

# Light-Weight Perlite Medium Cultivation of Plants used in Extensive Green Roof Feasibility Studies

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**Keywords:** Extensive Green Roof, Medium, Perlite, Plants, Sandy Loam

**Abstract.** We tested 8 plants and 3 medium and tested perlite base, thus achieving the results. The green coverage for media S6 (perlite to sandy loam is 8:2) is suitable for *Alpinia speciosa* the best growth 1040.5cm<sup>2</sup>, followed is *Duranta repens* the growth 675cm<sup>2</sup>, with *Portulaca grandiflora* as the third growth 365.12cm<sup>2</sup>. The green coverage for media S7 (perlite to sandy loam is 5:5) is suitable for *Alpinia speciosa* the best growth 843. 93cm<sup>2</sup>, followed is *Duranta repens* the growth 587.38cm<sup>2</sup>, with *Zoysia matrella* as the third growth 435. 81cm<sup>2</sup>. The green coverage for media S8 (perlite to sandy loam is 2:8) is suitable for *Alpinia speciosa* the best growth 501.03cm<sup>2</sup>, followed is *Duranta repens* the growth 324.39cm<sup>2</sup>, with *Zoysia matrella* as the third growth 298.55cm<sup>2</sup>. Perlite to sandy loam medium is more suitable for *Duranta repens*, *Alpinia speciosa*, and *Zoysia matrella* with growth. S6 medium the best green coverage growth (biomass) 3185.49 cm<sup>2</sup>. *Eight kinds of plants Alpinia speciosa* the best green coverage growth (biomass) 2385.46 cm<sup>2</sup>. Different media prescriptions are well-grown planting combinations, in which one can choose different plant species based on the environment and in order to create biodiversity. This can be achieved to reduce the building load and may provide a good environment for the growth of plants and create space in favor of green roofs.

## Introduction

Urban land cover artificial sites, green space decreasing, causing urban heat island effect (7), increase the rate of urban green cover to mitigate environmental pressures, scholars advocate green roofs to increase the green covering reached to reduce surface runoff , urban floods delayed, ease to improve the urban heat island effect , using green materials as a matrix of planting, maintaining plant growth, reaching environmental protection, light, waste reduction , as a green roof material purposes of this study (2, 3, 4).

In view of global warming, urban heat island effect, urban ecological corridor, storm water, reduced runoff, and other issues, during the process of land development and construction it has been helpful to start thinking about how a piece of natural land can improve the global environment (1, 2, 3, 4, 5, 7, 9, 11).

Basic needs that planting green roof growing media, the traditional construction method mostly general soil (loam or sandy loam), but consider reducing the load floor, should be applied as a lightweight media, to build the body of the load was lighter, and more with safety (2, 3, 4).

After the site is actually observed as well as public works budgeted found that the industry practice the construction of green roofs completed waterproofing and pavement works on the roof after the laying of the drainage board and non-woven, the choice of growing media are mostly direct backfill sandy loam, this experimental studies of hope can be, the choice of current market easily accessible and lighter cultivation medium, instead of using one 100 percent of the sandy loam,

with a view to achieve lower structural loads buildings and provide an ideal environment for the growth plant(1, 2, 3, 4).

## Materials and Methods

**Empirical Location.** Taiwan (Tainan), Cheng Kung University Department of Architecture roof.

**Empirical Facilities.** In this study the choice of plant pots, growing media thickness should be 10cm~15cm (4, 8), to facilitate the turf and shrub in irrigation water on the growth supplemented where planting is possible. For planting and growth, the average growth of the crown is in a circular manner (Figs. 1, 2).



Fig. 1 Plant pot containers.

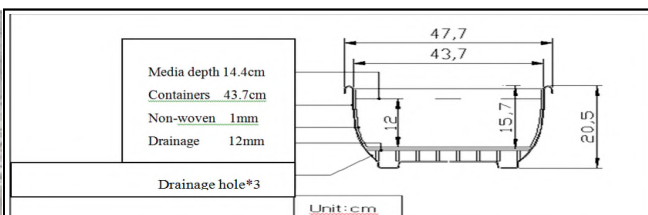


Fig. 2 Plant pot containers' cross-section.

