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Suitability of Fine Perlite for Conditioning Some Physical Properties of Soils for Multiply Onion

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Abstract
The main objective of this research was aimed to study the some physical properties of soils and the quantity of macronutrient in multiply onion. The Randomized Complete Block Design were carried out in 4 treatments with 4 replications. Treatment 1 was the control made up only of the soil whereas in the treatments 2-4 perlite of 15, 22.5 and 30 kg were mixed with the soil of 150 kg each, respectively. The results showed that soil texture in all treatments become sandy clay loam with higher proportion of sand particles. The soil moisture parameters i.e. the highest field capacity and the highest available water capacity in Treatment 2 are 18.88 and 8.75 % by volume, respectively. The hydraulic conductivity in all treatments ranges within the moderate standard conductivity of 28.35-45.17 cm/hr. The value of 28.35 cm/hr in Treatment 2 showed the better storage condition of the plant nutrients. Considering both soil moisture and hydraulic conductivity, Treatment 2 could contain more micropores than the others; therefore it is the most effective condition for the multiply onion. The bulk density value of all treatments range between 1.42–1.49 g/cm^3, the particle density ranges from 2.50-2.59 g/cm^3 and the total porosity ranges from 40.20-44.00 % by volume. These indicate that the density and porosity of all treatments are suitable for plants in general.
Keywords : Perlite, Physical Properties, Macronutrient, Multiply Onion, Randomized Complete Block Design (RCB).

1. Introduction

Physical properties of Soil deals with the dynamics of physical soil components and their phases as solids, liquids and gases. In several cases to improved some physical properties of soil by ground mineral or material of rock has been indicated that the scientific experiments and analysis on the effect of using perlite in agriculture applications are very important [1,2]. There have been research results on distribution and use of perlite in agriculture. Both fine perlite and expanded perlite have been used in pot experiment and in growth block. Reports indicated that it can improve physical properties of soils as well as of agricultural products [2-4].

This research is an analysis on properties of fine perlite and its effect on soil and growth material particularly relating to the improvement on physical properties of soils and trend on supplying macronutrients for the multiply onion. The soil physical properties of growth material studied which included soil texture, soil moisture, hydraulic conductivity, density and porosity.

2. Experimental Section

1) Perlite and soils samples

Perlite used was from Srabote and Khokcharoen Districts in Lop-buri Province (Fig 1). The soil samples were from the site of the experiment. The soil samples were collected from surface down to 30 cm depth.

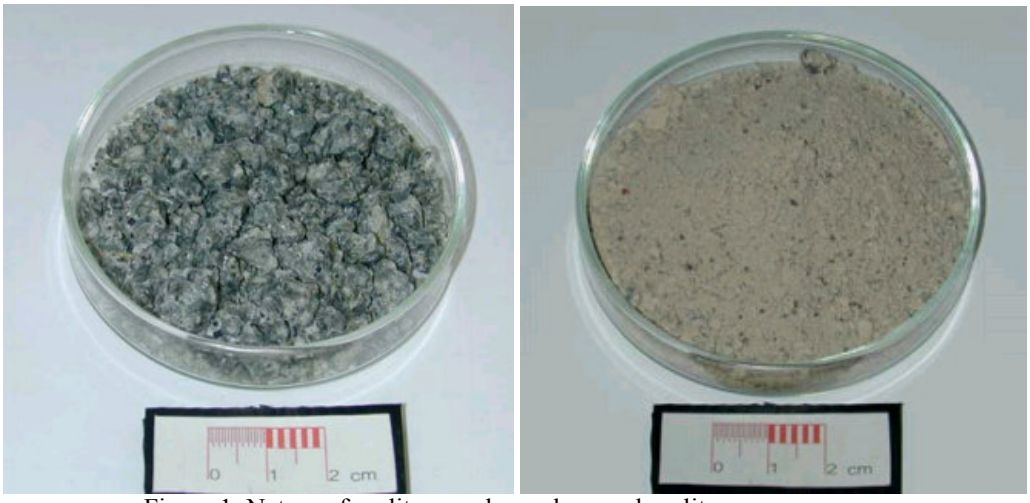

Figure 1. Nature of perlite samples and ground perlite.

