in specific amounts improves soil's air and water conductivity, and reduces negative effects of crusting, cracking, flooding, and shrink-swelling. It can also be used for a long periods because of its stable physical and chemical properties [8] and it can be provided easily since there are many pumice deposits distributed around the world [18]. Pumice used only after sieving has a high water retention capacity, and very low bulk density value compared to soil [16].

The growing healthy and the best quality seedlings is an important issue in strawberry production. This is possible if used suitable growing media [9]. The practice of adding amendments to growing media goes back years. The effectiveness of pumice amendments does not seem to have been studied before, particularly in strawberry plants.

The aim of the present investigation was to determine whether pumice amendments to soil could improve both soil properties and strawberry plant growth.

Materials and Methods

The day-notr strawberry cv. Fern cold-stored seedlings were planted directly in 3 liter plastic bags filled with mixture of soil (S) and pumice (P). The characteristics of pumice and soil used are given in Table 1. Two grades (2-4 mm and 4-8 mm) of pumice and three amendment levels (15%, 30% and 45% by volume) were applied. Finally 6 different growing media were formulated and 100% soil used as control. The distribution of particle size of control is given in Fig. 1. The treatments were as follow;

85% S + 15% P-1(I) S:Soil
70% S + 30% P-1(II) P:Pumice
55% S + 45% P-1(III) P-1: Pumice with 2-4 mm grade
85% S + 15% P-2(IV) P-2: Pumice with 4-8 mm grade
70% S + 30% P-2(V)
55% S + 45% P-2 (VI)
100% S (VII)

The amount of moisture the media retained in different tensions (pF 1, pF 2, pF 2.52, pF 3, and pF 4.18) was determined by a pressure membrane [10]. Porosity was estimated by calculation [4].

Plants were planted into plastic bags on 13 March 2004 and plastic bags were kept under greenhouse temperature regime of 25/20 °C day/night respectively. The daily nutrient solution prepared according to Day [5]. After 4.5 months growing period, each plant was uprooted and evaluated in terms of the numbers of leaves, leaf area, length of the most developed roots, fresh root weight, dry root weight and increasing fresh weight.

The experiment design was of a completely randomized design with three replicates including ten plants per replicate. Analysis of variance (ANOVA) for the data of pore size distribution, amounts of moisture retain in different tensions and plant growth, and Duncan's multiple range tests were used for important treatments.

## RESULTS AND DISCUSSION

The amounts of moisture retain in different tensions ($P_v$) and pore size distribution (%) of the 6 different media are given in Table 2.

The amount of moisture retained at < 0.98 kPa increased with increasing pumice amendments in both pumice grade statistically important level ($p<0.01$). 30% and more pumice amendment ratio increased water retention capacity as compared to control ($p<0.01$). 30% and 45% pumice amendments ratio were also increased the amount of macropores which supply both drainage and aeration when compared to control ($p<0.01$). However, micropores

Table 1. Some physical and chemical properties of soil and pumice used

| Properties | Soil | Pumice |
|---|---|---|
| Clay (%) | 18.9 | - |
| Silt (%) | 37.2 | - |
| Sand (%) | 43.9 | - |
| Bulk density (g $cm^{-3}$) | 1.12 | 0.38 (for 2-4 mm) |
| | | 0.44 (for 4-8 mm) |
| Particle density (g $cm^{-3}$) | 2.65 | 2.24 |
| pH | 8.21 | 8.40 |
| Electrical conductivity (dS $m^{-1}$) | 0.29 | 0.11 |
| Carbonates (%) | 0.86 | 0.80 |
| Organic matter (%) | 0.57 | - |

