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# Rhizopsheric studies of Green roof plants grown in sub-tropical conditions of Ujjain (Madhya Pradesh)

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**Abstract:**

Rhizosphere is the most active zone of soil, which expresses the interaction between microorganisms and plant roots. Most of the studies have been carried out in rhizosphere of agricultural soils, but in the present study an attempt to evaluate the rhizospheric composition (bacterial and fungal count) of five local green roof plants (*Kalanchoe bolssfeldiana, K. thyrsiflora, K. delagoensis, Portulacaria afra* and *Trachyspermum ammi)* with specific substratum instead of normal soil was made. For a comparison, a control (Non-rhizospheric substratum) was also assessed for microbial counts. Interesting results were observed, bacterial count was higher than fungal count, also the form diversity was more in fungi as compared to bacteria. Species wise difference in microbial count and diversity was also observed over respective control. Comparatively, *Kalanchoe sp., harbored* more microflora than other two test plant species. Among the three *Kalanchoe sp., m*aximum microbes were recorded in *Kalanchoe delagoensis.*

**Key words:**

Green roof, *Kalanchoe* sp., Rhizosphere

**Introduction:**

Green roofs are in general roofs that are planted with different variety of vegetation on the top of a substrate (growth medium). This conception was intended to promote the greenery on the top of the buildings to achieve numerous economic, social, aesthetic and environmental benefits. According to Hoffman and McDonough, (2005), Green roofs, vegetated roofs or living roofs consist of a multilayered system with vegetation on the top. The whole system can be placed atop various kinds of infrastructures such as buildings and parking lots (Francis and Lorimer, 2011). Rapid development of urban environments is often followed by the degradation of the environmental quality i.e. through increase in pollution (by excessive energy consumption, noise, greenhouse gases and other pollutants), development of urban heat islands, reduction in biodiversity, increase of impermeable areas and, loss of arable land and green areas (Guilland et al., 2018). Hereupon, the increasing awareness of the importance of plant–microbe interactions underlines the need to elucidate the nature of microbial communities on green roofs and the influence of biotic and abiotic factors on their establishment (McGuire et al., 2015). Consider the microbiological characteristics of the substrate, besides the common physicochemical ones, can contribute to the evaluation of

substrate quality and fertility to plant development and hence increase knowledge regarding appropriate green roof components under the selected conditions (Ondoño, 2015b).

Most of the studies in this field have been conducted in temperate and sub-temperate regions but present study deals with sub-tropical climatic conditions. The study has been carried out in green roofs projected in Ujjain city, south west of Madhya Pradesh state.

**Materials and Methods:**

The present study was conducted in Ujjain city (A sub tropical region under the Malwa plateau) of Madhya Pradesh. Maximum temperature in April and May ranges from 38°C to 44°C. The minimum temperature during December and January varies between 7° to 13°C. The historic city Ujjain is also famous as Tropic of Cancer passes through it. The city is situated at 23°18′N, and 75°78′E**.** Five local green roof plants (*Kalanchoe bolssfeldiana, K. thyrsiflora, K. delagoensis, Portulacaria afra* and *Trachyspermum ammi)* were planted on roof tops.

In the present study extensive type of green roof was prepared on the lounge room of residential home with a roof area about 50 sq mt. the installation process included sealing of Reinforced Cement Concrete (RCC), roof with water proofing paste, layering with root protection High Density Polyethylene (HDPE), non woven protection / insulation layer, putting of 3 cm thick porous drainage tiles, filter fabric, compost layer and the inorganic mixture of burnt air-filled brick residue (from brick kilns) plus broken tiles from old houses as waste material. The substrate was planted with pot grown test plants (*Kalanchoe bolssfeldiana, K. thyrsiflora, K. delagoensis, Portulacaria afra* and *Trachyspermum ammi)* and a drip irrigation system was assembled. The standard extensive structure of the green roof was followed as per International standard (FLL 2008; Appl and Ansel 2009). The original roof of the study house was constructed of RCC with a cover of mosaic tiles (size 25 X 25 X 2 cm) as the supporting structure. This was made leak proof by applying a double coat of liquid additive of high performance water proofing material.

**Isolation and enumeration of rhizospheric microorganisms**

The main aim of this study was to evaluate the microbes found in rhizosphere substratum of the plant roots. Bacterial population was isolated using standard dilution plate method. Two dilutions viz., $10^{-5}$ and $10^{-6}$ were used for bacterial isolation. Nutrient agar medium (HiMedia Lab) was used for cultivation of bacteria. In the same manner, serial dilution and plate count method was used for isolation of fungi. For the determination of fungal

count two dilutions viz., $10^{-3}$ and $10^{-4}$ were used. Media for cultivation of fungi were Rose Bengal-Streptomycin agar, Sabourd Dextrose agar, Czepak Dox agar, and Potato Dextrose Agar medium (HiMedia Lab).