2) Experimental design

The size of culture blocks for the multiply onion was 1.00 x 1.00 meter, and 15 centimeter deep. The Randomized Complete Block Design (RCB) was used in the experiments with 4 treatments and 4 replications. A total of 16 growth blocks were used.

3) Culture medium in the growth block

Each block was composed of perlite, soil and fertilizer to culture the multiply onion in each treatment. The spacing of the blocks is 15-20 centimeter apart, all in the rows.

Treatment 1 Soil without perlite and fertilizer
Treatment 2 Soil and Perlite, ratio of; 150 : 15 kg + fertilizer
Treatment 3 Soil and Perlite, ratio of; 150 : 22.5 kg + fertilizer
Treatment 4 Soil and Perlite, ratio of; 150 : 30 kg + fertilizer
*A chemical compound fertilizer, formula 15-15-15, 55 g was used in each treatment.

4) Analysis

Analyses were carried out on soil and multiply onion samples. Physical properties of soils included 6 parameters i.e. soil texture, soil moistures, field capacity, (FC); permanent wilting point, PWP; available water capacity, (AWCA), hydraulic conductivity (K_{sat}), density, total porosity (E) and micropores. The multiply onion samples were analysed for the macronutrients (N, P and K). The Duncan's New Multiple Range Test (DMRT) was used for statistical analyses.

3. Results and Discussion

1) Physical properties of perlite and soil samples.

The analysis results on physical properties of perlite and soils are shown in Table 1. The texture of perlite is sandy loam. The texture of soil is sandy clay loam. Soil moisture, in perlite and soil are different. The results also show % by volume of FC, PWP and AWCA of 13.52, 8.38 and 5.14 for perlite and 17.16, 10.20, 7.56. for soil samples, respectively. The mixtures of the soil and perlite used as growth material for multiply onion in Treatments 2, 3 and 4 show an effective trend on their physical properties affecting the growth of the multiply onion. The Treatments 1-4 were then the efficient evaluation of physical properties profitable to the multiply onion.

Table 1. Some physical properties of perlite and soil samples used.

physical properties	Perlite	soils
1. Texture	sandy loam	sandy clay loam
sand (%)	72	55.2
silt (%)	18	20.7
clay (%)	10	24.1
2. Moisture		
Field Capacity (FC) (% by volume)	13.52	17.76
Permanent Wilting Point (PWP) (% by volume)	8.38	10.20
Available Water Capacity (AWCA) (% by volume)	5.14	7.56
3. Hydraulic Conductivity (cm/hr)	-	35.22
4. Density		
Bulk Density (g/cm^3)	-	1.53
Particle Density (g/cm^3)	-	2.53
5. Total Porosity (%)	-	39.5
6. Micropores	-	-

- = not analysed

2) Physical properties of growth materials (Treatment 1- Treatment 4.)

2.1) Soil textures

The analysis showed an increasing trend of sand particle with the amount of perlite of 55.2, 56.5 57.2 and 57.8 % by weight in the Treatments 1, 2, 3 and 4, respectively i.e. and with a decreasing trend of clays. The Treatment 4 had the lowest clay content (21.9%) and the texture became sandy clay loam.

2.2) Moisture

The Treatment 2 shows the highest FC and AWCA 18.88 and 8.75 % by volume (Figure 2). The Treatment 3 also showed high FC and AWCA 17.86 and 8.26 % by volume. These confirm that water available for plant is contained in pores with diameters of 0.2-50 μm [5-8].

