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# Effects of expanded clay (Leca) and Styrofoam as inorganic growing media substances on growth and development of *Spathiphyllum wallisii*

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## ABSTRACT

The present study was conducted to evaluate the effect of expanded clay (Leca) and Styrofoam on the physical characteristics of growing media and their relationship with the growth of *Spathiphyllum wallisii*. The experiment was laid out in a complete randomized design (CRD) with 9 treatments and 3 replications. Cocopeat and peat moss combined with different proportions of inorganic materials Leca and Styrofoam were used as conventional media for the growth control. Growing indices of plants consisting of the number of leaves, shoot length, the fresh and dry weight of shoot and fresh and dry weight of roots, and physical characteristics of the media including bulk density, particle density, total porosity, water retention and air space were determined in this work. Chemical characteristics of the media including total nitrogen, absorbed phosphorous, and absorbed potassium, organic carbon, pH, and EC were also evaluated. Our results show that growth of the plant is much better in control media containing 40% cocopeat and 60% peat moss. Moreover, Leca and Styrofoam can be used as additives in the media, but the suitable proportion Leca and Styrofoam in the growing media was 25% because an excessive amount of these substances led to a change in the physical characteristic of the media and a drop in the growth rate of *Spathiphyllum wallisii*. Moreover, using more than 25% of these substances made a change in the volume of pots, leading to their reduced stability and some difficulties during their irrigation and shipment to the greenhouse.

**Keywords:** Expanded clay (Leca), spathiphyllum wallisii, styrofoam.

# اثر رس منبسط شده (لیکا) و استایروفوم به عنوان مواد غیر آلی در بسترهای کشت بر رشد گیاه اسپاتی فیلوم

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## چکیده

تحقیق ذیل به منظور بررسی اثررس منبسط شده (لیکا) و استایروفوم بر خصوصیات فیزیکی بسترهای رشد گیاه اسپاتی فیلوم و ارتباط آنها با رشد گیاه در قالب طرح کاملاً تصادفی با نه تیمار و سه تکرار انجام شد. کوکوپیت و پیت ماس به ترتیب با نسبت‌های ٤٠ و ٦٠ درصد به عنوان بستر شاهد متداول با مقادیر مختلف مواد غیر آلی، لیکا و استایروفوم ترکیب شدند. شاخص های رشد گیاه شامل: تعداد برگ‌ها، وزن تر و خشک برگ‌ها و ریشه‌ها و ارتفاع گیاه و خصوصیات فیزیکی بسترها شامل: وزن مخصوص ظاهری و حقیقی، ظرفیت نگهداری آب و هوا و خلل و فرج مورد اندازه‌گیری قرار گرفت. همچنین خصوصیات شیمیای بسترها مانند نیتروژن، پتاسیم و فسفر و هدایت الکتریکی و pH مورد اندازه گیری قرار گرفتند. نتیجه آزمایش نشان داد که رشد گیاه اسپاتی فیلوم در بستر حاوی٦٠ ٪ پیت ماس و ٤٠٪ کوکوپیت نسبت به سایربسترها بسیار بهتر بوده است. همچنین نسبت مناسب لیکا واستایروفوم مورد استفاده در بسترها ٢٥٪ بوده و مقدار بیشتر از آن منجر به تغییرات خصوصیات فیزیکی بستر و کاهش رشد گیاه می‌شود. به علاوه مصرف نسبت‌های زیاد این مواد منجر به تغییر حجم گلدان‌ها و در نتیجه کاهش استقرار گلدان‌ها در حین آبیاری و نقل و انتقال شان در گلخانه می‌شود.

