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## Improving physical properties of plant growing media using perlite

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### Abstract

The most widely used growing media in the production of potted ornamental plants is peat. However, the studies for alternative solutions are being conducted due to the reasons such as restricted peat sources, high cost, destruction of natural environment due to peat production and variability in the quality of produced peat. In the relevant literature, there are two basic ideas on which the studies have focused on. The first one is the development of new growing media using organic-origin wastes, the second one is the preparation of the mixtures in which organic and inorganic materials are used as a component of growing media. In this study which was prepared in parallel with the relevant main ideas in the literature, the effects of perlite utilization on the physical properties of indigenous peat, and on those of the growing media obtained from hazelnut cinder, which is among agricultural organic materials in our country and has considerable potential to be the most important alternative of peat, were investigated. For this purpose, the physical properties of the growing medium, prepared by mixing perlite with raw peat and hazelnut husk, at various ratios (10,15,20,25%), were investigated, and the results obtained were compared with sphagnum peat, and with desired properties for ideal growing medium, in the literature. When the results obtained from the study were examined, it was seen that as well as the highest values were observed in the mixtures using 25% perlite, The perlite addition increased the porosity of raw peat by 68.25% and air capacity by 30.03%, and that the hazelnut husk decreased air capacity, higher than the ideal values, by 47.19%, thus approximating it its ideal value range. With increasing perlite ratio in the mixtures, the organic substance contents and water holding capacities of the growing medium decreased as their pH values increased. However, in applications using 25% Perlite, the shrinkage rates of raw peat and hazelnut husk were found as 17.05% and 6.41% respectively, and the water resuction times of those were found as 1.52 and 1.21 minutes, respectively. Based on these results, it can be said that the most important contribution of perlite utilization for raw peat and hazelnut husk is to decrease shrinkage rates and water resuction times, and that this improvement will avail in preventing the damages that occur in plant roots due to drying and shrinking of the growing media, and in decreasing the irrigation frequency.

**Keywords:** perlite, peat, hazelnut husk, growing media, ornamental plant

### 1. INTRODUCTION

The required properties for a growing media are listed as high stability for roots to be able to fasten onto soil, and support the plant, good hydraulic

properties to be able to provide water to the plant, allow the necessary air for the roots to be provided, and contain various plant nutrients [1]. Considering that the content of plant nutrient can be improved by simple applications such as natural or synthetic manure use, it can be said that the suitability of the physical and hydraulic properties of organic

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materials are determinative in their utilization as a growing media [2,3]. As an ever-increasing practice throughout the world, organic wastes, composted or fractured by suitable methods, are used as growing media components, in line of the purpose, sometimes in pure state, sometimes in mixtures with different proportions in order to provide the desired properties in the plant growing media.

However, the mixture of natural soil, native rawpeat and animal manures are often used as plant growing media, in potted ornamental plant production in our country. Natural soil and indigenous peat are not sufficient as a growing media, and the plants cultivated in these mediums can not satisfy the criteria demanded by the industry [4,5,6]. The lowness in the quality of indigenous peat resources direct consumers to import peat (sphagnum peat) [7]. On the other hand the fact that although import peat has good properties, its price is too high, which limits its utilization because of that it significantly increases production costs.

On the other hand, there are plenty of agricultural, domestic and industrial organic wastes and natural resources such as perlite and pumice in our country, which can be used as growing media component. Since they are in sight due to their formation locations, domestic and industrial ones of these wastes are collected, stored, and even if it is very limited in our country, composted and used in plant production. But, especially agricultural organic wastes do not attract attention because they come into being in rural areas. Hazelnut husk occurring as a result of hazelnut cultivation, one of the leading agricultural products of our country, is the main of these wastes occurring abundantly. Currently, since any usefull purpose for the utilization of hazelnut husk hasn't been identified so far, they are attempted to be removed sometimes by being burned near fields or gardens, and sometimes by being poured to the sides of roads, into forests and stream beds. This leads to many problems such as air pollution, contamination of water resources, odour, reproduction of pathogenic microorganisms and vector attractiveness.