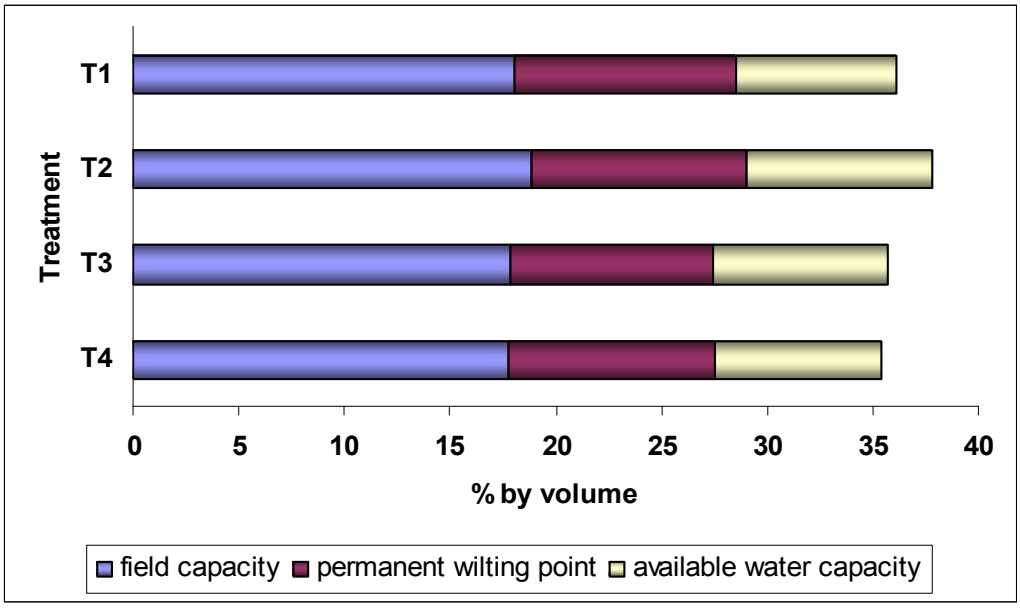

Figure 2. Field capacity, permanent wilting point and available water capacity of growth materials.

2.3) Hydraulic Conductivity

The analysis showed that K_{sat} (Fig.3) in the Treatment 3 is the highest at 45.17 cm/hr and the Treatment 2 has the lowest K_{sat} at 28.35 cm/hr. Based on standard value scale, all treatments had the moderate K_{sat} in a range of 20-60 cm/hr [9]. Therefore the growth materials of all treatments showed a good range of K_{sat} and sufficient water will be available for the rate of plant growth in the experiment.

The growth material in Treatment 2 had a lower K_{sat} than that in the other treatments. Therefore it is good for holding and supplying water and nutrients to plant. The higher K_{sat} value indicated the higher rate of leaching and nutrient loss in the Treatments 3 and 4 as compared to that of the Treatment 2.

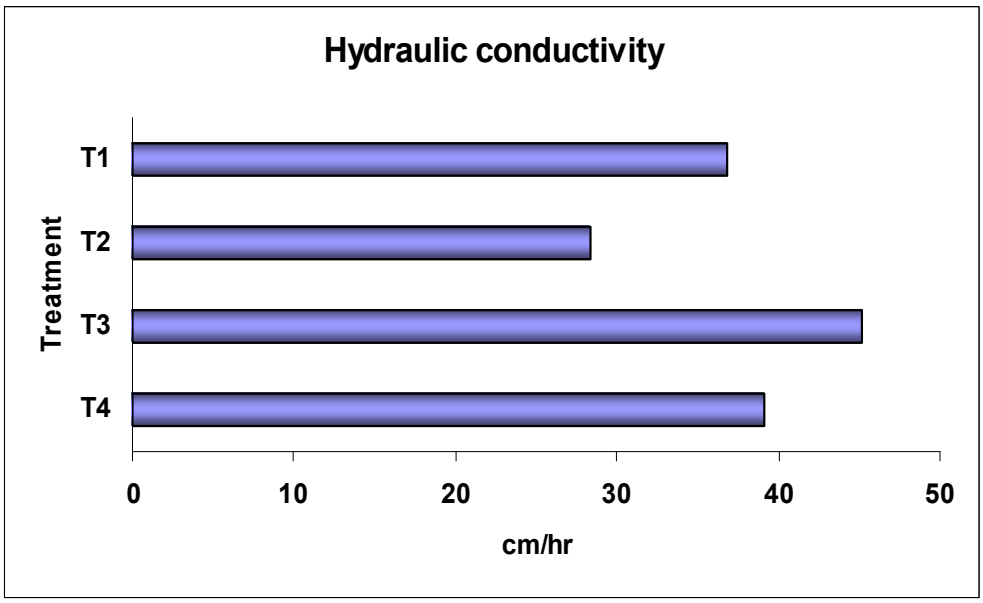

Figure 3. Hydraulic conductivity values of growth materials.

