Evaluation of Microclimate for Cucumber Production under Polyhouse

Abstract

Polyhouse is the most practical method of achieving the objectives of protected agriculture, where the natural environment is modified by using sound engineering principles to achieve optimum plant growth and yields. The main reason for applying micro climate control in polyhouse is to create optimal growing environment. Because of its complexity, excessive control in polyhouse can adversely affect the growing crops. Moreover, there is a need to develop an optimal ambiental control to approach these complicated objectives, including low emissions and reduced production cost. It can describe one practical approach to the real time control system in a poly house. Control system considers internal and external ambient factors related to the regulation process. Microclimate of polyhouse is important for better plant growth and greater yield.Cucumber is one of the popular vegetable crops grown broadly throughout the world. Cucumber is a thermophilic and frost susceptible crop, growing best at a temperature above 20°C. Cucumber crop grows successfully under conditions of high light, high humidity, high soil moisture, temperature and fertilizers in polyhouse.A methodological approach of monitoring the microclimate persisted in the naturally ventilated polyhouse using the gadgets like Digital hygrometer, Lux meter etc., at three times a day i.e. 8.30 Am, 12.30 Pm and 4.30 Pm respectively.Air temperature variation in the polyhouse revealed the fact that the inside temperature (36.3℃) is less than compared to outside temperature (40.8℃) by lowering nearly 4℃ due to ample ventilation added to this, maintaining foggers in the polyhouse reduced the temperature further.

Key words: Poly house, Temperature, Relative Humidity, Light intensity, Cucumber

1. Introduction

Cucumber (Cucumis sativus L.) is one of thepopular vegetable crops grown broadlythroughout the world (Soleimani et al., 2009). This crop is from Cucurbitaceace family and having a chromosome number 2n = 14. Cucumber is native of south Asia, specifically warm and humid climate of the Himalaya in North West India and probably Northern Africa. It gives best response under high temperature, humidity and light intensity with sufficient supply of water and nutrients(El-Aidy et al., 2007). In India cultivation of

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cucumber is noted at least 3000 years ago and during 100 B.C. in China(Robinson et al., 1997).

The immature fruit of cucumber is used as salad and for making pickles, paharirayataand brined on commercial scale(Bairagi et al.,2013). The fruit contains around 93- 95% water and it delivers sodium, magnesium vitamins, potassium, sulphur, silicon, fluorides etc. in a good amount. The mineral which present and make it alkaline represents 64.05 % and acid creating material is about 35.95%. These are helpful to make it maintaining the human blood alkalinity.Cucumber is aprimary source of vitamins and minerals for humanbody (Keopraparl, 1997). Cucumber contains carbohydrates 2.6 gm, protein 0.6 gm, calcium 18 mg, thiamin 0.02 mg, energy 12 cal, riboflavin 0.02 mg, Iron 0.2 mg, C vitamin 10 mg, and niacin 0.01 mg in each 100 g edible portion(Rashid 1999). Cucumber is a good source of calcium, potassium, magnesium and folate also. It also provides silica, which helps to give strength and connecting tissue and helps to relief from joint pain. Cucumber also contains secoisolariciresinol, lignans, lariciresinol and pinoresinol, which are helpful to reduce risk of different kinds of cancer.

In India protected cultivation area is around 30000 ha which contribute 0.23% of horticulture cropped area (Shweta et al., 2014). Cucumber is a semi-tropical vegetable and grows best under polyhouse condition. In polyhouse under stable environmental, with favourable conditions and optimum nutrients, less pest-disease infestation, the cucumber plant grows speedily and produces greatly. The optimum temperature for better development of fruits is 14-200°C. Cucumber requires mild climate (Mishra et al., 2010) and it does well under polyhouse condition.

The total area of cucumber, growing in India is 78,000 hectares with an annual production of 11.42 lakh MT (National Horticulture Board 2016-17). Around 2.7 mha under protected cultivation in Chinawhich make largest in world. (Janapriya et al.,2010). Now-a-days, polyhouse is most effective against adverse climatic conditions (Bisht et al., 2011). Vegetable production under polyhouse by using advanced technology to make control over the environment increased crop productivity per unit area and produced the quality of vegetables (Singh 2005) and (Pozderec et al.,2010). It further, protects the crops from adverse conditions like extra solar radiation, high temperature, rain, pest and disease(Tiwari, 2006).Improves the productivity and quality of the vegetables(Kohli et al., 2007).It also helps to increase photosynthetic rate which results in increased productivity and improved quality of food

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under better management (Rawat et al., 2014). The protected cultivation of cucumber presents a lot of opportunity in term of better economic gain in shorter span of cropping period (Varsha et al., 2016).

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2. Materials and Methods

Evaluation of microclimate for cucumber production under polyhouse was conducted at College of Agricultural Engineering Sangareddy in year of 2019. The college is located at 15^0N latitude and 78^0 E longitudes. Cucumber cultivation was done in 441 m^2 area under saw tooth type ploy house.The environmental factors that are temperature, relative humidity and light intensity are noted inside and outside of polyhouse.