In this study, the usability of perlite in the improvement of the physical properties of indigenous peat and hazelnut husk, not having desired properties as plant growing media, was investigated.

## 2. MATERIAL AND METHOD

The indigenous peat used in the study was supplied from the peat extraction area located within the borders of Sakarya Province, and subjected to drying and disintegration operations at laboratory conditions before being used in the mixtures. The hazelnut husk was taken off during the blending process, and put through the disintegrator, without applying any composting process. The Perlite, which is used in the study by being mixed with native raw peat and hazelnut husk at different ratios, is commercial perlite produced for agricultural applications. The mixtures of the growing medium to be prepared, and the ratios used in the mixtures are given in Table 1. Besides, the usability of the examined samples as a growing media was intended to be identified by comparing their properties with Sphagnum peat, and with features on demand for an ideal growing media, specified in the literature.

Table 1. The prepared growing medium and ratios used in the mixtures

Growing Media	Application of growing media (%V/V)
CONTROL	Commercial Peat
RP	%100 Raw Peat
HZ	%100 Hazelnut Husk
RP+P1	%90 Raw Peat + %10 Perlite
RP+P2	%85 Raw Peat + %15 Perlite
RP+P3	%80 Raw Peat + %20 Perlite
RP+P4	%75 Raw Peat + %25 Perlite
HZ+P1	%90 Hazelnut Husk + %10 Perlite
HZ+P2	%85 Hazelnut Husk + %15 Perlite
HZ+P3	%80 Hazelnut Husk + %20 Perlite
HZ+P4	%75 Hazelnut Husk + %25 Perlite

In order to reveal the characterisation of the growing medium, their physical and physico-chemical properties were determined using the European Union Standards and standardized methods in the literature. The weights of the samples, as specified in EU standards, were found by measuring the dry weights of the samples, in known volumes, after being subjected to 10 cm suction pressure in a water column [8,9]. The total porosity was calculated by the ratio (in percentages) of the mass of the samples with a certain weight (volume-weight) to the pore volume in that mass. The air capacity was found through the loss occurred due to the draining of the samples at 10 cm pressure after being saturated with water [8,9,10]. The volumetric shrinkage of the samples were determined as the expression of the volumetric loss of the samples in percentages occurred as a result of being dried of the samples at

105 ° C [8,9,10]. The water holding capacity of the samples was measured by determining the amount of water left in the samples after they have been subjected to 10 cm pressure subsequent to being made saturated to water [8,9,10]. The water resuction properties of the samples were determined as the time elapsed for the dried samples to absorb 10 mm distilled water, as specified in Australian Standard [11]. The aqueous suspension method was used to determine the pH value of the samples. The pH was measured with a pH meter with a glass electrode in a material-distilled water suspension prepared in the ratio of 1:5 [8,9,10]. The total organic substance content of the samples was calculated in percentages, according to the principle of being burned of the samples for four hours dried in a furnace at 105 ° C, at 550 ° C for 4 hours [10].

### 3. EXPERIMENTAL FINDINGS

The weight, porosity, air capacity and shrinkage ratios of the growing medium, prepared mixing raw peat and hazelnut husk with perlite at varying rates, in the scope of the study, and the desired values in the growing medium are given in Table 2. The weight (0,132 g/cm<sup>3</sup>) of the perlite used in the mixtures was smaller than the volume of raw peat and hazelnut husk.

Table 2. Some physical properties of the growing medium

Growing Media	Bulk Density (g/cm <sup>3</sup> )	Porosity (% V/V)	Air Capacity (% V/V)	Shrinkage (% V/V)
RP	0,358	62,95	21,46	28,88
HZ	0,169	88,91	55,12	16,12
P	0,132	71,16	43,82	3,64
RP+P1	0,356	63,18	23,15	26,60
RP+P2	0,352	64,97	25,83	23,46
RP+P3	0,349	66,39	28,76	20,93
RP+P4	0,347	68,25	30,03	17,05
HZ+P1	0,165	87,12	54,35	14,98
HZ+P2	0,162	86,55	52,67	12,19
HZ+P3	0,158	83,08	49,93	10,82
HZ+P4	0,153	80,62	47,19	6,41
Kontrol	0,458	73,28	27,72	31,99
Ideal Values*	<0.40	>80	20-30	<30