**واژه‌های کلیدی:** استایروفوم، رس منبسط شده، اسپاتی فیلوم.

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## Introduction

Peace lily (*Spathiphyllum wallisii*) is a member of the family of Araceae and one of the most popular indoor houseplants (Sardoei, 2014). Interests in peace lily are steadily increasing, as it is a shade tolerant and easy-care indoor plant with dark green foliage and white spathes. The showy white spathes *Spathiphyllum* is gaining popularity and market niche as a “flowering” foliage plant. Soilless media has become very popular among plant growers because of their consistency, excellent aeration, reproducibility, and low bulk density, which reduce shipping and handling costs of the medium itself and the produced plants (Mamba & Wahome, 2010). Due to the relatively shallow depth and the limited volume of a container, growing media must be amended to provide the appropriate physical and chemical properties necessary for plant growth. Field soils are generally unsatisfactory for the production of plants in containers primarily because soils do not provide the aeration, drainage, and the required water-holding capacity. To improve this situation several “soilless” growing media have been developed. Garcia (1999) carried out a research to investigate suitable growing media for *Spathiphyllum wallisii*, and then prepared the growing media with a 70% (v/v) organic fraction consisting of pine bark, composted rice hulls, coconut coir dust or green-waste compost. The inorganic fraction accounted for 30% (v/v) of the media was either pumice or lava. Overall, it was observed that the best plant productivity and quality were present in those substrates based on either coconut coir dust or peat. These materials along with perlite have been proved to be far superior to the standard forest topsoil-based medium used in Mexico. The plant-growing medium must be porous for root aeration and drainage and also capable of water and nutrient retention. Commercial mixtures are often used because they are sterilized and ready to use, and may even contain some fertilizer (Hochmuth et al., 1996). Different growing media can be used to grow *Spathiphyllum wallisii* while the physical and chemical properties of media, like structure, texture, pH as well as nitrogen, phosphorus, and potassium are the dominant factors for the growth and development of the plant. Composition and nutritional status of the medium are considered to be helpful for the production of good quality flowering plants with more number and greater size of flowers and leaves. Meiken (1997) used expanded clay (Leca) in three horizontal layers from containers with indoor plantings grown under different fertilization regimes for 21 months. This study showed that the accumulation of nitrogen, phosphorus, and potassium in Leca rises considerably with an increase in fertilization levels, the nutrients can diffuse into the clay granules and released again, nitrogen and potassium remain water-soluble, and, consequently, both nutrients move to a greater extent up to the top layer by capillary action. From these results, it can be concluded that Leci is able to produce a quite considerable buffer effect. For this reason, the usual amount of water-soluble fertilizers applied to indoor plantings can be raised. Thus, it is inferred that water-soluble fertilizers are also applicable in the case of longer fertilization intervals instead of slow release fertilizers on an ion exchange basis. Ground polystyrene has been proposed as an amendment to soil or compost since it can potentially serve as a substitute for perlite, a common additive to potting mixes (Matkin, 1999). Using Perlite and Styrofoam as the growing media for Lolium revealed that perlite is better than Styrofoam in water retention. The plant growth was also better in perlite compared to plants growing in Styrofoam. However, some studies compared polystyrene to perlite with some degree of success. Substituting polystyrene with perlite has been also proved advantageous when used on a golf course. By increasing the drainage, grasses dried faster and were playable quicker after heavy rains (Matkin, 1999). In a study carried out by the Perlite Institute, researchers found that by using a mixture of two parts peat to one part amendment, polystyrene retained 40-50% as much water as perlite (Matkin, 1999). This percentage increases slightly as the amount of peat in the mix is increased. In the present study, peat moss, coconut compost, Styrofoam, and Leca in various mixtures were used to evaluate their effects on the growth of Spathiphyllum. The main objective of this work is to find whether Leca and Styrofoam can be used as inorganic additives in the media in order to reduce the cost, the volume of the pots, and ease of plants transporting in the greenhouse. Chen (2003) used the mix of cocopeat and peat moss with the proportion of 40% and 60%, respectively, is used as a conventional and suitable media for Spathiphyllum. Accordingly, these substances were chosen as the control and combined with a different proportion of Leca and Styrofoam in the present work.