2.4) Density, Porosity and Micropores

For the density analysis, a range of the bulk density of all treatments between 1.42-1.49 g/cm^3 was obtained (Fig. 4). It is within the standard range of bulk density (1.2-1.6 g/cm^3)for plant growth [10-14]. Therefore, all treatments have a suitable range of bulk density and adding perlite could reflect trend on improving the bulk density of the culture media in all treatments. The particle density values of growth materials range from 2.5-2.6 g/cm^3.

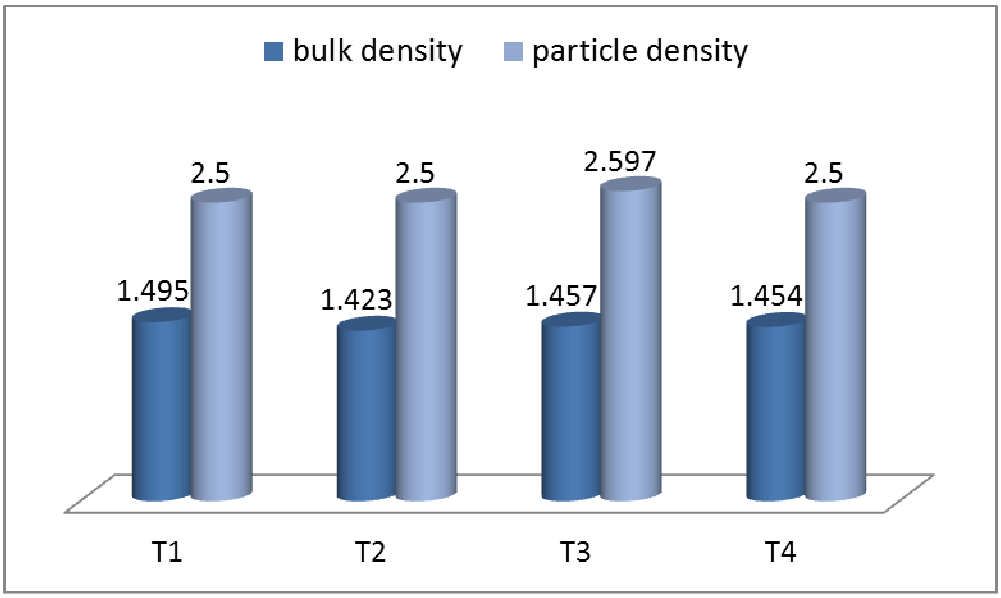

Figure 4. The bulk density and particle density of growth materials.

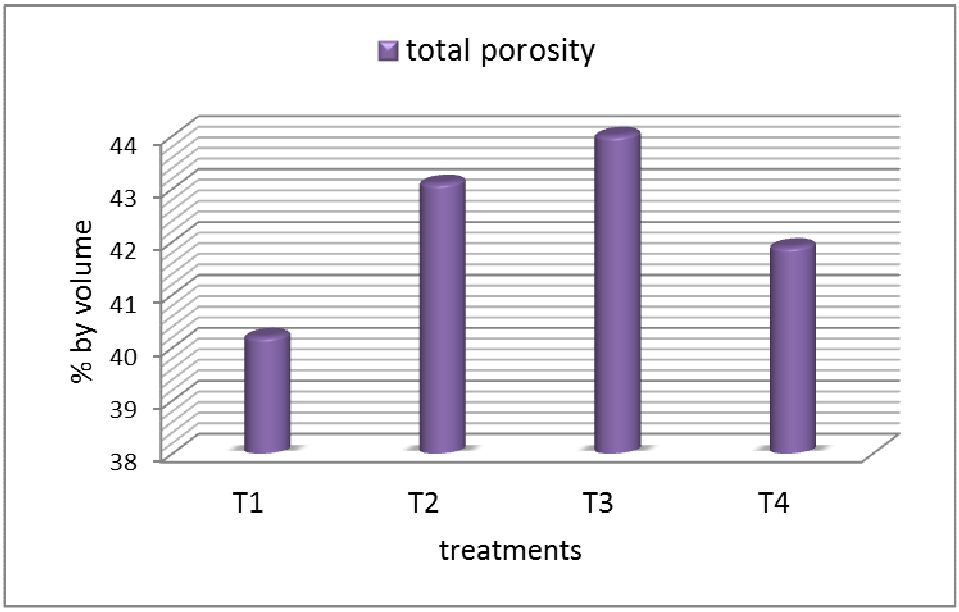

Figure 5. The total porosity of growth materials.