**Results and Discussion:**

Substrate of five years old green roof system was assessed for the microbial flora in the rhizosphere of various test plants. Rhizosphere of *Kalanchoe delagoensis* showed maximum number of bacterial and fungal population followed by *K. thyrsiflora, K.bolssfeldiana, Portulacaria afra* and lastly *Trachyspermum ammi* (**Table-1**). However fungal population was slightly more *T. ammi* as compare to *P. afra*. **Figure-1** represents the percent increase in different microflora over the respective control. **Photo plate-1** showing the fungal isolates from the rhizosphere of test plants. Among all fungal isolates *Aspergillus, Trichoderma, Alternaria*, and *Rhizopus* sp., were dominant in *Kalanchoe* plants. However except *Aspergillus* other fungal sp., were not recorded in other test plant rhizosphere. *Bacillus, Staphylococcus* and *Micrococcus* bacterial sp., were recorded in three *Kalanchoe* sp., while only *Bacillus* and *Staphyococcus* were recorded in other two test plant sp., *T. ammi* and *P. afra*. However, the bacterial count was comparatively varied in different test species. There is no optimal substrate to green roofs in all regions as the climatic conditions and plant species differ (Ampim *et al.,* 2010). However, as proposed by the German guideline FLL (2008), green roofs substrates should combine the following properties; high stability to resist decomposition and erosion caused by rain water, wind or frost; have on its constitution components that can retain water and keep it available to plants; good oxygen diffusion; appropriate pH; low salt content; provide nutrients and physical support to plants and be as light weight as possible to not exceed the load bearing capacity of the roof. The usual practice is to mix different components that offer the essential properties to the plant growth.

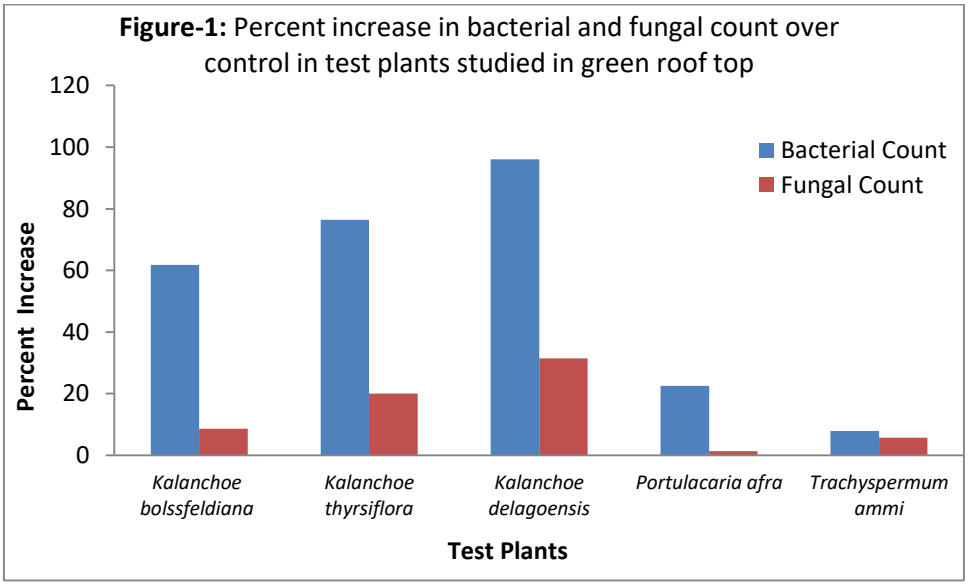
This fraction serves as fuel to plants and microorganisms aiming to promote soil biodiversity and continuous cycling of nutrients. Besides, having direct impact on thermal conductivity and water retention capacity, it influences the growth conditions, water availability and nutrients necessary for plant development (Best *et al.*, 2015).

Hence, as substrate are one of the most important components in the construction of green roofs (Noya *et al.*, 2017), it is necessary to have a continuous study regarding the influence that components of the substrate can have on the green roof system and services. Even the rhizospheric microbial flora study needs a further exhaustive experimentation regarding certain growth promoting species, as some of the microorganisms (both bacteria and fungi) have been reported to show phosphate solubilization, IAA production and other growth promoting activities (Sharma and Kumawat, 2013).

