



Experiment on different indoor vertical gardening by hydroponic method for sustainable infrastructure

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ABSTRACT

This paper discusses about conducting experiment on different indoor vertical gardening for the room dimension of 10' x 10' as specimen area aimed to improve indoor environment. Here four types of plants namely Tulsi, Aloe Vera, Money Plant, and spider plants are used for vertical gardening. Four residential single room located in different places in Bangalore is considered for this experiment. Each day these plants were increased from 0, 5, 10, 15 plants and checked for environmental parameters. The indoor environmental monitoring parameters are Air Quality index, Temperature, Noise, Humidity Check, Air Pressure. These parameters are checked in real time for the four days. The plants were grown by using Hydroponic method and the plants rooted by 80% soil and 20 percent coco peat. The result shows that maximum of 37% of Indoor Air Quality index is improved by using Aloe Vera plants, Indoor temperature is reduced up to 2° C between indoor and outdoor, and 12% of increase in humidity by Tulsi plant. This project recommends that vertical gardening helps stabilizing the indoor environment and promotes sustainable infrastructure.

Keywords: Indoor Vertical Gardening, Hydroponic method, Sustainable infrastructure, Air quality Index, eco-city

1. INTRODUCTION

Life styles in Indian metropolitan cities have migrated from separate homes into residential apartments in order to counter the dense population [2]. The Garden city of India, Bengaluru has got its first vertical garden which contains more than 10 species of plants planted already [4]. This result in cutting of trees (deforestation) thereby is making the ecosystem to become unproductive to live. Government have made several initiatives like Green India, Clean India and by allowing

2. HYDROPONIC METHOD

[3] Hydroponics is a subset of hydro culture, the method of growing plants without soil, using mineral nutrient solutions in a water solvent. Terrestrial plants may be grown with only their roots exposed to the mineral solution, or the roots may be supported by an inert medium, such as perlite or gravel. [4] The nutrients in hydroponics can come from an array of different sources; these can include but are not limited to by product from fish waste, duck manure, or normal nutrients. Continuous-flow solution culture — Nutrient Film Technique (NFT) [7] The result of these advantages is that higher yields of high-quality produce are obtained over an extended period of cropping. A downside of NFT is that it has very little buffering against interruptions in the flow (e.g. power outages). But, overall, it is probably one of the more productive techniques

3. MATERIALS USED

- Water tank
- Ball valve
- PVC pipes
- Flexible pipe
- Bio 20(chemical)
- U-clamps and screws



Fig. 1: Water tank

Water Tank: The water tank of capacity of 5-10liters is used to supply the water from tank to the plants by using drip irrigation system

Ball Valve: The ball valve arrangement is provided to have control on supply of water from the tank to the plants. Also, to supply water to the plants from tank by drip irrigation system.



Fig. 2: Ball valve

In PVC PIPES: PVC pipes of different sizes can be use in this system according to the requirement and based on some parameter of plants.



Fig. 3: PVC pipe

Flexible Pipe: These pipes are used to supply the water to each plant. These pipes are passed through the PVC pipes in which the holes are made



Fig. 4: Flexible pipe

4. INDOOR VERTICAL FORESTING METHODOLOGY

Initially a trial setup was made by growing the plants with 0% soil medium. These plants are grown by using nutrient water. In the water some chemicals are added like magnesium (Mg), Nitrogen (N), Phosphorus (P), potassium (K), sulphate etc, The Garden city of India, Bengaluru has got its first vertical garden which contains more than 10 species of plants planted already¹². Automated Drip Irrigation facility has farmed the garden of about 100 ml of water daily.



Fig. 5: Trial setup

The water is pumped from the tank or sump to flow through the pipes and passes through the plants placed in the pipe. The water flow in the pipe should be slow and the water should flow partially in pipe so as to maintain the oxygen content in the pipe and for the plants. The plants grow in this method by means of “hydroponic method.” This setup failed to retain nutrient water to supply to plants. Due to this loop hole setup plants became weak and dying day by day. Hence a modified setup was established.