As shown in Figures 4 and 5, perlite decreases the bulk density of soils and increases the porosity in the Treatments 2 and 3, but not in a progressive trend since the total porosity of the Treatment 4 is lower than that of the Treatments 2 and 3. Therefore, the mixtures of soil and perlite is in an optimum limit to make growth materials high in total porosity. The porosity values are similar on the range of 40.2-44.0 % by volume.

In addition, the micropores (Fig. 5) of growth material mixtures in the Treatments 1-4 were 18.0, 18.9, 17.9 and 17.7 % by volume., respectively. The Treatment 2 had high volume of micropores which is good for water retention and the capacity to store and release plant nutrients. There is also a good a relationship between micropores and available water capacity.

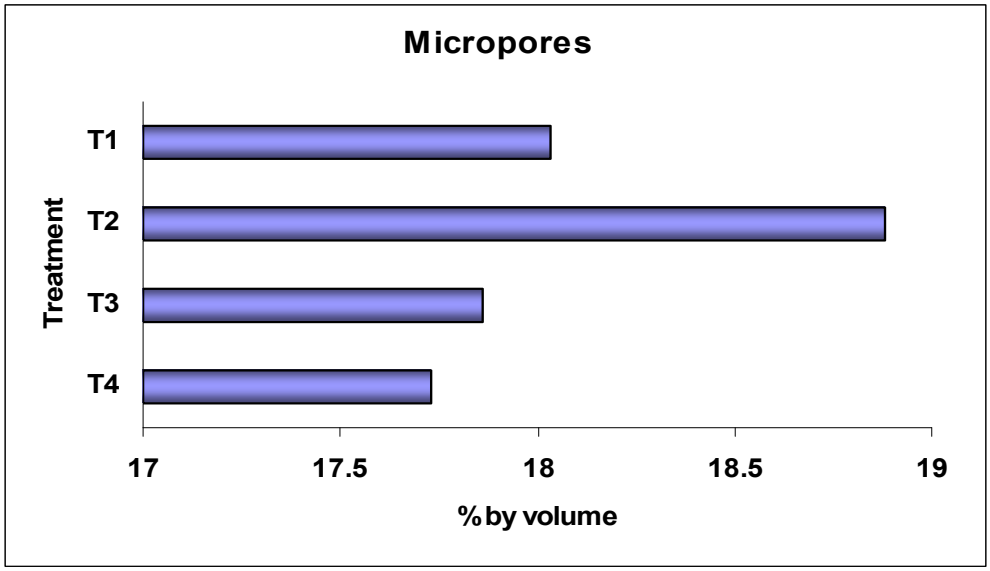

Figure 5. Micropores of growth materials.

4. Conclusions

The results of the analysis on some physical properties of soil and on macro nutrients of multiply onion response reveal two relevant important conclusions:.

Firstly, the physical properties of soil such as the soil moisture and hydraulic conductivity can be improved by using perlite as indicated by the good response in the Treatment 2 whereas there is the good available water and nutrient storage for plant, which shows the slow leaching.

Secondly, the response of multiply onion by adding perlite shows a significant effect on total phosphorus and total potassium in the Treatment 2 and Treatment 4.

Based on those two conclusions, the Treatment 2 shows a better result on the effect of microporesin the growth material promoting the suitable moisture condition and retarding the loss of nutrients from leaching.

The use of perlite can be effective on clayey soils since perlite can improve their physical properties. In an intensive agriculture applications the use of perlite can be considered for a more efficient practice. However, more experiments are advised to increase the confidence on its use.

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