



Performance of Ornamental Plants in Different Media Composition for Outdoor Vertical Gardening: Experimental Investigation

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The present experiment was carried out during August 2022 to November 2022 in Research Field, Department of Horticulture SHUATS, Prayagraj. The experiment was conducted in Factorial Plot Design (FPD) with five media composition i.e (Soil, Perlite, Sand, Cocopeat,) in different proportion viz. M0-Soil,M1- Perlite +Cocopeat+Sand 1:1:1,M2- Perlite +Cocopeat+Sand 1:1:2,M3- Perlite+Cocopeat+Sand 1:2:1,M4- Perlite+Cocopeat+Sand 2:1:1 in plastic pot for outdoor vertical gardening. Total number of plants are 150, there are two factors .Five variety and each varieties have five plants with three replication. Second factor is the different types of plant such as *Begonia semperflorens*, *Crassula ovata*, *Syngonium podophyllum*, *Coleus scutellarioide*, *Iresine herbstii*. From the present experimental growth parameter and ornamental morphological characters

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observed. Among the five ornamentals plants used Coleus scutellarioide and Jade performed better as ornamentals plants used in vertical garden system with growing media and the media composition M4 (Perlite+Cocopeat+Sand 2:1:1) is the best media composition for the plant growth.

Keywords: *Coleus scutellarioide*; *Syngonium podophyllum*; *Begonia semperflorens*; *Crassula ovata*; *Iresine herbstii*; vertical gardening.

1. INTRODUCTION

A vertical garden also known as green wall or living wall or bio-wall is self sufficient vertical garden attached to exterior or interior walls of a building. The plants receive water and nutrients from within the vertical support instead of from the ground.

The Vertical Garden conceived and realized by the botanist Patrick Blanc (he was awarded an Honorary Fellow of the Royal Institute of British Architects. He is a French botanist, he is the modern innovator of the green wall, or the vertical garden). Vertical garden was invented by Stanley Hart White who patented a green wall system in the late 1930s [1,2]. Green walls provide an attractive design feature, but also add to building insulation by direct shading of the wall surface. They create cooler microclimates and improve local air quality, and provide the possibility of growing plants in locations that would not normally support vegetation. A wide range of plants is used on green walls, usually herbaceous, some small shrubs can also be suitable [3,4].

In vertical gardens, various types of modular panels can be used along with plastic pot, growing media, irrigation systems, and plants. Living wall are particularly suitable for cities as they allow good use of available vertical surface area. The living wall could also function for urban agriculture, urban gardening, or for its beauty as art. Green walls may be indoor or outside, freestanding or attached to an existing wall, and come in great variety of sizes. Vertical gardens are newly getting populating and pervading in urban areas. They enhance urban biodiversity and thus the urban environment by allowing spontaneous vegetation to colonize these systems [5-7].

A well- designed green wall system will fulfill both design and functional aims by providing growing condition suitable for the selected species, have a long lifespan, require minimal component replacement and have achievable demands for maintenance. The wall greenery

improves visual and aesthetic aspects of indoor spaces. The vegetation plants helps to ameliorate the effects of air pollution, trap dust, absorb noise and recycle carbon dioxide by photosynthesis. Vertical garden is solution to implement beautiful plant in any location where there are no horizontal places lefts for plants [8,9]. It has been proved that visual and physical contacts with plants can result in direct health benefits. Green wall can generate restorative effects leading to decreased stress improve patient recovery rate and higher resistance to illness. Vertical garden act as natural air filter and help in absorbing harmful toxins and releasing oxygen in the air. They help in improving the air quality and creating a clean and breathable environment and thus reducing the risk of stroke, depression, heart and respiratory ailments. Vertical garden enables to maximize limited space and reclaim disregarded space. Potting media for these type of structures should be weightless, high water holding capacity, high nutrient holding capacity, good porosity.

2. MATERIALS AND METHODS

2.1 Experimental Site and Climate

The research will be carried out at the Department building and at the Horticulture research farm, Department of Horticulture, Sam Higginbottom University Agriculture, Technology and Sciences (SHUATS), Prayagraj situated in the semi-arid agro climatic zone of Uttar Pradesh. Geographically, Prayagraj is located at 25° 45' North latitude, 81° 85' East longitude and at an altitude of 98m (322ft) above mean sea level (MSL). The research is done using Factorial Plot Design with three replications. In this experiment living wall system of vertical garden was established with fabricated iron frame to hold the planter boxes. The plastic pots was fabricated with two slits in the front side to accommodate two rows of plants to cover the side of wall. The vertical garden system made of plastic pot container (11cm x 11cm x 11cm) of square shape, black in colour. Mixture comprising soil, sand as basic components in combination with cocopeat, perlite, peat moss.

