# Regulating the Room Temperature in Residential Buildings through Houseplants

Bhawana Asnani

*Assistant Professor, Polytechnic in Home Science, Junagadh Agricultural University, Amreli, Gujarat, India*

***Abstract:*** **Plants are natural sinks of carbon dioxide, it results into the reduction of air temperature. The vegetation is like "air-conditioner" that evaporates water and cools the surrounding. In order to reduce the room temperature and ultimately improving the indoor environmental status, the study was done with the 2 objectives, like to compare the utilization of foliage and succulent houseplants in decreasing the room temperature and to study the impact of houseplants in reducing the room temperature with different variations in the residences. *Experimental research design* was used in the 10 west facing RHB constructed houses along with the National Highway- 8 of polluted zone, in Udaipur. Four parameters, viz., Variation in houseplants, Placement of houseplants, Variation in days and Variation in habits were selected to be precised. Arithmatic Mean, paired t-test and ANOVA test for statistical analysis were used as per data observed. 4 in 1 Environment Tester was used to measure the temperatures for the study. Under the condition of keeping four succulent plants in drawing room with opened windows have shown that the average room temperature was decreased from 31.61°C to 23.11°C which means a fall in temperature. Further, all the statistical values of impact of houseplants among all the parameters further justifies the credibility of houseplants, hence, enhance the Indoor Air Quality (IAQ).**

***Keywords:*** **Houseplants, Room Temperature, IAQ.**

## I. INTRODUCTION

Indoor plants connect the human beings to nature. People, who feel connected to nature, feel happier. Indoor plants make them feel cooler on hot days, especially when they move softly in the breeze from a ceiling fan[1]. Plants are like lungs of the planet. As the plants are natural sinks of carbon dioxide, it results into the reduction of air temperature. Simultaneously, plants maintain the required relative humidity level by transpiring water vapours into the air. The leaves of the plants moves with the air movement, which increases the air flow rate. Thus, these factors in combination ultimately help in decreasing the air temperature[2].

Plants can reduce air temperature by blocking sunlight. Further cooling occurs when water evaporates from the leaf surface. The conversion of water to air vapor - a chemical process- removes heat energy from the air. They can be a natural air conditioner. The evaporation from a plant can produce the cooling effect[3].

The vegetation is like "air-conditioner" that evaporates water and cools the surrounding. But as the plant die, that cooling function disappears. It has the potential to speed global warming worldwide. It was found that plants cool the surroundings by the process called transpiration, which, according to the U.S. Department of Agriculture, decreases air temperature by ten degrees. As per the International Society of Arboriculture, the net cooling effect of young healthy plant is equivalent to room size air conditioner operating 20 hours a day. Proper selection and placement of plant materials can lower heating and cooling costs by as much as 20%. This enthusiastically endorses the use of indoor plants[5].

Houseplants reduce temperatures by using sunlight for photosynthesis, converting the solar energy (heat) into food and life-giving oxygen, and also by evapo-transpiration to cool themselves and the surrounding air. A single healthy plant can transpire up to several gallons of water a day, producing the cooling effect[6].

Most of the researches have been conducted in foreign countries that to in the glass chambers with controlled conditions. So this had been conducted to find out the impact of houseplants on IAQ in the Indian context with day to day routine, without any control on surroundings. Furthermore, in order to reduce the room temperature and ultimately improving the indoor environmental status, following are the objectives:

1) To compare the utilization of foliage and succulent houseplants in decreasing the room temperature.
2) To study the impact of houseplants in reducing the room temperature with different variations in the residences.

## II. MATERIALS AND METHODS

### *A. Research Design:*

To achieve the planned objectives the present study was carried out by using *Experimental research design.* The zone selected as sample for the purpose of the present study falls under the polluted zone as per the U.I.T, Udaipur. In this polluted zone, there were 15 west facing houses along with the National Highway- 8 in Udaipur. These houses were constructed by Rajasthan Housing Board (RHB). Out of these 15 houses, 10 houses were selected purposively for conducting all the experiments. The drawing and living/dining rooms of the ten residences selected as sample were purposively utilized for conducting all the experiments.