**Medium.** Media mixing ratio of deliberate industry and research experience selected.

Table 1. Prescriptions of medium.

No.	S6	S7	S8
Media	Perlite 20%, Sandy loam 80%	Perlite 50%, Sandy loam 50%	Perlite 80%, Sandy loam 20%

Table 2. Amount of sample media.

Medium	Medium volume	Medium weight	Total Medium weight
Perlite 20%	0.0031 m <sup>3</sup>	0.31 kg	17.174 kg
Sandy loam 80%	0.0124 m <sup>3</sup>	16.864 kg	
Perlite 50%	0.00775 m <sup>3</sup>	0.775 kg	11.315 kg
Sandy loam 50%	0.00775 m <sup>3</sup>	10.54 kg	
Perlite 80%	0.0124 m <sup>3</sup>	1.24 kg	5.456 kg
Sandy loam 20%	0.0031 m <sup>3</sup>	4.216 kg	

**Planting Sample.** The study selected 8 plant species: *Duranta repens*, *Alpinia speciosa*, *Murraya paniculata*, *Portulaca grandiflora*, *Zoysia matrella*, *Liriope platyphylla*, *Podocarpus costalis*, and *Spathoglottis plicata*, each with 9 seedlings, for a total of 72 seedlings. The study was equipped with 3 kinds of plant pots in different media containers (4, 8) with plant cultivation and a detailed view of each seedling planted, after cutting bad branches and leggy branches (5, 6, 7, 10, 14).

Experiment and Record. This study had 24 sample group (3 Repeat), covering 3 kinds of planting medium and 8 planting kinds, for a total of 72 groups. The experimental construction date was February 13, 2011 (2, 3, 4, 5).

pH value measurement method. The electrode method to detect the pH of each sample, pH testing equipment for the SUNTEX PH METER TS-110.

## Photo Data Record.



Fig. 3 Record camera tripod.



Fig. 4 Green coverage History.

**Sampling Frequency and Number.** From the date of the beginning of the experiment, for the preceding month the photograph mode recorded the green coverage (Fig. 3, 4) (4, 6, 9, 11). This study conducted the process on July 24, 2011, 160 days later, with a month as an observation period. The camera recorded 5 times and the planting measuring 5 times.

**Statistical Methods.** For the planting medium pH value, Excel 2013 recorded pH changes made after the graph to understand the trends. The green coverage data was entered into the Excel 2013 file content, in order to analyse the same planting in a different media green coverage of change, so as to find out the ideal cultivated plant cultivation medium (2, 3, 4, 5, 7, 8).

## Results and Discussion

This study focused on lightweight media suitable for landscape plants. For facilities with green roofs, this study added the original medium sandy loam in different proportions of lightweight media, perlite, and sandy loam to examine different proportions after the planting medium (Table 1, 2) was used in the plant along with the growth of high-performance green coverage in different media. The appearance of the physiological condition of the plant can determine the suitability of the planting medium. The ratio of the various media, depending on the experimental results, can help verify the proper proportion of the medium.

**Medium pH Value Detection.** The pH of the medium is detected for different media at the beginning, mid-term, and end of the sampling, thus providing the sample testing results (Table 3, Fig. 5).

Table 3. Medium pH value detection history.

Sampling period		Beginning	Mid-term	End
Medium	Date	2011/2/13	2011/4/30	2011/7/27
	days	1	77	165
	Ave. value 1	Ave. value 2	Ave. value 3	
S6	Perlite 20% + Sandy loam 80%	7.44	7.86	7.61
S7	Perlite 50% + Sandy loam 50%	7.54	8.01	7.61
S8	Perlite 80% + Sandy loam 20%	7.65	7.94	7.74

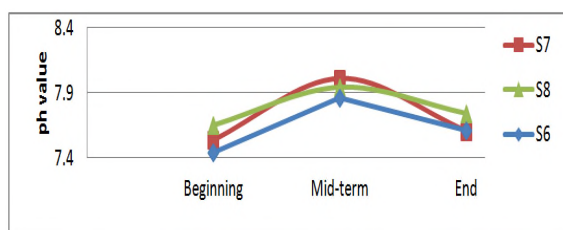


Fig. 5 Perlite Medium pH value detection graph.