Table 1. Effect of potting media on plant height of ornamental plants in vertical gardening

| Media | Plants | Treatments | 30dap | 60dap | 90dap |
|-------------------------------------|------------|------------|----------|----------|----------|
| SOIL (M0) | BEGONIA | M0P1 | 15 | 18 | 20.66667 |
| SOIL (M0) | JADE | M0P2 | 15.66667 | 16.83333 | 18.5 |
| SOIL (M0) | SYNGONIUM | M0P3 | 12.33333 | 14.5 | 14.66 |
| SOIL (M0) | COLEUS | M0P4 | 15.83333 | 17.33333 | 18.33333 |
| SOIL (M0) | BLOOD LEAF | M0P5 | 13.16667 | 13.16667 | 16.5 |
| PERLITE+COCOPEAT+SAND 1:1:1(M1) | BEGONIA | M1P1 | 18.16667 | 18.66667 | 20.16667 |
| PERLITE+COCOPEAT+SAND 1:1:1(M1) | JADE | M1P2 | 17.83333 | 18.16667 | 18.66667 |
| PERLITE+COCOPEAT+SAND 1:1:1(M1) | SYNGONIUM | M1P3 | 15.33333 | 14.5 | 14.66667 |
| PERLITE+COCOPEAT+SAND 1:1:1(M1) | COLEUS | M1P4 | 12.66667 | 15 | 19 |
| PERLITE+COCOPEAT+SAND 1:1:1(M1) | BLOOD LEAF | M1P5 | 11.16667 | 12.66667 | 14.83333 |
| PERLITE+COCOPEAT+SAND 1:1:2(M2) | BEGONIA | M2P1 | 14.66667 | 18.5 | 19.16667 |
| PERLITE+COCOPEAT+SAND 1:1:2(M2) | JADE | M2P2 | 16.83333 | 18.5 | 17.83333 |
| PERLITE+COCOPEAT+SAND 1:1:2(M2) | SYNGONIUM | M2P3 | 12.83333 | 15.5 | 13.5 |
| PERLITE+COCOPEAT+SAND 1:1:2(M2) | COLEUS | M2P4 | 12.83333 | 13.33333 | 16.66667 |
| PERLITE+COCOPEAT+SAND 1:1:2(M2) | BLOOD LEAF | M2P5 | 12.33333 | 11.33333 | 15 |
| PERLITE+COCOPEAT+SAND 1:2:1(M3) | BEGONIA | M3P1 | 14 | 15.33333 | 17.66667 |
| PERLITE+COCOPEAT+SAND 1:2:1(M3) | JADE | M3P2 | 18.33333 | 17.16667 | 17.66667 |
| PERLITE+COCOPEAT+SAND 1:2:1(M3) | SYNGONIUM | M3P3 | 14.16667 | 15.5 | 14.66667 |
| PERLITE+COCOPEAT+SAND 1:2:1(M3) | COLEUS | M3P4 | 14.66667 | 20.33333 | 22.66667 |
| PERLITE+COCOPEAT+SAND 1:2:1(M3) | BLOOD LEAF | M3P5 | 11 | 11.16667 | 13.83333 |
| PERLITE+COCOPEAT+SAND 2:1:1 (M4) | BEGONIA | M4P1 | 18.33333 | 17.16667 | 21 |
| PERLITE+COCOPEAT+SAND 2:1:1 (M4) | JADE | M4P2 | 18.83333 | 18.66667 | 18.66667 |
| PERLITE+COCOPEAT+SAND 2:1:1 (M4) | SYNGONIUM | M4P3 | 12 | 14.16667 | 13.33333 |
| PERLITE+COCOPEAT+SAND 2:1:1 (M4) | COLEUS | M4P4 | 14.83333 | 21.5 | 26 |
| PERLITE+COCOPEAT+SAND 2:1:1 (M4) | BLOOD LEAF | M4P5 | 10.66667 | 12.66667 | 15.5 |
| | | F Test | S | S | S |
| | | C.D (5%) | 4.86 | 4.01 | 1.82 |
| | | CV | 30.9 | 30.9 | 20.8 |
| | | SE(d) | 2.41 | 2.41 | 1.99 |