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In order to be precise in measuring the impact of houseplants on room temperature in residences considering the following **4 parameters**, viz., Variation in houseplants, Placement of houseplants, Variation in days and Variation in habits

- *Variation in houseplants*: The two most common types of houseplants, i.e., foliage and succulent plants had been purposively selected. The varieties of these two types of houseplants are as under:

*Type 1: Foliage Plants*- Leafy plants grown for their broad, green/ coloured leaves. Varieties of foliage houseplants selected for the experiment were: Alocasia (*Alocasia indica*), Syngonium (*Syngonium podophyllum*), Money-plant (*Scindapsus arboricola*), Dumb cane (*Dieffenbachia amoena*).




*Type 2: Succulents*- Evergreen attractive plants with fleshy leaves. Varieties of succulents selected for the research were: Kalanchoe *(Klanchoe pinnata*), Mother in-law's tongue (*Sansevieria trifasciata 'Laurentii'*), Devil's backbone *(Pedilanthus tithyloides*), Boat Lily (*Rhoeo spathacea*).




- *Placement of houseplants:* Potted houseplants were placed in the following manner:
  - Single potted plant in one suitable corner of the room,
  - Two single potted plants in two suitable corners of the room,
  - Four single potted plants in four corners of the room.

- *Variation in days:* The time required for conducting each experiment was 3 days.

*Day 1 (Pre test)* - Before placing the houseplants, to find out the existing status of Room temperatures.

*Day 2 (Post test)* - Keeping the selected number of houseplants in selected rooms in the residences to judge the impact of houseplants on Room temperatures.

*Day 3 (Post test for retention)* – After removal of houseplants to identify the retention of changed Room temperatures, if any.

- *Variation in habits:* People generally live with the following practices in their houses, so the same practices were included in the variations for conducting the experiments: **1.)** Opened and closed windows, **2.)** Fan in ON and OFF mode.

*B. Conducting the experiments:*

To measure the room temperature in selected residential buildings the equipment "4 in 1 Environment Tester" was used. This equipment records four measure, viz., temperature, relative humidity, air flow rate and intensity of light at a time.

**4 in 1 Environment Tester**

To avoid ambiguity in data collection the following measures were taken:

- ❖ The experiments were conducted in the month of April and May, when the atmospheric ambient temperature was maximum.
- ❖ The ambient temperature each day for the complete duration of the experiments were collected from the data recorded by the office of the daily newspaper, Rajasthan Patrika, published in Udaipur. This measure was taken to help the researcher in avoiding day to day environmental changes, if any in the temperature and indoor readings of temperatures were calculated accordingly.
- ❖ All the readings were taken on day 1, day 2 and day 3 at 3:00 PM.

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- On day 2 houseplants were kept at 10:00 AM.
- On day 3 houseplants were removed at 10:00 AM. Thus the duration of keeping houseplant/s was 24 hours.
- The data was collected with performance of daily routine activities such as normal living conditions, dusting, brooming and mopping and other miscellaneous activities.

*C. Analysis of Data*

1. To study the role of houseplants in improving the indoor environmental status Arithmatic Mean was calculated.
2. To study the impact of houseplants on the indoor environmental status paired t-test was applied.
3. To analyze the role of different attributes of houseplants in judging the various parameters of the environmental status ANOVA test was used.

## III. Results & Discussion

Room Temperature measurement is often collected as part of an IAQ investigation because this parameter affects the perception of comfort in an indoor environment. This parameter of thermal comfort is related to one's metabolic heat production, the transfer of heat to the environment, physiological adjustments and body temperature. The ideal room temperature for human beings recommended by ASHARE (*American Society of Heating, Air conditioning and Refrigeration Engineers, U.S.*) ranges between 22° C- 24° C.[4]

It can be observed from the data presented in tables 1 and 2 that the use of houseplants in residential buildings have shown a greater impact in improving the IAQ with special reference to regulating room temperature by creating thermal comfort. The tables 1 and 2 shows the comparative mean differences in room temperature prevailing during the time of experiments under various parameters selected for the study to judge the impact of houseplants. All the selected areas had an average room temperature ranging between minimum 22.59°C to maximum 33.47°C during the experiment period irrespective of various parameters. To be more specific about impact of houseplants on IAQ with special reference to room temperature with different parameters, the discussion has been presented under the following heads:

*A. Impact of Types of Houseplants on Room Temperature*

- *Foliage v/s Succulent plants:*

Among the parameters selected first was to judge the difference between the selected foliage and succulent houseplants and their impact on IAQ with special reference to room temperature. It is apparent from the data presented in tables 1 and 2 that the succulent plants were found to be more effective under all the selected variations, as compared to the foliage plants. Under the condition of keeping four succulent plants in drawing room with opened windows have shown that the average room temperature decreased from 31.61°C to 23.11°C which means a fall in temperature was recorded to be 8.50° C. Whereas, on comparison with four foliage plants under the same condition there was a difference in room temperature from 29.10°C to 22.59°C resulting into a fall in average room temperature up to 6.51°C. The room temperature recorded during the experimentation after keeping houseplants found to be much closer to the ideal range of room temperature (22°C- 24°C). On the contrary, the minimum declination in room temperature was 2.69°C between day one (without any houseplant) and day 2 (after keeping houseplant/s) by keeping only one succulent houseplant in dining/ living room with fan OFF condition.

Likewise, it can also be extrapolated that after removal of houseplant on day three (after removal of houseplant/s), the room temperature started rising (from 23.11°C- 30.20°C) and was reaching almost similar to the average room temperature recorded on day 1, i.e., without keeping any houseplant in the room. Thus, it further emphasizes that the presence of houseplants help in maintaining the ideal range of room temperature for comfort.

Though the foliage plants also helped in regulating the room temperature as per the standards for thermal comfort but the performance was observed to be more significant in case of succulent plants. Overall, it can be concluded that one, two or four succulent plants were more efficient as compared to foliage plants to regulate the room temperature.

*B. Impact of Number and Placements of Houseplants on Room Temperature*

The second parameter selected was to find out the impact on average room temperature according to the variation in number and placements of houseplants. The average mean difference in declining the room temperature increased as the number of houseplants augmented, in both types of plants. The one succulent plant, in drawing room with fan ON condition, was helpful in decreasing the room temperature with a fall of 3.90°C (30.53°C to 26.63°C). While seeing towards the two or four succulent houseplants under the same conditions there was a fall in room temperature of 5.14°C and 6.24°C, respectively. The same pattern was visible in fall of room temperature in all the experiments with the selected parameters can be visualized. Thus, it can be analyzed that increment in number of plants for keeping indoors can be decided as per the room size. Spacious rooms may require a large number of plants for better IAQ. Hence, number of plants can be increased to improve IES by regulating the room temperature.

*C. Impact of Houseplants on Room temperature with Variation in Days*

It is noticeable in tables 1 and 2 that the average room temperature in all the conditions was found to be higher when no houseplant/s were kept on day one as compared to average room temperature with houseplant/s on day two. Similarly when houseplant/s were removed on day three the

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average room temperature consequently started rising and reached almost equivalent to day one. The difference in mean room temperature can easily be seen in any of the combination of parameters between day one and day two, and day two and day three to judge the impact of houseplants in reducing the room temperature. The room temperature decreased from day one's temperature 28.81°C to 22.60°C with a fall of 6.21°C after placing the two foliage plants in drawing room on day two. Room temperature of day three came back to average mean room temperature of day one after removing the plants. So there was an increment of 5.00°C in room temperature was observed from 22.60°C to 27.50°C.

*D. Impact of Houseplants on Room Temperature with Variation in habits*

Perusal of tables 1 and 2 clearly reveals that the people tend to keep the windows opened or closed and fan ON and OFF position. All the experiments were done to find out the impact of houseplants on IES, especially with room temperature, with these habits, so that people can keep the plants indoors accordingly.

❖ *Opened windows v/s Closed windows:* It can be alleged from the horizontal average total of tables 1 and 2 that both types of houseplants helped in maintaining the thermal comfort in both the habits. Further succulents' performance was better in declining the room temperature in both the situations, i.e., 6.69°C (from 32.52°C to 25.83°C) and 7.85°C (from 31.60°C to 23.75°C), respectively as compared to foliage plants with 6.18°C and 7.36°C in opened and closed windows, respectively.

❖ *Fan ON v/s Fan OFF condition:* It was observed in tables 1 and 2 that houseplants again performed well in regulating the room temperature in both the situations. Further, four succulent plants' performance in dining / living room was better with a reduction of 7.08°C in comparison to four foliage plants with a reduction of 6.07°C in the fan OFF situation. On the other hand, the four foliage plants were able to reduce average room temperature up to 7.10°C as compared to four succulent plants with the ability to reduce average room temperature up to 6.13°C in fan ON condition. So, it can be concluded that to make the indoor surroundings comfortable, people can try the combinations of houseplants with variation in their habits by considering the above results.