## Materials and Methods

The present research was conducted in Sad Abad Complex Greenhouse, Tehran, Iran, and it took almost 8 months from October to June. Greenhouse temperature was adjusted between 31°C and 37°C in the summer and 28°C to 30°C in the winter. Besides, the humidity was approximately 70% to 80%, which requires installing a cooling system. All the young plants were similar in length and number of leaves (15 cm length and 10 leaves per plant). One month after the beginning of the experiment, all plants were fertilized with a fertilizer from Florist Company. According to the suggested feeding program of the company for indoor plants, which was also applied in the present work, one month after planting young plants and every 10 days each plant received 77 cc of the fertilizer.

Nine treatments were used for the present experiment with 40% and 60% of cocopeat and peat moss as control media, respectively. Then, Leca and Styrofoam were added to the control media with different proportion shown in Table 1.

Table 1. Proportion of leca and Styrofoam were used in combination with control media

| Treatments | Control | Styrofoam | Expanded clay (leca) |
|---|---|---|---|
| T1 | 75% | 25% | 0 |
| T2 | 50% | 50% | 0 |
| T3 | 25% | 75% | 0 |
| T4 | 75% | 0 | 25% |
| T5 | 50% | 0 | 50% |
| T6 | 25% | 0 | 75% |
| T7 | 50% | 25% | 25% |
| T8 | 25% | 50% | 25% |

**Statistical Analysis**

In this work, 27 pots were used and the experimental design was randomized using the complete block design with 9 treatments and 3 replications. Five parameters of media including bulk density, total porosity, water retention, air space (Koenig et al., 2005), and particle density (Karimi, 2003) were measured and six growth indices of plants including shoot length, leaf number, dry and fresh weights of root and shoot (Stamps, 1997) were determined.

**Data Analysis**

Data analysis was performed using MSTATC and EXCEL program, respectively. Duncan's multiple range tests were used to compare sets of means at 1% significance level.

## Results and Discussion

There was a considerable difference among plants growth in 9 different media in terms of vegetative growth and physical characteristics of growing media and a negative link between the excessive amount of Leca and Styrofoam used in *Spathiphyllum* media and its growth. Thus, it can be inferred that in the media with a higher proportion of Leca (75%) and Styrofoam (75%), plants had lower growth compared to control. In growing media with the highest percentage of peat moss and cocopeat the growth indices including shoot length, leaf number, and the dry and fresh weight of shoots were more noticeable (Table 2). Dry and fresh weights of roots were the highest in T1 with 75% basic media and 25% Styrofoam. It was seen that numbers of leaves were highest in control and increasing the Leca and Styrofoam content led to the reduced number of leaves. Although there was no significant difference between shoot lengths in 9 growing media, a relatively larger shoot length was shown in control and T7. There were similar trends for the fresh and dry weight of shoots, meaning that in growing media with only 25% of Leca and Styrofoam, T1, T4, and T7 were higher than those with a greater amount of these substances. As a result, an excessive proportion of Leca and Styrofoam led to reducing the fresh and dry weight of shoots. In terms of root fresh weight, it was higher in the media with Styrofoam than Leca; however, it was lower than the media with a higher amount of peat moss and cocopeat. The dry weight of roots, by contrast, was higher in media with a higher proportion of Leca than Styrofoam, but lower than T1 and control. This observation is due to the higher total porosity of Leca compared to Styrofoam (Table 3). The results showed that there is no considerable difference in terms of electronic conductivity among different media; therefore, the role of the media seems to be unimportant in this regard. Apparently, the organic carbon content was the highest (38.13) in control compared to growing media with soilless substances. As can be seen from Table 4, growing media with a higher proportion of Styrofoam and Leca, T3 and T6, have a higher level of pH, with 6.08 and 6.66, respectively. In comparison, this value was lower (5.907) in the control containing a greater proportion of peat moss and cocopeat. The phosphorous content was higher in growing media with a higher percentage of Styrofoam, while the one containing a higher proportion of Leca indicates greater levels of nitrogen and potassium, probably due to the buffer effect of Leca. Accordingly, it can be stated that accumulation of nitrogen, phosphorus, and potassium in Leca rises absolutely with increasing fertilization levels.