Medium pH value is detected, most of the medium showed a low-alkaline environment. (Table 3, Fig. 5).

**Growth Planting History.** We tested 8 plants and 3 medium and tested perlite base, thus achieving the results.

S6 (Perlite to Sandy loam is 2:8) eight kinds of plant growth analysis.

The green coverage for media S6 (perlite to sandy loam is 2:8) is suitable for *Alpinia speciose*. The best growth 1040.5 cm<sup>2</sup>, followed is *Duranta repens* the growth 675cm<sup>2</sup>, with *Portulaca grandiflora* as the third growth 365.12cm<sup>2</sup> (Fig. 6).

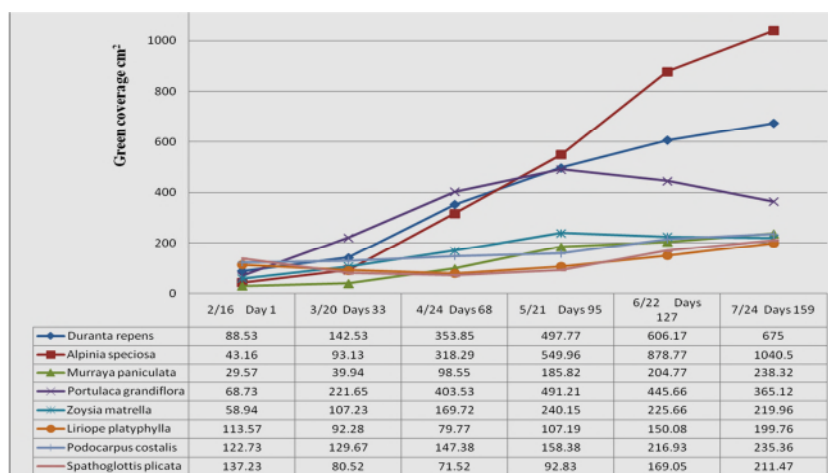


Fig. 6 S6 (Perlite to Sandy loam is 2:8) eight kinds of plant growth biomass graph.

S7 (Perlite to Sandy loam is 5:5) eight kinds of plant growth analysis.

The green coverage for media S7 (perlite to sandy loam is 5:5) is suitable for *Alpinia speciosa* the best growth 843.93cm<sup>2</sup>, followed is *Duranta repens* the growth 587.38cm<sup>2</sup>, with *Zoysia matrella* as the third growth 435.81cm<sup>2</sup>(Fig. 7).

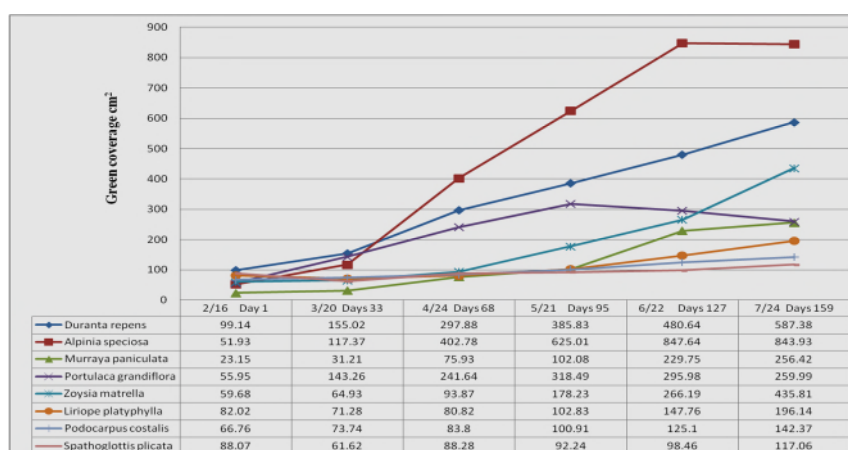


Fig. 7 S7 (Perlite to Sandy loam is 5:5) eight kinds of plant growth biomass graph.