Table 2. The Amount of Moisture Retained in Different Tensions ($P_v$) and Pore Size Distribution (%) of media

| Media | Moisture Tension (kPa) | | | | Pore size (µm) | | | |
|---|---|---|---|---|---|---|---|---|
| | 0.0-0.98 | 0.98-9.81 | 9.81-32.36 | 32.36-1471.0 | >100 | 100-30 | 30-3 | <3 |
| I | 23.18c | 9.39 | 4.63 | 10.25a | 28.96c | 3.61 | 10.65a | 16.14 |
| II | 28.39b | 8.81 | 4.50 | 9.67ab | 33.99b | 3.21 | 9.88ab | 15.41 |
| III | 34.91a | 9.74 | 3.94 | 8.32c | 41.20a | 3.45 | 7.87ab | 15.21 |
| IV | 23.87c | 8.88 | 4.27 | 10.27a | 29.48c | 3.27 | 9.83ab | 16.77 |
| V | 27.97b | 10.03 | 3.26 | 8.91bc | 34.21b | 3.79 | 8.37ab | 15.74 |
| VI | 34.18a | 8.19 | 2.84 | 9.39abc | 39.95a | 2.92 | 7.19b | 15.69 |
| VII | 21.83c | 8.92 | 4.39 | 9.73ab | 27.11c | 3.64 | 10.41a | 16.45 |
| $LSD_{0.01}$ | 2.51 | NS* | NS | 1.10& | 2.27 | NS | 2.54 | NS |

*Non significant
&$P < 0.05$

Table 3. The effect of growing media on some plant properties of strawberry cv. Fern

| Media | Leaf number | Leaf area ($cm^2$) | Length of the most developed roots (cm) | Fresh root weight (g) | Dry root weight (g) | Increase of fresh weight (%) |
|---|---|---|---|---|---|---|
| I | 8.61abc | 90.05cd | 28.17c | 16.95cd | 3.10c | 85.48ab |
| II | 9.72abc | 100.22c | 32.28bc | 17.46bcd | 3.42bc | 95.88ab |
| III | 9.42abc | 138.50ab | 31.56bc | 23.26abc | 4.70abc | 112.08a |
| IV | 7.81bc | 90.35cd | 28.47c | 16.72cd | 3.30bc | 101.90a |
| V | 11.61ab | 106.29bc | 37.03ab | 24.12ab | 4.78ab | 108.18a |
| VI | 11.83a | 157.04a | 40.97a | 28.07a | 5.41a | 118.17a |
| VII | 6.44c | 60.78d | 28.61c | 15.99d | 3.20bc | 59.03b |
| $LSD_{0.01}$ | 3.57 | 35.73 | 7.76 | 6.58 | 1.48 | 38.15 |

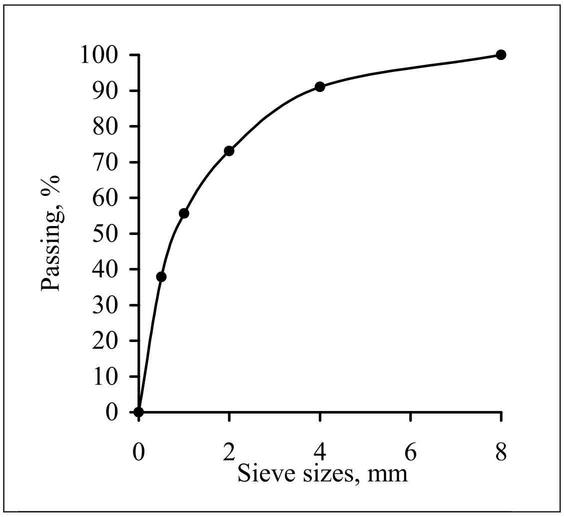


Figure 1. The aggregate distribution of soil

which are important for water retention only found less in number VI growing medium than control (Table 2).

The number of leaves, leaf area, most developed root length, fresh and dry root weight and increasing fresh weight of strawberry plants were increased at an important level ($p<0.01$) in 30% and 45 % pumice amendments in 4-8 mm grade compared to control. The highest number of leaves, leaf area, most developed root lengths, fresh and dry root weight and increasing fresh weight were also obtained from 45% pumice amendments in 4-8 mm grade (Table 3).

Field soils are generally unsatisfactory for the production of plants in containers. This is primarily because soils do not provide the aeration, drainage and moisture retain in low tensions required [2].

Parallel to increasing pumice amendments ratio, macropores and the amount of water retained at low tensions increased at an important level. This situation effected plant growth positively as well as (Table 2,3).

As a conclusion, pumice amendments to soil increased growth of strawberry plants. This is the reason of increasing level of macropores and optimum water retention capacity in pumice amended media [1, 2, 3].

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