These results can be explained by physical characteristics of different growing media that are the result of adding inorganic materials such as Leca and Styrofoam (Table 2). As can be seen from Table 2, bulk density is highest (0.38 g/cm$^3$) in T6 (75% Leca and 25% basic media) compared to the 0.008 g/cm in T3 (75% Styrofoam and 25% basic media), suggesting that the increase in Leca leads to a rise in bulk density (Bilderbarck, 2005). However, the suitable bulk density for ornamental plants was seen in T7 (50% control media, 25% Leca and 25% Styrofoam) (Lemaire, 1995); which is similar for the particle density, with 2.55 g/cm3 in T6. Adding Leca caused increasing the volume of pots, but using Styrofoam led to a dramatic fall in the volume of pots. In addition, adding inorganic materials causes increasing the bulk and particle density, and as a result an enhanced stability of pots in the greenhouse. However, using more than 25% of Styrofoam led to a considerable drop in the stability of pots and more difficulty in its irrigating and shipping in the greenhouse. By contrast, 50% and 75% of Leca may lead to difficulties transporting plants in the greenhouse. The highest total porosity was seen in the control with 40% and 60% cocopeat and peat moss, respectively, with approximately 85.25%, compared to nearly 22.64% in the growing media including 75% Styrofoam and 43.67% in the media with 75% Leca. Thus, it can be stated that an excessive amount of Leca and Styrofoam contributes to the reduced plant growth. The greatest water retention was also seen in the control (34.98%) while the media with a higher proportion of Styrofoam could retain the least quantity of water (13.2%). This result can be supported by the study of Farina and Cervelli (1994) who stated that Styrofoam is not able to retain water so that great amount of water and nutrition is released. Another physical characteristic of media affecting the plant growth is the amount of air space (AS), which was highest in the control (40% cocopeat and 60% peat moss) with about 50,27%, as opposed to nearly 11% and 8% in treatments including a higher proportion of Leca and Styrofoam. These results show that higher amount of Leca and Styrofoam results in a drop in AS and then the reduced growth rate. However, for T7 and T8, the results showed that growth indices were higher in the media with 25% of Styrofoam and Leca than the media with 50% Styrofoam. Consequently, only 25% of Styrofoam could be enough for improving the physical characteristic of media and increasing the growth of *Spathiphyllum wallisii*. Analysis of chemical characteristics of growing media also supports the findings of Wilkins (1976) stating that organic substances like peat moss and cocopeat have higher EC compared to soilless substances such as Leca and Styrofoam. Moreover, the most appropriate level of pH for ornamental plants would be between 5 and 6.5; and higher pHs may have negative effects on the development of *Spathiphyllum wallisii*. The results of the present study show that due to the buffer effect of Leca, nutrients accumulate in Leca and then gradually release. Furthermore, it was seen that the growth of *Spathiphyllum wallisii* is better in media including peat moss and cocopeat (Garcia et al., 2001). Similar results were reported by Chen (2003) stating that a mix of 40% cocopeat and 60% peat moss provides a suitable growing media for *Spathiphyllum wallisii*.

Table 2. Effect of various growth media on vegetative plant characteristics of *Spathiphyllum wallisii*

| Treatments | Number of leaves/plant | Shoot length (cm) | Fresh weight of shoots (g/plant) | Dry weight of roots (g/plant) | Fresh weight of roots (g/plant) | Dry weight of roots (g/plant) |
|---|---|---|---|---|---|---|
| T1 | 60.67 | 27.17 | 51.53 | 6.743 | 130.5 | 14.45 |
| T2 | 54.67 | 27.33 | 41.43 | 5.753 | 101.6 | 5.40 |
| T3 | 44.67 | 26.33 | 40.06 | 5.233 | 70.21 | 5.16 |
| T4 | 52.00 | 30.33 | 49.48 | 7.05 | 61.29 | 9.263 |
| T5 | 46.00 | 29.17 | 47.59 | 6.957 | 37.15 | 9.73 |
| T6 | 24.00 | 28.17 | 24.99 | 3.63 | 36 | 13.78 |
| T7 | 43.33 | 31.17 | 45.12 | 6.463 | 64.66 | 6.777 |
| T8 | 37.67 | 27.17 | 27.34 | 4.047 | 48.53 | 5.913 |
| Control | 71.33 | 30.33 | 62.25 | 7.913 | 120 | 8.713 |