Table 2. Effect of potting media on plant spread of ornamental plants in vertical gardening

| Media | Plants | Treatments | 30dap | 60dap | 90dap |
|-------------------------------------|------------|------------|----------|----------|----------|
| SOIL (M0) | BEGONIA | M0P1 | 11.43333 | 15.5 | 14.33333 |
| SOIL (M0) | JADE | M0P2 | 11.16667 | 12.16667 | 13.16667 |
| SOIL (M0) | SYNGONIUM | M0P3 | 7.5 | 6.583333 | 7.5 |
| SOIL (M0) | COLEUS | M0P4 | 5 | 7 | 11.33333 |
| SOIL (M0) | BLOOD LEAF | M0P5 | 9.833333 | 10.83333 | 11.33333 |
| PERLITE+COCOPEAT+SAND 1:1:1(M1) | BEGONIA | M1P1 | 11.5 | 15.5 | 17.5 |
| PERLITE+COCOPEAT+SAND 1:1:1(M1) | JADE | M1P2 | 8.5 | 10.16667 | 9.333333 |
| PERLITE+COCOPEAT+SAND 1:1:1(M1) | SYNGONIUM | M1P3 | 6.166667 | 7.166667 | 11.83333 |
| PERLITE+COCOPEAT+SAND 1:1:1(M1) | COLEUS | M1P4 | 5.5 | 8.333333 | 11 |
| PERLITE+COCOPEAT+SAND 1:1:1(M1) | BLOOD LEAF | M1P5 | 7.166667 | 9.333333 | 9.5 |
| PERLITE+COCOPEAT+SAND 1:1:2(M2) | BEGONIA | M2P1 | 15.66667 | 14.16667 | 16.66667 |
| PERLITE+COCOPEAT+SAND 1:1:2(M2) | JADE | M2P2 | 10.33333 | 8.666667 | 10.16667 |
| PERLITE+COCOPEAT+SAND 1:1:2(M2) | SYNGONIUM | M2P3 | 6.833333 | 5.166667 | 14.66667 |
| PERLITE+COCOPEAT+SAND 1:1:2(M2) | COLEUS | M2P4 | 6.5 | 7.166667 | 11.66667 |
| PERLITE+COCOPEAT+SAND 1:1:2(M2) | BLOOD LEAF | M2P5 | 7 | 10 | 13 |
| PERLITE+COCOPEAT+SAND 1:2:1(M3) | BEGONIA | M3P1 | 12.33333 | 13.5 | 12.83333 |
| PERLITE+COCOPEAT+SAND 1:2:1(M3) | JADE | M3P2 | 12.66667 | 8.666667 | 10.83333 |
| PERLITE+COCOPEAT+SAND 1:2:1(M3) | SYNGONIUM | M3P3 | 6.333333 | 7.333333 | 10.16667 |
| PERLITE+COCOPEAT+SAND 1:2:1(M3) | COLEUS | M3P4 | 6.833333 | 8 | 10 |
| PERLITE+COCOPEAT+SAND 1:2:1(M3) | BLOOD LEAF | M3P5 | 6.5 | 8.5 | 9.5 |
| PERLITE+COCOPEAT+SAND 2:1:1 (M4) | BEGONIA | M4P1 | 9.333333 | 11.83333 | 13.16667 |
| PERLITE+COCOPEAT+SAND 2:1:1 (M4) | JADE | M4P2 | 10 | 10 | 13.33333 |
| PERLITE+COCOPEAT+SAND 2:1:1 (M4) | SYNGONIUM | M4P3 | 7.5 | 8.166667 | 8.833333 |
| PERLITE+COCOPEAT+SAND 2:1:1 (M4) | COLEUS | M4P4 | 7 | 6.833333 | 11.33333 |
| PERLITE+COCOPEAT+SAND 2:1:1 (M4) | BLOOD LEAF | M4P5 | 7.833333 | 10.5 | 9.833333 |
| F Test | | | S | S | S |
| C.D (5%) | | | 4.86 | 4.01 | 1.82 |
| CV | | | 30.9 | 30.9 | 20.8 |
| SE(d) | | | 2.41 | 2.41 | 1.99 |

Table 3. Effect of potting media on number of branches of ornamental plants in vertical gardening