*E. Impact of Houseplants on Room Temperature in selected Rooms of residences*

It is clear from the tables 1 and 2 that houseplants regulated the room temperature equally, in both the selected rooms (viz. drawing room and dining/living room). There was no noticeable difference observed. Whatsoever differences were observed they were because of variations in constructional features.

*F. Statistical Analysis of Data*

❖ Table 3 highlights the differences in Analysis of Variance (ANOVA) values of impact of houseplants among all the parameters further justifies the credibility of houseplants.

❖ Table 4 indicates the paired- t values to find out the day wise impact of houseplants in regulating the room temperature. It may be seen that a highly significant difference at 1% level of significance in judging the effectiveness of houseplants with respect to all the selected parameters.

## IV. Summary & Conclusion

A study supported the results that plants are like lungs of the planet. They breathe-in carbon dioxide and breathe-out oxygen. Carbon dioxide is one of the major contributing element to green house effect. Plants trap carbon dioxide from the atmosphere and make carbohydrates that are used for plant growth. They give oxygen in return. As the plants are natural sinks of carbon dioxide, it results into the reduction of air temperature. Simultaneously, plants maintain the required RH level by transpiring water vapours into the air. The leaves of the plants moves with the air movement, which increases the air flow rate. These factors in combination ultimately help in decreasing the air temperature. Hence, it is extrapolated that houseplants have a significant role in maintaining the thermal comfort by regulating the room temperature inside the residential buildings and help in improving the IAQ [4].

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TABLE I

COMPARATIVE MEAN ROOM TEMPERATURE (IN ° C) IN SELECTED ROOMS ACCORDING TO HABITS AND NUMBER OF FOLIAGE PLANTS

| **Type of houseplants** | **Foliage houseplants** | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Number of houseplants** | **One Foliage Plant** | | | | | | **Two Foliage Plants** | | | | | | **Four Foliage Plants** | | | | | |
| **Rooms** | **Drawing Room** | | | **Dining/ Living Room** | | | **Drawing Room** | | | **Dining/ Living Room** | | | **Drawing Room** | | | **Dining/ Living Room** | | |
| **Days** | **1** | **2** | **3** | **1** | **2** | **3** | **1** | **2** | **3** | **1** | **2** | **3** | **1** | **2** | **3** | **1** | **2** | **3** |
| **Habits** | | | | | | | | | | | | | | | | | | |
| Opened Windows | 29.14 | 26.31 ↓2.83 | 28.82 ↑2.51 | 29.16 | 24.51 ↓4.65 | 28.73 ↑4.22 | 28.81 | 22.60 ↓6.21 | 27.50 ↑5.00 | 29.20 | 23.68 ↓5.52 | 28.79 ↑5.11 | 29.10 | 22.59 ↓6.51 | 27.81 ↑5.22 | 29.11 | 23.00 ↓6.18 | 28.82 ↑2.51 |
| Closed Windows | 31.11 | 26.40 ↓4.71 | 29.63 ↑3.23 | 32.66 | 26.99 ↓5.67 | 30.95 ↑3.96 | 31.11 | 25.72 ↓5.39 | 30.14 ↑4.42 | 32.68 | 25.92 ↓6.76 | 31.05 ↑5.13 | 32.68 | 25.85 ↓6.83 | 30.90 ↑5.05 | 31.35 | 23.99 ↓7.36 | 29.63 ↑5.64 |
| Fan "ON" | 29.08 | 24.36 ↓4.72 | 28.67 ↑4.31 | 29.08 | 23.76 ↓5.32 | 28.67 ↑4.91 | 28.62 | 24.70 ↓3.92 | 28.04 ↑3.34 | 28.94 | 22.66 ↓6.28 | 27.41 ↑4.75 | 28.59 | 24.00 ↓4.59 | 27.87 ↑3.87 | 30.10 | 23.00 ↓7.10 | 28.84 ↑5.84 |
| Fan "OFF" | 29.14 | 25.91 ↓3.23 | 28.82 ↑2.91 | 29.20 | 26.28 ↓2.92 | 28.79 ↑2.51 | 29.10 | 23.60 ↓5.50 | 27.31 ↑3.71 | 29.16 | 24.86 ↓4.30 | 28.73 ↑3.87 | 29.71 | 22.59 ↓7.12 | 27.64 ↑4.95 | 28.91 | 22.84 ↓6.07 | 27.63 ↑4.79 |