Fig. 6: Modified Setup

In this system the plants are grown using 80% soil and 20percent coco peat. The plants are grown in a PVC pipes which are filled with natural soil and cocopeat. The supply of nutrient water is done by the tank by drip irrigation system. In this system the plants are water once in a day while watering the plants special care should be taken the water should not excess or more during the supply. To control the supply of water a ball valve arrangement is made. The whole setup is fixed on the wall surface by the help of U-clamps and screws. By providing this system we can control air pollution it also provides a good appearance. This system was successful because of retain the nutrient water by increasing the soil medium to hold the nutrients for longer duration and supply the plants when requires.

The following environmental monitoring parameters were measured by using prkruti lite device it is the smallest personal air quality monitoring device. a tiny, low powered and easy to

plug in device that helps you to track the air you breathe. measures indoor air quality, temperature, humidity, air pressure, noise Tracker Monitoring Device



Fig. 7: Prkruti Lite Indoor Personal Air



Fig. 8: Testing

5. RESULT AND DISCUSSION

5.1 Indoor Air Quality (IAQ)

Indoor air quality is the measurement algorithms being calculated from indoor CO₂ CO & dust particles. It has been observed in this experiment the air or indoor air quality depends on many parameters like room size, members in family etc.. By conducting this experiment for four days we have observed the variation in IAQ are as follows.

Day-01

The indoor air quality was measured for 24 hours by the interval of 2 hours. It has observed that if the area is surrounded by IAQ level varies from the time. Depending upon the atmospheric content or air quality.

Day-02 (Five Plants)

In the Day-02 we have kept 5nos of plants & observed the reading of IAQ which has slightly reduced, the IAQ levels varied due to the plants.

Day-03 (10 Plants)

In the Day-03 we have kept 10nos of plants & we can see the gradual decrease in IAQ due to which we can say that air quality is getting better.

Day-04 (15 Plants)

It has observed that planting more plants can reduce the IAQ more. plants absorb airborne substances through tiny openings in their leaves. The IAQ level will be less during night time because plants absorb oxygen and releases carbon dioxide. During 4days experiment using 4different plants we observed

common thing that increasing number of plants improves the indoor air quality. Indoor air quality measurements higher the IAQ air quality indoor air quality is the measurement algorithms being calculated from indoor CO₂, TVOC and dust particles.

The following are the Ranges and health effects

*Good (0-50)

Air quality is good it poses little or no risk

*Little bad (101-150)

Sensitive people and children may face the health effect, unhealthy to the people having heart and lungs disease.

*Bad (151-200)

Everyone may begin to experience health effects when AQI values are between 151-200. Members of sensitive groups may experience more serious health effects.

*Worse (201-300)

Causes the health alert, meaning everyone may experience more serious health effects.

*Very bad (301-500)

Health warning of emergency conditions. The entire population is even more likely to be affected by serious health effects

Table 1: Indoor Air Quality Test Result

IAQ	NO. OF PLANTS	TULSI PALNT	ALOVE RA PLANT	MONEY PLANT	SPIDER PLANT
DAY 1	0	40	60	55	52
DAY 2	5	35	55	53	50
DAY 3	10	32	46	50	45
DAY 4	15	29.5	38	46	36

Table 2: Temperature Test Result

Tempa rture (°c)	Tulsi plan t		Alovera plant		Money plant		Spider plant	
	Indoor	Outdoor	Indo or	Outdo or	Indo or	Outdo or	Indo or	Outdo or
DAY 01	30	31	30	31	30	32	29	30
DAY 02	29	30	29	30	29	30	29	29
DAY 03	30	31	29	30	29	31	28	29
DAY 04	29	30	29	30	28	30	28	28

Temperature is the one of the common parameters in measuring the environmental. Condition they can be either indicated in Celsius or Fahrenheit. During these 4 Days of observation we observed that the temperature is varied by 1⁰ to 2⁰ C. By planting plants in the indoor environment. The indoor temperature varies from the outdoor. If the number of plants is more in the room, then the temperature is reduced up to certain limit as observed in table 2.