| Media | Plants | Treatments | 30dap | 60dap | 90dap |
|-------------------------------------|------------|------------|----------|----------|----------|
| SOIL (M0) | BEGONIA | M0P1 | 3.833333 | 8 | 8.333333 |
| SOIL (M0) | JADE | M0P2 | 4.5 | 10.33333 | 27 |
| SOIL (M0) | SYNGONIUM | M0P3 | 4.5 | 7.333333 | 8.166667 |
| SOIL (M0) | COLEUS | M0P4 | 4.166667 | 8.833333 | 13.66667 |
| SOIL (M0) | BLOOD LEAF | M0P5 | 6 | 12.66667 | 18.5 |
| PERLITE+COCOPEAT+SAND 1:1:1(M1) | BEGONIA | M1P1 | 5 | 13.16667 | 14.66667 |
| PERLITE+COCOPEAT+SAND 1:1:1(M1) | JADE | M1P2 | 4.333333 | 11 | 19 |
| PERLITE+COCOPEAT+SAND 1:1:1(M1) | SYNGONIUM | M1P3 | 5.333333 | 6.166667 | 10.16667 |
| PERLITE+COCOPEAT+SAND 1:1:1(M1) | COLEUS | M1P4 | 4.333333 | 7.833333 | 17.16667 |
| PERLITE+COCOPEAT+SAND 1:1:1(M1) | BLOOD LEAF | M1P5 | 4.833333 | 13.16667 | 20.5 |
| PERLITE+COCOPEAT+SAND 1:1:2(M2) | BEGONIA | M2P1 | 3.166667 | 8.333333 | 10 |
| PERLITE+COCOPEAT+SAND 1:1:2(M2) | SYNGONIUM | M2P3 | 4.5 | 5.5 | 7.833333 |
| PERLITE+COCOPEAT+SAND 1:1:2(M2) | COLEUS | M2P4 | 3.333333 | 8 | 18.83333 |
| PERLITE+COCOPEAT+SAND 1:1:2(M2) | BLOOD LEAF | M2P5 | 4.833333 | 12.16667 | 19.16667 |
| PERLITE+COCOPEAT+SAND 1:2:1(M3) | BEGONIA | M3P1 | 3.166667 | 6.833333 | 9.5 |
| PERLITE+COCOPEAT+SAND 1:2:1(M3) | JADE | M3P2 | 3.333333 | 8.166667 | 16.66667 |
| PERLITE+COCOPEAT+SAND 1:2:1(M3) | SYNGONIUM | M3P3 | 4.333333 | 4 | 4.833333 |
| PERLITE+COCOPEAT+SAND 1:2:1(M3) | COLEUS | M3P4 | 2.333333 | 8 | 14.83333 |
| PERLITE+COCOPEAT+SAND 1:2:1(M3) | BLOOD LEAF | M3P5 | 4 | 10.5 | 14.33333 |
| PERLITE+COCOPEAT+SAND 2:1:1 (M4) | BEGONIA | M4P1 | 3 | 9 | 12.83333 |
| PERLITE+COCOPEAT+SAND 2:1:1 (M4) | JADE | M4P2 | 4.166667 | 8.166667 | 22 |
| PERLITE+COCOPEAT+SAND 2:1:1 (M4) | SYNGONIUM | M4P3 | 4.666667 | 6 | 8.166667 |
| PERLITE+COCOPEAT+SAND 2:1:1 (M4) | COLEUS | M4P4 | 4 | 9.333333 | 13.5 |
| PERLITE+COCOPEAT+SAND 2:1:1 (M4) | BLOOD LEAF | M4P5 | 5.333333 | 12.33333 | 20.5 |
| F Test | | | S | S | S |
| C.D (5%) | | | 1.82 | 5.42 | 7.35 |
| CV | | | 26.4 | 34.8 | 29.1 |
| SE(d) | | | 0.91 | 2.69 | 3.65 |

Table 4. Effect of potting media on different ornamental plantspecies grown in vertical gardening