TABLE II

COMPARATIVE MEAN ROOM TEMPERATURE (IN ° C) IN SELECTED ROOMS ACCORDING TO HABITS AND NUMBER OF SUCCULENT PLANTS

| **Type of houseplants** | **Succulent houseplants** | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Number of houseplants** | **One Succulent Plant** | | | | | | **Two Succulent Plants** | | | | | | **Four Succulent Plants** | | | | | |
| **Rooms** | **Drawing Room** | | | **Dining/ Living Room** | | | **Drawing Room** | | | **Dining/ Living Room** | | | **Drawing Room** | | | **Dining/ Living Room** | | |
| **Days** | **1** | **2** | **3** | **1** | **2** | **3** | **1** | **2** | **3** | **1** | **2** | **3** | **1** | **2** | **3** | **1** | **2** | **3** |
| **Habits** | | | | | | | | | | | | | | | | | | |
| Opened Windows | 32.52 | 27.70 ↓4.82 | 30.42 ↑2.72 | 31.55 | 27.16 ↓4.39 | 30.06 ↑2.90 | 33.45 | 27.64 ↓5.81 | 32.27 ↑4.63 | 31.51 | 25.67 ↓5.84 | 29.26 ↑3.59 | 31.61 | 23.11 ↓8.50 | 30.20 ↑7.09 | 32.52 | 25.83 ↓6.69 | 31.26 ↑5.43 |
| Closed Windows | 32.30 | 27.54 ↓4.76 | 31.40 ↑3.86 | 32.30 | 27.83 ↓4.47 | 31.33 ↑3.50 | 30.34 | 24.74 ↓5.60 | 29.83 ↑5.09 | 31.02 | 24.92 ↓6.10 | 30.35 ↑5.43 | 31.35 | 23.00 ↓8.35 | 30.65 ↑7.65 | 31.60 | 23.75 ↓7.85 | 30.61 ↑6.86 |
| Fan "ON" | 30.53 | 26.63 ↓3.90 | 29.61 ↑2.98 | 30.66 | 26.82 ↓3.84 | 29.66 ↑2.84 | 31.56 | 26.42 ↓5.14 | 30.20 ↑3.78 | 32.64 | 27.40 ↓5.24 | 30.89 ↑3.49 | 30.04 | 23.80 ↓6.24 | 28.54 ↑4.74 | 30.60 | 24.47 ↓6.13 | 29.59 ↑5.12 |
| Fan "OFF" | 31.07 | 25.94 ↓5.13 | 30.32 ↑4.38 | 31.45 | 28.76 ↓2.69 | 30.06 ↑1.30 | 33.47 | 26.72 ↓6.75 | 32.40 ↑5.68 | 31.56 | 25.67 ↓5.89 | 29.32 ↑3.65 | 32.52 | 24.56 ↓7.96 | 31.26 ↑6.70 | 32.52 | 25.44 ↓7.08 | 31.26 ↑5.82 |

**Days-** Day 1- Existing Room Temperature without any Houseplant.
Day 2- Room Temperature after keeping the Houseplant/s.
Day 3- Room Temperature after removal the Houseplant/s.

**Arrows-**
↓- denotes decrease in Room temperature (Temp. of Day 2 was subtracted from the temp. of Day 1).
↑- denotes increase in Room temperature (Temp. of Day 3 was subtracted from the temp. of Day 2).

TABLE III

ANOVA VALUES OF ROOM TEMPERATURE (IN ° C) IN SELECTED ROOMS ACCORDING TO HABITS AND NUMBER OF HOUSEPLANTS

| Type of Houseplants | Foliage Houseplants | | | | | |
|---|---|---|---|---|---|---|
| No. of Houseplants | One Foliage Plant | | Two Foliage Plants | | Four Foliage Plants | |
| Rooms | Drawing Room | Dining/ Living Room | Drawing Room | Dining/ Living Room | Drawing Room | Dining/ Living Room |
| Habits | | | | | | |
| Opened windows | 15. 91* | 32. 05* | 49. 26* | 51. 97* | 161.65* | 34.77* |
| Closed windows | 35. 53* | 37. 51* | 39. 16* | 59. 08* | 50.60* | 67.01* |
| Fan ON | 46. 71* | 64. 38* | 37. 62* | 103. 43* | 33.41* | 168.44* |
| Fan OFF | 32. 01* | 25. 61* | 132. 04* | 43.38* | 66.75* | 46.98* |
| Type of | Succulent Houseplants | | | | | |