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2.1 Light intensity

The growth of plants is controlled by three light (photo) process, namely photosynthesis, photo morphogenesis and photoperiodism. Light intensity in polyhouse measured with sinometer lux meter LX330B. Lux meter is used for checking the level of light falling on a surface.

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2.1.1 Operation

Press the power key to turn on the meter. Remove the photo detector cap and face it to light source n a horizontal position, the reading aretaken at centre of polyhouse. Read the luminance nominal on display, it displays one in the MSD, and a higher range should be selected. Press the hold key to select hold mode, when hold mode selected, the illuminance meter stops all further measurements. To press the hold key again to cancel hold mode then it resume normal position. Press the peak key to select the peak mode for stop the further measurements in lux meter. When the measurement is completed, replace the photo detector cap and turn the power selector off shown in fig. 1

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2.1.2 Specifications Lux meter

Table 1 : Specifications of Lux meter

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circuit	custom one -chip of microprocessor LSI circuit

Display	LCD size :52*38 mm dual function LCD display
Measuring	Co_2 (carbon dioxide). temperature
Response time	CO_2: < 2 minutes Reach the 63% reading value Depend the environment air circulation.
CO_2Altitude (height) value setting	0 to 9000 meters.
Temperature compensation	Automatic temperature compensation
Operating temperature	0 to 50 °C.
Operating humidity	Less than 85 % R.H
Power supply	DC 1.5 V battery (UM3, AA) × 6PCs or equivalent.
Power current	CO_2 measurement Approx. DC 9.6 mA for 90% period Approx. DC 128 mA for 10% period

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Fig 1.Lux meter

2.2 Temperature and Relative humidity

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Temperature and relative humidity has a direct impact on the physiological development phases like germination, flowering and development of the plant growth. The favourable temperature and relative humidity for cucumber crop is 40oc and 50-60%. These temperature and relative humidity were measured with a make hygrometer.

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2.2.1 Operation method

The hygrometer used has measurement range of temperature and relative humidity is -50 to + 70°C and 10-99%. Initially switch clock and alarm clock display mode set the current time, alarm clock, 12 or 24 hours a day date. In the current clock time mode, switch display for the alarm clock. Hygrometer placed at centre of the poly house shown in fig. 2.

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2.2.2 Specification of hygrometer:

1. Temperature measurement range: -50°C to +70°C (-58°F to 158°F)
2. Temperature measurement precision: ± 1 °C (1.8 °F)
3. Temperature resolution: 0.1°C (0.2°F)
4. Humidity measurement range: 10 % to 99 %
5. Humidity measurement precision: ± 5 %
6. Humidity resolution: 1%
7. Battery: AAA 1.5 V
8. Storage condition: - 10°C to 50°C (20 to 80% RH)

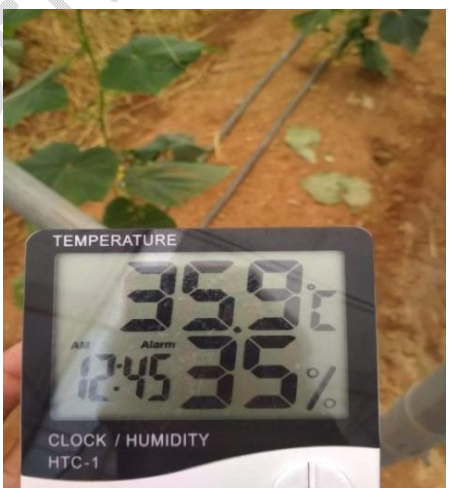

Fig2.Hygrometer

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3. Results and Discussion

In semi-arid tropical climate of Telangana, importance of the polyhouse, is growing very fast because of the existence of favorable climate, resulting in high economic returns.The experiment was conducted in 441 m^2 area of saw tooth type polyhouse. A set of observation on micro climate parameters such as temperature, relative humidity and light intensity in the polyhouse at 3 times of the day i.e. at 8:30 Am, 12:30 Pm, and 4 Pm were analyzed and recorded during the entire crop growth period. Variation in the temperature relative humidity and light intensity changes where graphically represented below.

1.Variations of air temperature in the poly house ranging from 34°C to 37°C ,30°C to 33°C and 32°C to 35°C respectively throughout the season which is favourable for cucumber growth.

2. The observed variations in relative humidity in the poly house 23% to 24 %(inside polyhouse) and 20% to 22% (outside poly house) reveal to higher in case of poly house as compared to especially in the afternoon time inside poly house is high humidity.

3. Light intensity levels varies significantly in the poly house 241k lux to 261k lux

3.1 Temperature variation

The temperature variation in polyhouse was measured with suitable digital hygrometer. The daily variation of temperature monitored three times daily that is 08:30Am, 12:30Pm and 04:00Pm during the experimental period is presented below in subheadings.

3.1.1 Variation in temperature at 08:30 Am:

The weekly variation air temperatures inside and outside of polyhouse and ambient condition at 08:30Am varied from 32.1to 32.5℃ and 38.5to 40.5℃

3.1.2 Variation in temperature at 12:30 Pm:

The mean weekly variation of air temperature inside and outside of polyhouse and ambient conditions at 12:30 Pm varied from 37 to 40℃ and 38.5 to 41.6℃ respectively during the April to May.