| Media | Plants | Treatments | Root spread | Rh | Lai |
|-------------------------------------|------------|------------|-------------|-------|-------|
| SOIL (M0) | BEGONIA | M0P1 | 6.98 | 59.33 | 16.00 |
| SOIL (M0) | JADE | M0P2 | 8.30 | 62.00 | 17.17 |
| SOIL (M0) | SYNGONIUM | M0P3 | 8.00 | 64.33 | 18.83 |
| SOIL (M0) | COLEUS | M0P4 | 9.83 | 65.33 | 19.33 |
| SOIL (M0) | BLOOD LEAF | M0P5 | 11.00 | 64.33 | 18.33 |
| PERLITE+COCOPEAT+SAND 1:1:1(M1) | BEGONIA | M1P1 | 8.33 | 66.33 | 17.33 |
| PERLITE+COCOPEAT+SAND 1:1:1(M1) | JADE | M1P2 | 9.50 | 60.67 | 16.67 |
| PERLITE+COCOPEAT+SAND 1:1:1(M1) | SYNGONIUM | M1P3 | 9.33 | 65.67 | 16.83 |
| PERLITE+COCOPEAT+SAND 1:1:1(M1) | COLEUS | M1P4 | 10.33 | 65.00 | 18.17 |
| PERLITE+COCOPEAT+SAND 1:1:1(M1) | BLOOD LEAF | M1P5 | 8.47 | 65.00 | 15.83 |
| PERLITE+COCOPEAT+SAND 1:1:2(M2) | BEGONIA | M2P1 | 9.83 | 64.67 | 17.33 |
| PERLITE+COCOPEAT+SAND 1:1:2(M2) | SYNGONIUM | M2P3 | 9.83 | 63.00 | 19.33 |
| PERLITE+COCOPEAT+SAND 1:1:2(M2) | COLEUS | M2P4 | 10.50 | 68.33 | 17.50 |
| PERLITE+COCOPEAT+SAND 1:1:2(M2) | BLOOD LEAF | M2P5 | 9.17 | 63.67 | 16.50 |
| PERLITE+COCOPEAT+SAND 1:2:1(M3) | BEGONIA | M3P1 | 10.00 | 64.67 | 20.50 |
| PERLITE+COCOPEAT+SAND 1:2:1(M3) | JADE | M3P2 | 9.33 | 62.00 | 21.33 |
| PERLITE+COCOPEAT+SAND 1:2:1(M3) | SYNGONIUM | M3P3 | 9.67 | 63.00 | 16.33 |
| PERLITE+COCOPEAT+SAND 1:2:1(M3) | COLEUS | M3P4 | 10.00 | 67.33 | 19.00 |
| PERLITE+COCOPEAT+SAND 1:2:1(M3) | BLOOD LEAF | M3P5 | 9.33 | 63.67 | 15.67 |
| PERLITE+COCOPEAT+SAND 2:1:1 (M4) | BEGONIA | M4P1 | 9.83 | 58.67 | 20.83 |
| PERLITE+COCOPEAT+SAND 2:1:1 (M4) | JADE | M4P2 | 9.83 | 65.67 | 20.17 |
| PERLITE+COCOPEAT+SAND 2:1:1 (M4) | SYNGONIUM | M4P3 | 10.17 | 65.33 | 19.17 |
| PERLITE+COCOPEAT+SAND 2:1:1 (M4) | COLEUS | M4P4 | 8.97 | 65.67 | 17.83 |
| PERLITE+COCOPEAT+SAND 2:1:1 (M4) | BLOOD LEAF | M4P5 | 8.15 | 62.67 | 16.67 |
| F Test | | | S | S | S |
| C.D (5%) | | | 1.80 | 5.35 | 2.99 |
| CV | | | 11.60 | 5.12 | 10.12 |
| SE(d) | | | 0.89 | 2.66 | 1.49 |

Control treatment was maintained with normal soils. The plant growth characters like days taken for establishment, plant height, number of branches, plant spread, leaf area index, relative humidity.

The statistical analysis of data was done by adopting the standard stastical procedure given by Panse and Sukhatme.

3. RESULTS AND DISCUSSION

The present investigation entitled performance of ornamental plants in different media composition for outdoor vertical gardening was carried out at the department of horticulture, Sam Higginbottom University of agriculture technology and sciences, Prayagraj during the August 2022. The objective is to find out the best media

composition and the best plant in these potting media which have been presented in Table 1. The media compositions are (Soil, Perlite, Sand, Cocopeat,) in different proportion. M0-Soil, M1- Perlite +Cocopeat+Sand 1:1:1, M2- Perlite +Cocopeat+Sand 1:1:2, M3- Perlite+ Cocopeat+Sand 1:2:1, M4- Perlite+ Cocopeat+ Sand 2:1:1 and the plants are Begonia semperflorens, Crassula ovata, Syngonium podophyllum, Coleus scutellarioide, Iresine herbstii can be used to establish the above ornamentals plants in plastic pot container of vertical gardening fabricated in iron frames. The quality parameter of the ornamentals plants grown containers can be determined by assessing the plants morphological characters. In present experiment data was recorded for various character Plant Height (cm) ,Plant Spread(cm),Leaf area, Number of branches, Root spread, Relative humidity. By considering the mean performance of all the five ornamentals plants (Table 1) it is concluded that Coleus and Jade plants can be used as ornamentals plants for the establishment of vertical garden.The result of the present work are presented under following Table 1.

4. CONCLUSION

From the above experimental it may be concluded that the media composition M4P4 was found to be best in term of growth viz, plant height at 30 DAP (18.33) at 60 DAP (19.66) at 90 DAP (24), and in term of plant spread Begonia was found to be best for vertical gardening at 30 DAP (15.66),at 60 DAP (16.66),at 90 DAP (16.96), In term of number of branches Jade was found to be best at 30 DAP(4),at 60 DAP (11) ,at 90DAP (24).

The plant which is most suitable in the media composition is *Coleus scutellarioides*.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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