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Popular Article

Vertical Gardening: A new dimension in today's era to mitigate the effects of changing climate and global warming

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ABSTRACT

With change in the climate globally, weather is becoming highly unpredictable, but with the advancement of new technology like vertical gardens are one of the best measures to mitigate the ill effects of climate change. The absence of vegetation in urbanized areas due to human settlements has a direct impact on people's quality of life, both physically and aesthetically. In cities people living in the flats have little space for conventional type of gardening but can easily afford to take up vertical garden. A Vertical Gardening is a special kind of urban gardening which is suitable to small spaces, particularly for decorating the walls and roofs in various styles. Vertical gardens provide extra biologically active surfaces to an urban landscape, enhancing its biodiversity. They also offer an intriguing way to fill an underutilized area of the urban fabric. When planning a vertical garden, some of the most crucial factors to take into consideration are the average temperature (as well as the extremes), wind, sun, ambient humidity, and water availability.

Keywords: Vertical Garden, urbanization, air pollution, green facades

Introduction

Cities are expanding quickly over the world, and this is accompanied by a decrease in vegetation and an increase in the urban heat island effect. Changing climate has made the concept of changing our living ambiance very important to make quality living. There are several factors that contribute to rise in global temperatures, especially in the urban areas. The reliance on fossil fuels, combustion-engine vehicles, industry, hard building surfaces and lack of green spaces, all combine to create heat build-up within towns and cities. This built environment is an important factor in user behavior, health and well-being. Stress is a major contributing factor in everyday life and it negatively affects the health both physically and psychologically. Accordingly, Vertical gardens can be one of the alternatives in adding restorative characteristics that could lower stress levels and consequently, enhancing the urban

quality of life for individuals. Vertical gardens are the tools that can be employed to enhance the quality of air, solve the heat problems in urban areas and at the same time improves the aesthetic value of our living places. Green walls and green facades are also proven solutions that positively impact the microclimate of buildings and surroundings. Due to the decreasing amount of available area for gardening and the proliferation of high-rises, vertical gardens are increasingly being used in modern garden designs. A vertical garden also referred to as plant walls, bio walls, green walls or living walls is a garden that grows vertically using a trellis or other support system, rather than on the ground and are attached to the exterior or interior of the building. These are vertical structures that have different types of plants or other greenery attached to them. The plants are often planted in a growth medium which consists of soil, stone, or water and since the walls have living plants in them, they usually feature built-in irrigation and drainage systems. One of the important features of the vertical garden is therefore its ability to grow in already built-up places. The plants receive water and nutrients from within the vertical support instead of from ground. It is a special kind of urban gardening which is suitable to small spaces, particularly for decorating the walls and roofs in various styles and is also an alternative method for gardening by expanding the scope of growing plants in a vertical space. They differ from green facades because in that the plants root in a structural support is fastened to the wall itself.

History of Vertical Gardening

This concept of vertical gardening was developed in Switzerland from where it developed world over but has still not become popular in Indian gardens. Though the cost of establishment for setting up a vertical garden is high enough but it can be compensated by the environmental benefits such as raising the vegetation surfaces and reducing the pollution effect. However, the concept of creating natural surfaces on the walls dates back to the hanging gardens of Babylon that is one of the Seven Wonders of the World during 600 BC. The first Vertical Gardening System was created in 1990's by the world French Botanist Patric Blanc in which the plants were grown on the surface of a hydroponic culture with an integrated irrigation and fertilizing system and after which the vertical gardening system began to gain lots of popularity.