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| Houseplants | | | | | | |
|---|---|---|---|---|---|---|
| No. of Houseplants | One Succulent Plant | | Two Succulent Plants | | Four Succulent Plants | |
| Rooms | Drawing Room | Dining/ Living Room | Drawing Room | Dining/ Living Room | Drawing Room | Dining/ Living Room |
| Habits<br>Opened windows | 25.67* | 29.92* | 52.01* | 46.90* | 90.05* | 34.66* |
| Closed windows | 35.94* | 31.23* | 53.87* | 36.68* | 127.92* | 64.28* |
| Fan ON | 30.09* | 54.32* | 27.76* | 40.05* | 29.10* | 63.32* |
| Fan OFF | 35.15* | 19.59* | 54.57* | 47.93* | 53.03* | 43.67* |

* Significant at 5 % Level of Significance.

TABLE IV

PAIRED- T VALUES OF ROOM TEMPERATURE (IN ° C) IN SELECTED ROOMS ACCORDING TO HABITS AND NUMBER OF HOUSEPLANTS

| Type of Houseplants | Foliage plants | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number of Houseplants | One Foliage Plant | | | | Two Foliage Plants | | | | Four Foliage Plants | | | |
| Rooms | Drawing Room | | Dining/ Living Room | | Drawing Room | | Dining/ Living Room | | Drawing Room | | Dining/ Living Room | |
| Days | $D_1$-$D_2$ | $D_2$-$D_3$ | $D_1$-$D_2$ | $D_2$-$D_3$ | $D_1$-$D_2$ | $D_2$-$D_3$ | $D_1$-$D_2$ | $D_2$-$D_3$ | $D_1$-$D_2$ | $D_2$-$D_3$ | $D_1$-$D_2$ | $D_2$-$D_3$ |
| Habits<br>Opened Windows | 12.52** | 12.07** | 13.64** | 13.31** | 13.50** | 10.64** | 13.27** | 13.10** | 15.30** | 12.99** | 20.92** | 7.56** |
| Closed Windows | 12.08** | 8.20** | 12.97** | 7.82** | 15.62** | 13.00** | 20.35** | 12.40** | 13.05** | 7.31** | 11.93** | 12.37** |
| Fan "ON" | 17.55** | 15.56** | 18.03** | 18.67** | 20.42** | 17.58** | 29.07** | 16.38** | 7.67** | 8.32** | 34.13** | 24.85** |
| Fan "OFF" | 15.45** | 15.40** | 9.87** | 9.30** | 16.77** | 8.63** | 15.36** | 16.54** | 12.97** | 8.24** | 15.64** | 10.81** |
| Type of houseplants | Succulent plants | | | | | | | | | | | |
| Number of Houseplants | One Succulent Plant | | | | Two Succulent Plants | | | | Four Succulent Plants | | | |
| Rooms | Drawing Room | | Dining/ Living Room | | Drawing Room | | Dining/ Living Room | | Drawing Room | | Dining/ Living Room | |
| Days | $D_1$-$D_2$ | $D_2$-$D_3$ | $D_1$-$D_2$ | $D_2$-$D_3$ | $D_1$-$D_2$ | $D_2$-$D_3$ | $D_1$-$D_2$ | $D_2$-$D_3$ | $D_1$-$D_2$ | $D_2$-$D_3$ | $D_1$-$D_2$ | $D_2$-$D_3$ |
| Habits<br>Opened Windows | 33.90** | 13.67** | 20.51** | 13.55** | 19.89** | 14.84** | 19.86** | 9.97** | 46.70** | 17.42** | 13.22** | 4.38** |
| Closed Windows | 15.35** | 14.40** | 11.67** | 9.59** | 16.20** | 15.71** | 12.07** | 7.96** | 22.51** | 20.29** | 16.77** | 11.34** |
| Fan "ON" | 12.00** | 9.77** | 11.74** | 12.24** | 11.68** | 6.81** | 9.79** | 6.78** | 16.00** | 7.25** | 13.36** | 10.18** |
| Fan "OFF" | 11.79** | 11.29** | 21.01** | 8.23** | 16.87** | 14.02** | 20.31** | 10.14** | 20.20** | 7.47** | 28.89** | 6.44** |

** Significant at 1 % Level of Significance.

$D_1$-$D_2$ – Difference in Room temperature between day 1 and day 2. $D_2$-$D_3$ – Difference in Room temperature between day 2 and day 3.

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