S8 (Perlite to Sandy loam is 8:2) eight kinds of plant growth analysis.

The green coverage for media S8 (perlite to sandy loam is 8:2) is suitable for *Alpinia speciosa* the best growth 501.03cm<sup>2</sup>, followed is *Duranta repens* the growth 324.39cm<sup>2</sup>, with *Zoysia matrella* as the third growth 298.55cm<sup>2</sup>(Fig. 8).

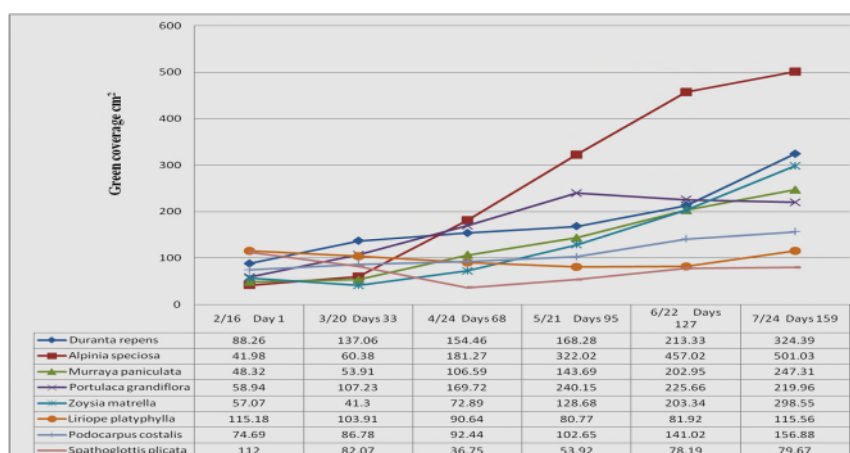


Fig. 8 S8 (Perlite to Sandy loam is 8:2) eight kinds of plant growth biomass graph.



Perlite to sandy loam medium is more suitable for *Duranta repens*, *Alpinia speciosa*, and *Zoysia matrella* with growth. S6 medium the best green coverage growth (biomass) 3185.49 cm<sup>2</sup>. Eight kinds of plants *Alpinia speciosa* the best green coverage growth (biomass) 2385.46 cm<sup>2</sup>.

*Duranta repens*. From the green coverage observed and recorded and the green coverage of the graph (Fig. 9), the growth of *Duranta repens* S6 (Perlite 20% + Sandy loam 80%) green coverage (675cm<sup>2</sup>) in the media is significantly superior versus the other media. The study observed a medium to high growth curve for *Duranta repens* S7(Perlite 50% + Sandy loam 50%). Here, the more than S8 (Perlite 80% + Sandy loam 20%) medium and S8 medium *Duranta repens* height growths are the worst. Thus, S6 is more suitable for *Duranta repens* growth.

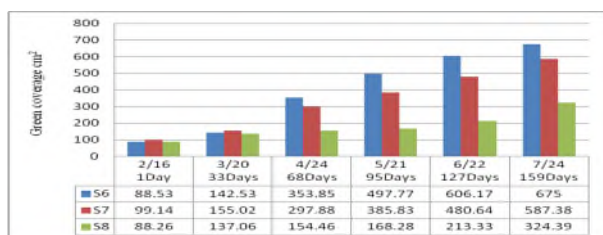


Fig. 9 *Duranta repens* green coverage graph.

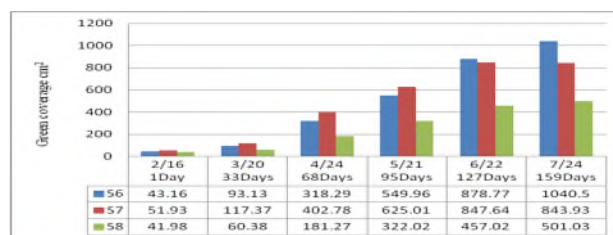


Fig. 10 *Alpinia speciosa* green coverage graph.