Table 3. Physical analysis of growing media of *Spathiphyllum wallisii*

| Treatments | Bulk Density ($g/cm^3$) | Particle Density ($g/cm^3$) | Total Porosity (%) | Water Retention (%) | Air Space (%) |
|---|---|---|---|---|---|
| T1 | 0.1 | 1/66 | 69/9 | 30/2 | 39/7 |
| T2 | 0.07 | 1/65 | 56/78 | 20/5 | 36/28 |
| T3 | 0.008 | 1/58 | 22/64 | 15/2 | 7/44 |
| T4 | 0.21 | 1/98 | 34/2 | 13/2 | 21/08 |
| T5 | 0.36 | 2/36 | 37/16 | 20/1 | 17/06 |
| T6 | 0.38 | 2/55 | 43/67 | 33/04 | 10/36 |
| T7 | 0.25 | 2/14 | 49/19 | 14/59 | 34/6 |
| T8 | 0.134 | 1/08 | 32/46 | 29/1 | 3/36 |
| Control | 0.129 | 1/7 | 85/25 | 34/98 | 50/27 |

Table 4. Chemical analysis of growing media before and after growing of *Spathiphyllum wallisii*

| Treatments | N (mg/Kg) | P (mg/Kg) | K (mg/Kg) | pH | EC (µs/cm) | OC % |
|---|---|---|---|---|---|---|
| T1 fresh | 0.53 | 22.05 | 354 | 5.05 | 1.478 | 30.75 |
| T1 used | 0.97 | 212 | 161.7 | 5.693 | 0.541 | 34.03 |
| T2 fresh | 0.36 | 14.7 | 236 | 5.49 | 0.4 | 20.5 |
| T2 used | 0.9533 | 202.3 | 244.7 | 5.857 | 0.62 | 36.47 |
| T3 fresh | 0.18 | 7.35 | 118 | 5.77 | 0.594 | 10.25 |
| T3 used | 0.8433 | 196 | 284.7 | 6.08 | 0.713 | 35.73 |
| T4 fresh | 0.54 | 22.05 | 354 | 5.29 | 0.596 | 30.75 |
| T4 used | 1.06 | 106 | 190 | 6.153 | 0.6207 | 37.33 |
| T5 fresh | 0.36 | 14.7 | 236 | 5.71 | 0.621 | 20.5 |
| T5 used | 0.9867 | 57.67 | 215.7 | 6.527 | 0.6102 | 36.33 |
| T6 fresh | 0.18 | 7.35 | 118 | 5.96 | 0.616 | 10.25 |
| T6 used | 0.9767 | 61.67 | 416 | 6.66 | 0.5973 | 32.8 |
| T7 fresh | 0.36 | 14.7 | 236 | 5.83 | 0.586 | 20.5 |
| T7 used | 0.9733 | 56.33 | 266.3 | 6.833 | 0.7587 | 37.43 |
| T8 fresh | 0.18 | 7.35 | 118 | 6.01 | 0.648 | 10.25 |
| T8 used | 0.9367 | 62.67 | 153 | 6.843 | 0.5874 | 36.43 |
| Control fresh | 0.72 | 29.4 | 472 | 6 | 0.6 | 41 |
| Control used | 0.8333 | 192 | 161.3 | 5.907 | 0.773 | 38.13 |

**Conclusion**

The present study confirms the fact that selecting an appropriate media for growing potted plants such as *Spathiphyllum wallisii* is of high importance. Thus, adding a small quantity of Leca and Styrofoam to other substances like peat moss and cocopeat can be effective in the growth of *Spathiphyllum wallisii*. However, these materials should not be dominant substrates because not only they reduce the quality of the media but also lead to an increasingly change in the weight and stability of pots when irrigated or shipped in the greenhouse.

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