It is a parameter of the weather measurements; its mean how hot or cold air is. Air temperature is measures in Celsius or Fahrenheit.

Air temperature change according to seasonal variation; however, global warming has made air temperature warmer throughout the world. The greenhouse gasses emission like CO₂ and CH₄ is the directly responsible for the rises of the world's average temperature. The result of the incising the temperature causes the melting of the freshwater glaciers and ice burgs at pole, this is leading to rising sea levels which is threatening the lives of people living in coastal areas.

Range:

- Cold (0 to 10c)
- Cooler (11 to 20c)
- Moderate (21 to 26c)
- Warm (27 to 40c)
- Hot (41 to 55c)

5.2 Noise (dB)

Noise generally is an unwanted or excessive sound that can have deleterious effects on human health & environmental quality. It has observed that in an urban area the noise is more compare to rural area. In this experiment we have observed that from Day-01 to Day- 02the noise level was same it may be due to less amount of plants. During the day-04 it has observed that the noise level varied by increasing the number of plants and vertical gardening materials. Unwanted or excessive sound that can have deleterious effects on human health and environmental quality. There are many sources of the noise like industry activity in work places, construction activity, and traffic at highways, airport and railways.

RANGE:

- Low (10-30dB)
- Moderate (30-60dB)
- High (60-90dB)

Table 3: Noise Test Result

Nois e (Db)	No. Of Plants	Tulsi palnt	Alovera plant	Money plant	Spider plan t
DAY 1	0	47	45	50	42
DAY 2	5	47	45	50	42
DAY 3	10	46	45	50	40
DAY 4	15	45	45	48	40

5.3 Air Pressure (mBar)

Table 4: Air Pressure Test Result

Air pressure (m bar)	No Of plants	Tulsi palnt	Alovera plant	Money plant	Spider plant
DAY 1	0	1002	927	909	947
DAY 2	5	1003	929	911	948
DAY 3	10	1005	929	914	949
DAY 4	15	1005	929	916	948

Air pressure atmospheric pressure or barometric pressure is the weight of air molecules pressing down on earth. The air pressure is more at the sea level & decreases as we move upwards with higher altitudes. Air pressure is constantly changing due to fluctuations in temperature, warm air causes air pressure to rise, cool temperature causes air pressure to drop and also due to plants transpiration process air pressure will varies

5.4 Humidity (RH)

To increase the humidity inside the building the best method is to growing plants even 1 or 2 plants in a room affect the humidity, but if we introduce more than 10 plants, humidity will increase. plants absorb water through their roots, and circulate the moisture through stem and leaves. water reaches leave, evaporates into air and increase indoor humidity. The gradual increase in humidity tells that as there is decrease in temperature and increase in number of plants day by day the humidity increases. Relative humidity is the measure of the

amount of the water vapor present in the air it measures either in relative terms (Relative humidity %RH) or absolute terms (dew point temperature c)

Table 5: Humidity Test Result

Humidit Y (RH)	No Of plants	Tulsi palnt	Alovera plant	Money plant	Spider plant
DAY 1	0	83	65	66	73
DAY 2	5	84	65	67	74
DAY 3	10	86	66	69	75
DAY 4	15	94	67	72	76

6. CONCLUSION

Vertical foresting is basically growing plants upwards on vertical surface, be it on the wall of a home or a large façade of a building. As a space is a constraint for many urban areas these days, having a vertical garden is certainly an option to still include some greenery in the house or building.

Vertical gardens can help reduce some of the impact that urbanization imposes on the environment and our quality life. In general, vertical gardens are promising methods to bring back greenery pushed away from urban areas. But the hour of the mark is to have cost effective and sustainable vertical garden using the latest innovations. From the result analysis it is found that increasing number of plants improves the indoor air quality. Indoor air quality will be less during night time compared to day time. The results also indicate that increasing number of plants decreases the noise, gradual increase in humidity, decrease in temperature inside the room

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