*Alpinia Speciosa*. The S6 medium is more suitable for *Alpinia speciosa* (Fig. 10), where the optimum growth temperature is 20~30°C. By observation, the high growth curve shows a proportional relationship between green coverage, with S6 of the green covering (549.96cm<sup>2</sup>) from May. The trend is gradually increasing, where the S7, S8 medium during the planting of the first 127 days slightly slows down away from the green coverage curve. Collocation *Alpinia speciosa* likes weather that is hot and humid, whereas the general growth of irrigation for *Alpinia speciosa* still seems inadequate.

*Murraya Paniculata*. In S7 the performance of the media better than the other two media (S6, S8). By the green coverage of the graph (Fig. 11), S6 medium in the sample since sixty-eighth days the green cover (98.55cm<sup>2</sup>) increased health trend, S7 medium in the sample since ninety-fifth days the green cover (102.08cm<sup>2</sup>) increased health trend, that increase the amount of green coverage in S7 the best performance, followed by S6 and S8, S6 and S7 period of increasing the amount of green cover, which may be related to changes in pH value, it can be seen.

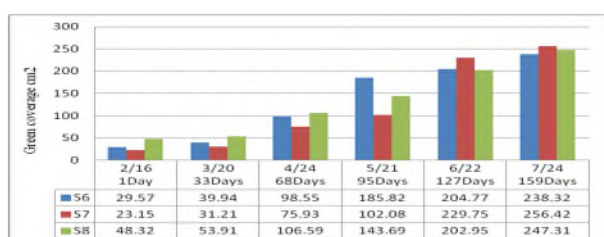


Fig. 11 *Murraya paniculata* green coverage graph.

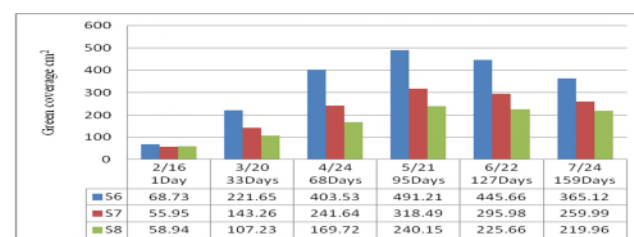


Fig. 12 *Portulaca grandiflora* green coverage graph.

*Portulaca Grandiflora*. *Portulaca grandiflora* is drought-tolerant succulents. , ninety-fifth days increase green coverage of the fastest medium S6(491.21cm<sup>2</sup>), S7(318.49cm<sup>2</sup>) second, S8(240.15 cm<sup>2</sup>) slowest (Fig. 12), the fourth observation after the measurement, due in May, June, July in rainy climate, green coverage of the three curves are showing a downward trend, the decline was minimal S8, S6 is the significant, so the Perlite media group for planting *Portulaca grandiflora* needles when weather conditions and watering should be classified as necessary considerations.

*Zoysia Matrell*. The growth trend's turf coverage is expressed in Fig. 13. The S7 medium *Zoysia matrell* green coverage(435.81cm<sup>2</sup>) is the maximum, followed by S7 followed, with S8 (298.55cm<sup>2</sup>) as the worst. S6, S7 beginning (February to May) green cover rate falling instead of rising (Fig. 10).

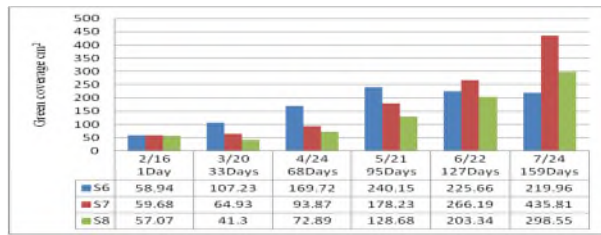


Fig. 13 *Zoysia matrella* green coverage graph.

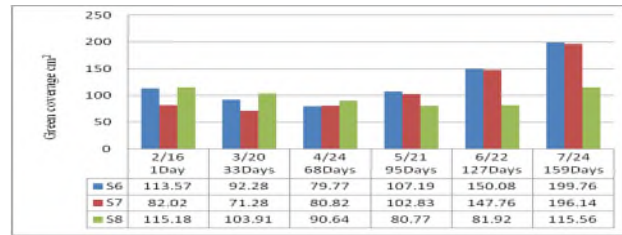


Fig. 14 *Liriope platyphylla* green coverage graph.