Advantages of Growing a Vertical Garden

- Maximizing the use of limited space.
- Keeping the garden contained.
- Protects exteriors of the building from UV radiations.
- Reduce home heat from sun.
- Stabilizes temperature and humidity.
- The growing media used for living walls also helps to reduce the sound levels that transmits through or reflects from the living wall system.
- Improved air quality and filters air by taking up dust particles, CO_2 and particulate matters.
- The "heat island effect" that is being generated in large cities as a result of global warming can be reduced by installing vertical gardens on the facades of buildings
- Provide privacy and disguise from unattractive views.
- Buildings with interior planting can be viewed as more expensive

looking and more welcoming to its residents.
- Greenery promotes a healthy indoor climate.
- Working or living in a green environment brings people together.
- Enhances biodiversity.
- Promotes native plants and species

Types of Vertical Garden

1. Green facades: They are created by the growth of the climbing plants up and across the face of the building using them as a structural support and these facades have roots either in the ground or in the containers installed at different levels up the face of the building. Moreover, the greenery of the façade can take a long time to grow enough to cover an entire wall, while green walls may be pre grown.

2. Smart and active green walls: They often look similar to the conventional green walls, but serve more purpose due to the use of artificial intelligence and technology. The features of a smart living wall can be automated and monitored enhancing its effects. In addition to the visual and biophilic benefits of all green walls, smart and active green walls can feature natural air purification and humidification.

3. Freestanding vertical garden: This is the best garden design for the beginners as they are easy to prepare and these can be easily mounted on balconies or small terraces. There is no requirement for any fancy growing medium or irrigation system. A little basic water, soil and traditional gardening is sufficient for this type of garden.

Construction and Installation of Vertical Garden

Living wall- there are two types

Hydroponic Green Wall - Modular containers or large panels are used. There must be gap between wall and backing sheet. Inert growing medium should be provided in the container for plants to physically anchor. Regular inspection of growing solution is necessary for a good hydroponic system.

Substrate Based Systems – Containers or synthetic fibre bag containers (plastic or metal) holding substrate/media are used which are anchored to the wall or a framework. Metal grid can be used for this purpose. Media provides a structure to support the growing plants

Green Facades

- Webbing metal grid techniques - It is the simplest type of making green facades. It consists of fixing the wall webbing leaving 30mm space between wall and webber. It takes 5-10 years for complete establishment and covering the face of building depending upon the size of the available surface.
- Cable and wire-rope net systems -Cables support faster growing climbers whereas wire nets support slow growing climbers. These provide a greater degree of designs to form as high tensile steel cables are used and wire ropes are connected through cross clamps
- Wooden trellises –These are less used as they are easily prone to damage by weather.

Irrigation and plant nutrition

- Irrigation should be aimed at minimizing water consumption using an automation unit and drippers. Average requirement of water is 2-5 l/m^2/day and for a hydroponic green wall systems 0.5-2.0 l/m^2/day of irrigation solution.

Drainage tray is provided at the bottom for recycling of water

- Any source of organic and inorganic fertilizers can be used.

Vertical gardens can last very long with good management practices such as maintaining and rejuvenating the climbing plants, maintaining the irrigation/fertigation with regular inspection, by providing adequate and timely nutrition, keeping the growing media in good condition and most importantly maintaining drainage properly. Good quality materials used in construction may also have impact on life of vertical gardens

Characteristics of the growing media for vertical garden

1. The media should be lighter in weight.
2. Should have high water holding capacity.
3. Should have a high nutrient holding capacity.
4. The media should be highly porous, and
5. It should have a neutral pH

Types of growing media used in living walls:

- **Loose media:** This system has their soil packed into a shelf or bag and then are installed onto the wall. These systems require their media to be replaced at least once a year on exteriors and approximately every two years on interiors.
- **Mat media:** Tend to be either coir fibre or felt mats. Mat media are quite thin, even in multiple layers, and as such cannot support vibrant root systems of mature plants for more than three to five years before the roots overtake the mat and water is not able to adequately wick through the mats.
- **Structural media:** They are growth medium "blocks" that are neither loose, nor mats, but incorporate the best features of both into a block that can be manufactured into various sizes, shapes and thicknesses. These media have the advantage that they do not break down for 10 to 15 years, can be made to have a higher or lower water holding capacity depending on the plant selection for the wall, can have their pH and EC's customized to suit the plants, and are easily handled for maintenance and replacements.