\*Ideal Values : [8,9,10,11,12,13,14]

That's why the increase in the perlite ratio in the mixtures caused a decrease in the weight of the growing medium. Among the applications using raw peat, the lowest weight was determined in the application of RP + P4 with 0,347 g / cm<sup>3</sup>, and in the application of HZ+P4 with 0,153 g / cm<sup>3</sup> among those using hazelnut husk. The weights obtained from all applications were found lower than the control application (0,458 g/cm<sup>3</sup>), and in the range of weight desired for ideal growing medium.

Besides, perlite addition to the growing medium caused an increased in the total porosity value of the applications in which raw peat was used, whereas, it decreased the porosity value of the applications in which hazelnut husk was used. While the porosity value in the mixtures containing raw peat which was initially 62.95%, increased up to 68.25%; that in the mixtures containing hazelnut husk, which was initially 88.91%, decreased down to 80.62%. Since the porosity value of ideal growing medium was desired to be greater than 80%, said it is concluded that Perlite addition is useful in approximating the porosity value of growing medium to the ideal value range. Likewise porosity, the air capacity of the growing media samples containing raw peat increased with the addition of perlite, and rose up to 30%, the upper limit of ideal growing medium. As the perlite ratio of the mixtures in the growing medium in which hazelnut husk was used increased, their air capacity decreased, and approximated to ideal values.

Table 3. Hydraulic properties of growing medium

Growing Medium	Water Holding Capacity (ml/l)	Wettability (min.)
RP	372	3,58
HZ	335	2,32
P	53	<1
RP+P1	368	3,21
RP+P2	361	2,53
RP+P3	353	2,08
RP+P4	338	1,52
HZ+P1	332	2,25
HZ+P2	324	2,13
HZ+P3	311	1,56
HZ+P4	302	1,21
Kontrol	458	3,28
Ideal Values *	600-1000	<5

\* Ideal Values: [8,9,10,11,12,13,14]

When the values of the shrinkage ratio, which is a sign of the volumetric compression occurred when the growing medium dried, was examined, it was found that the pure shrinkage value of raw peat and

hazelnut husk was very high, and determined as 28.88% and 16.12% respectively, and that these values decreased with perlite addition at increasing rates, and found 17.05% and 6.41%, respectively in the RP + P4 and HZ + P4 applications where the highest Perlite mixing ratio was used. However, the shrinkage rates of all applications were found lower than the control application, and within the ideal range for growing medium.

Table 4. Some physico-chemical properties of growing medium

Growing Media	pH	Organic Matter (%)
RP	5,57	43,69
HZ	4,82	94,22
P	7,2	-
RP+P1	5,59	39,92
RP+P2	5,64	37,71
RP+P3	5,82	36,03
RP+P4	5,91	34,82
HZ+P1	4,85	92,96
HZ+P2	4,98	90,47
HZ+P3	5,09	88,14
HZ+P4	5,23	85,06
Kontrol	6,92	51,7
İdeal Values *	5,2-6,3	>85

\* İdeal Values: [8,9,10,11,12,13,14]

The pH and organic substance values of Perlite addition, raw peat and hazelnut husk were also investigated, and the results are given in Table 4. The pH values of the pure states of raw peat, hazelnut husk and perlite used in the mixtures were found as 5,57, 4,82 and 7,2, respectively. As the perlite ratio in the mixtures rose up, pH value in the growing medium increased, since the PH value of perlite was higher than the other components'. Besides, the pH value of ideal growing medium is desired to be between 5,2-6,3. While the PH value of pure state of hazelnut husk and that of its applications mixed with perlite in the ratio of 5%,10% and 15% were found lower than ideal values, its PH value entered the ideal range, with the addition of 25% perlite. However, when organic substance values were examined, it was found that the use of perlite reduced the value of organic substance in all applications, and that the organic substance values of all applications other than the applications using hazelnut husk were under the values desired in growing medium.