***Liriope Platyphylla*.** Green coverage graph greater change of *Liriope platyphylla* three samples of beginning green covering is decline (Fig. 14). S8 sample beginning green coverage lower than S6 and S7 significantly. S6, S7 green coverage of since sixty-eighth days green cover increased health trend. The increase in green coverage for *Liriope platyphylla* is from the best medium of S6(199.76 cm<sup>2</sup>), followed by S6 followed, with S8(115.56cm<sup>2</sup>) as the worst.

***Podocarpus Costalis*.** For S6, S8 in the beginning and mid-term growth trends of green coverage gentle, there is only a more obvious increase during the period of 95 to 127 days(May and June) (Fig. 15). The increased green coverages of *Podocarpus costalis* for S6 and S8 are greater than S7; the best medium is S6(235.36cm<sup>2</sup>), followed by S8, with S7 (142.37cm<sup>2</sup>) as the worst.

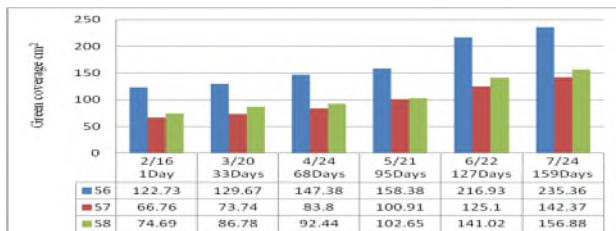


Fig. 15 *Podocarpus costalis* green coverage graph.



Fig. 16 *Spathoglottis plicata* green coverage graph.

***Spathoglottis Plicata*.** Green coverage graph greater change of *Spathoglottis plicata* three samples of beginning green covering is decline. However, for S6, only until its green coverage is 68 days does it see a rising gentle trend. For, S7 there is a slight increase from the first 33 days, and it continues until the end of the experiment observation (Fig. 16), the best medium is S6(169.05cm<sup>2</sup>), followed by S7, with S8 (78.19cm<sup>2</sup>) as the worst.

## Conclusion

We tested 8 plants and 3 medium and tested perlite base, thus achieving the results. The prescription for medium pH value is detected, with most of the medium showing a low-alkaline environment. The green coverage for media S6 (perlite to sandy loam is 8:2) is suitable for *Alpinia speciosa* the best growth 1040.5cm<sup>2</sup>, followed is *Duranta repens* the growth 675cm<sup>2</sup>, with *Portulaca grandiflora* as the third growth 365. 12cm<sup>2</sup>. The green coverage for media S7 (perlite to sandy loam is 5:5) is suitable for *Alpinia speciosa* the best growth 843.93cm<sup>2</sup>, followed is *Duranta repens* the growth 587.38cm<sup>2</sup>, with *Zoysia matrella* as the third growth 435.81cm<sup>2</sup>. The green coverage for media S8 (perlite to sandy loam is 2:8) is suitable for *Alpinia speciosa* the best growth 501.03cm<sup>2</sup>, followed is *Duranta repens* the growth 324.39cm<sup>2</sup>, with *Zoysia matrella* as the third growth 298.55cm<sup>2</sup>. Perlite to sandy loam medium is more suitable for *Duranta repens*, *Alpinia speciosa*, and *Zoysia matrella* with growth. S6 medium the best green coverage growth (biomass) 3185.49 cm<sup>2</sup>. Eight kinds of plants *Alpinia speciosa* the best green coverage growth (biomass) 2385.46 cm<sup>2</sup>. The prescriptions, whereby the ratio of lightweight medium (perlite to sandy loam) is 2:8, which is suitable for more kinds of plants. Different media prescriptions are well-grown planting combinations, in which one can choose different plant species based on the environment and in order to create biodiversity. This can be achieved to reduce the building load and may provide a good environment for the growth of plants and create space in favor of green roofs.

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