Plants suitable for vertical garden:

A. For Living Walls

Plants for exterior living walls/ sunny areas

- Ground covers
- Low shrubs
- Perennial flowers
- Annuals and
- Edible plants

Plants for interior living wall/shady areas

- *Zebrina pendula*
- *Scindapsus aureus*
- *Setcreasea spp.*
- *Chlorophytum comosum*
- *Episcia cupreata*
- *Cryptanthus spp.*
- Ferns
- *Pepromia spp.*
- *Syngonium podophyllum*

B. For Green Facades (Green Screens)

Any variety of climbing plants (vines) can be used for making green facades which may include:

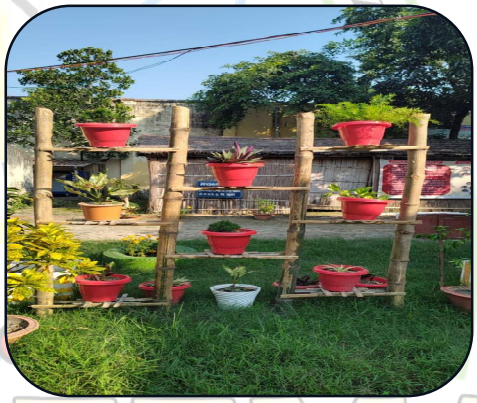
- Plants with trendrils e.g., grapes (*Vitis* Spp), Passion flower (*Passiflora*), *Pyrostegia venusta.*

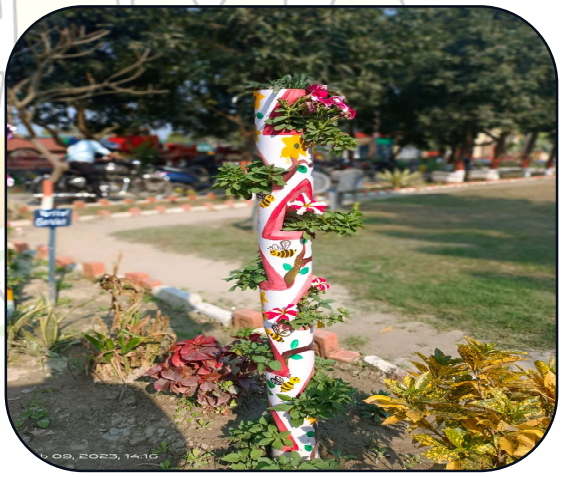
- Plants with twining stems or leaves -e.g., *Clematis gouriana*, *Adenocalyma alliaceum*, *Jasminum auriculatum*, *J. grandiflorum*
- Hold fasts, plants with aerial roots or stem roots -e.g., *Hedera helix, H. hibernica, Tecoma radicans, Monstera* spp., *Phelodendron* spp.
- Scramblers which have no direct means of attachment e.g., *Bougainvillea* spp., roses (*Rosa* spp.) *Petrea volubilis*, *Vernonia elaegnifolia*, *Quisqualis indica*, *Thunbergia*, *Stigmaphyllon peripocifolium, Tristellateia australis* etc.

Characteristics of plants suitable for vertical garden are:

- Plants that can be planted on both sides of the frame.
- Generally dense, compact and low growing plants are selected.
- Dwarf flowering and foliage plants.
- Shallow rooted plants that require very less anchorage
- Sun loving dwarf, trailing or flowering plants. E.g., *Allysum*, Pansy, *Nasturtium*
- Shade loving foliage or flowering plant.eg. begonia, African violets, *Pepromia, Zebrina pendula* etc.
- A single vertical garden should not have a mixed planting i.e., combination of both shade loving and sun loving plants.

Establishment of Vertical Garden at KVK, Vaishali





Vertical gardens on bamboo prepared during training programs at KVK, Vaishali

Preparation of vertical bamboo hangings during training program organized at KVK, Vaishali

Conclusion

Vertical gardening is an excellent opportunity of growing plants in areas where there is limited space, particularly in densely populated urban areas. Greening the building envelope and other surrounding areas with vegetation can be used as a mean to restore the environmental conditions in urban areas. Systematic introduction of vertical gardens into cities seems to be justified and is the right solution for implementing greenery in places where it is necessary because of the low quality of the environment and difficulty of current land use.