## CONCLUSIONS

The cultivation of potted ornamental plants is a rapidly developing agricultural application in recent years, and the most important need to increase the potential of the industry is to develop growing medium that will provide ideal plant growth. In addition to this, the best current growing media alternatives are the growing medium obtained from peat and some organic wastes. But, the supply of peat and organic waste that will have the characteristics of an ideal growing media is extremely difficult and costly. Therefore, it is very important to improve the properties of available resources. One of the most important sources for this purpose is perlite. In this study conducted to ensure for this resource to be effectively assessed, when all the data obtained are evaluated together, it was concluded that Perlite addition improved the important physical and physico-chemical properties of peat and hazelnut husk, such as porosity, air capacity, shrinkage ratio, water resuction and pH. On the other hand, in the study, the best results were obtained in the applications using 25% perlite, which suggests that perlite utilization has the potential of supplying 25% of the total needed growing medium, as well as improving the properties of a growing media.

## REFERENCES

- [1]. Nelson PV., 1991. Greenhouse Operation and Management. 4th ed. Reston, VA: Reston Publishing Company.
- [2]. Abad, M., Noguera, P., Puchades, R., Maquieira, A., Noguera, V. 2003, "Physico-Chemical and Chemical Properties of Some Coconut Coir Dusts for Use as a Peat Substitute for Containerised Ornamental Plants" *Bioresource Technology* 82, 241-245.
- [3]. Yahya, A., Sye, C. P., Ishola, T. A., Suryanto, h., 2010 "Effect of adding palm oil mill decanter cake slurry with regular turning operation on the composting process and quality of compost from oil palm empty fruit bunches" *Bioresource Technology* 101, pp 8736-8741
- [4]. Marfa O, Lemarie F, Caceres R, Giuffrida F & Guerin V (2002). "Relationships between growing media fertility percolate

- composition and fertigation strategy in peat-substitute" *Scientia Horticulturae* 94,309-321.
- [5]. Ribeiro HM, Romero AM, Pereira H, Borges P, Cabral F & Vaconcelos E (2007). "Evaluation of a compost obtained from forestry wastes and solid phase of pig slurry as a substrate for seedlings production" *Bioresource Technology* 98,3294-3297.
- [6]. Tariq, U., Rehman, S., Khan, M. A., Younis, A., Yaseen, M., Ahsan, M., (2012) "Agricultural and municipal waste as potting media components for the growing and flowering of *Dahlia hortensis* 'Figaro'" *Turk J Bot* 36 378-385 © TÜBİTAK doi:10.3906/bot-1109-16
- [7]. Caycı, G., Unver, I., Ataman, Y., Munsuz, N. 1989 "Distribution and horticultural values of the peats in Anatolia". Symposium on substrates in horticulture other than soil in situ, Dublin, Ireland, 12–16 September 1988. *Acta Horticulturae*, 238, pp. 189–196
- [8]. Abad, M, Noguera, P, Bures, S. 2001, "National inventory of organic wastes for use as growing media for ornamental potted plant production: case study in Spain" *Bioresource Technology* 77, 197-200.
- [9]. Standard Of European, Potting Mixes, UNE-EN 13650
- [10]. Martinez, F.X., 1992. "Proposal of methodology for the determination of the physical properties of the substrata" *Minutes of Gardening*, 11, pp. 55-66
- [11]. Australian Standard, Potting Mixes, AS 3743-1993
- [12]. Ozdemir, S., Dede, O. H., Koseoglu, G., "Recycling of MSW Compost and Sewage Sludge as Growing Substrate for Ornamental Potted Plants" *Fresenius Environmental Bulletin*, 13 – No 1, pp. 30-33, 2004
- [13]. Dede, O. H., Koseoglu, G., Ozdemir, S., Celebi, A. 2006. "Effects of Organic Wastes Substrates on the Growing of Impatiens", *Turkish Journal of Agriculture and Forestry*, 30, pp. 375-381
- [14]. Benito, M., Masaguer, A., Moliner, A., De Antonio, R. 2006, "Chemical and Physical Properties of Prunig Waste Compost and Their Seasonal Variability" *Bioresource Technology* 97, 2071-2076