**Table-1:** Bacterial and fungal count in rhizospheric soil of test plants

| S.No | Plants name | Number of bacterial cells ($10^{-5}$ dilution) | Number of fungal isolates ($10^{-3}$ dilution) |
|---|---|---|---|
| 1 | *Kalanchoe bolssfeldiana* | 165±1.2 | 76±2.6 |
| 2 | *Kalanchoe thyrsiflora* | 180±4.5 | 84±4.0 |
| 3 | *Kalanchoe delagoensis* | 200±2.8 | 92±4.9 |
| 4 | *Portulacaria afra* | 125±3.7 | 71±4.5 |
| 5 | *Trachyspermum ammi* | 110±4.1 | 74±3.7 |
| 6 | *Control (Non-rhizospheric substratum)* | 102±5.3 | 70±2.8 |

**±indicates the standard deviation (Values are mean of three)**



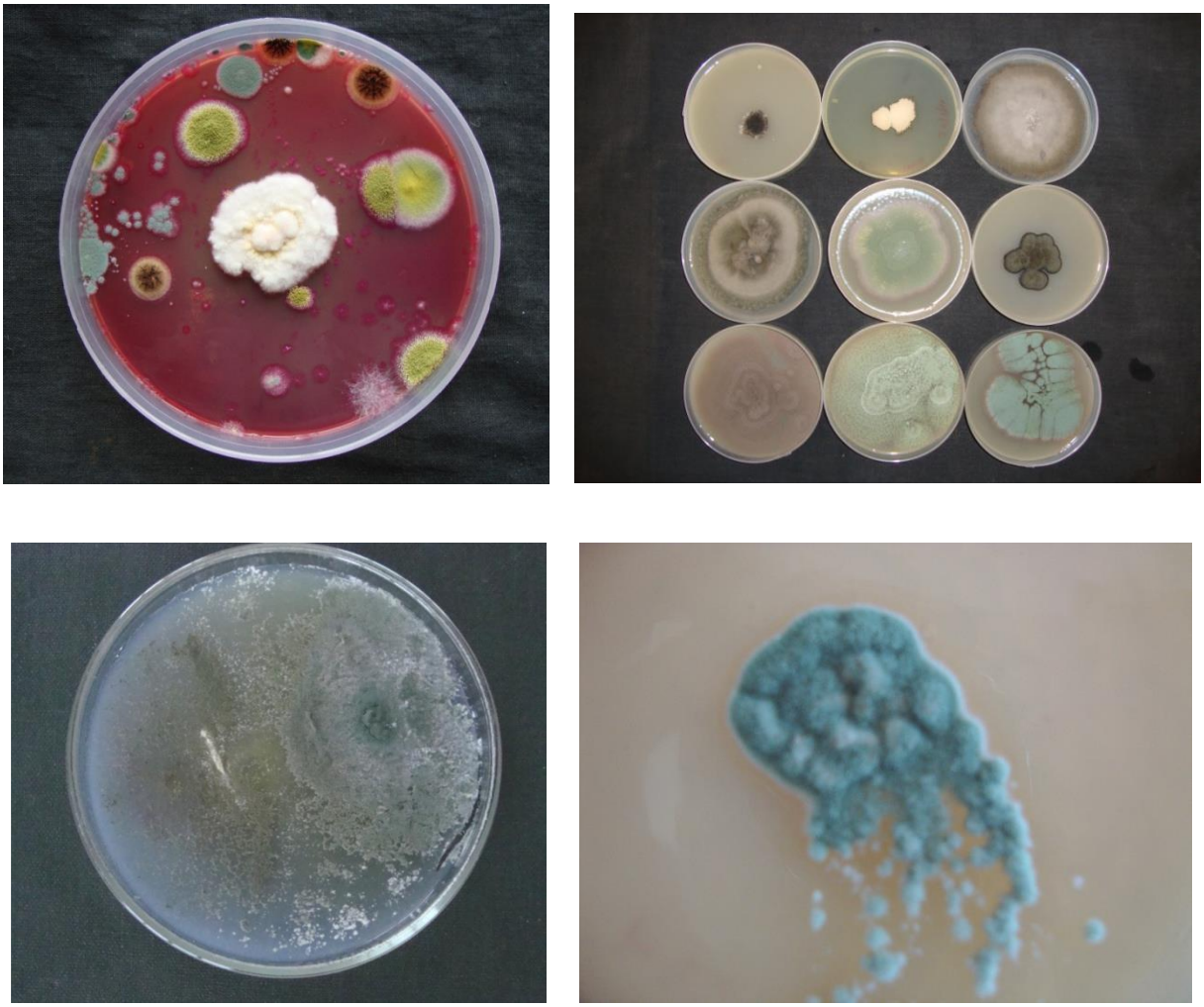


Photo plate-1: Rhizospheric fungal isolates

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