3.1.3 Variation in temperature at 4:00 Pm:

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From April to May the mean weekly variation of air temperature inside and outside of polyhouse and ambient condition at 4.00Pm varied from 37.1 to 39.1℃ and 37.2 to 40.1℃ respectively.

From the result of air temperature variation during different times of day, it can be inferred that, on an average, polyhouse maintained lowest temperature followed by outside temperature and ambient condition during the crop growth period.

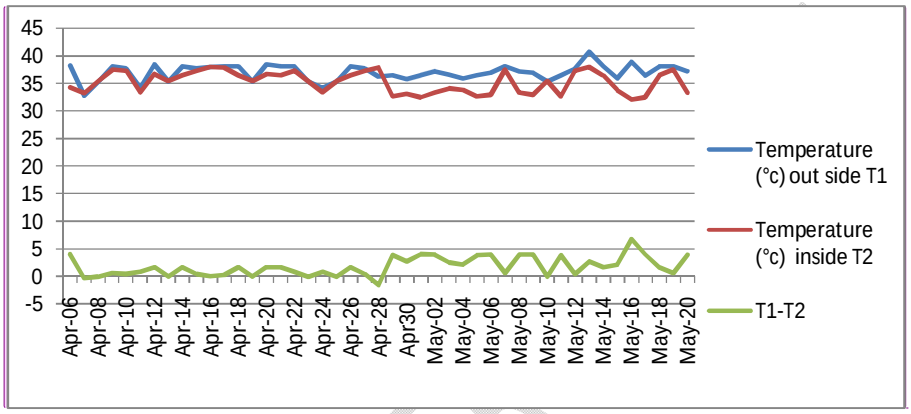

Fig.3. Variation of temperature inside and outside of polyhouse at 08:30 Am

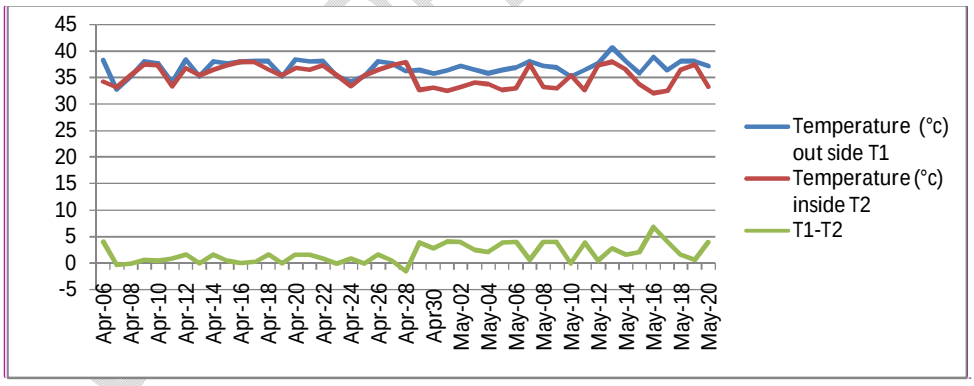

Fig 4. Variation of temperature inside and outside of polyhouse at 12:30 Pm

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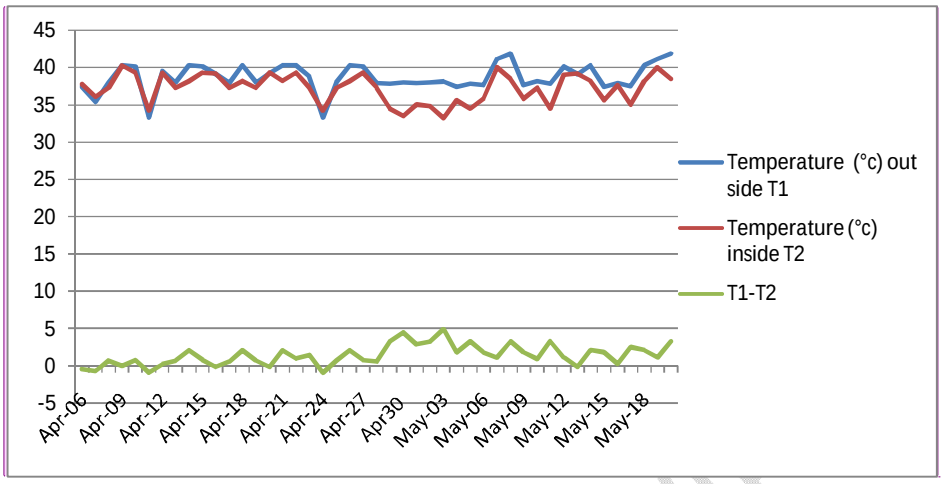

Fig 5. Variation of temperature inside and outside of polyhouse at 04:30 Pm

3.2 Relative humidity variation

Relative humidity was measure with suitable digital hygrometer. If the water vapour content stays the same and the temperature drops, the relative humidity increases. If the water vapour content stays the same and the temperature rises, the relative humidity decreases. The daily variation of relative humidity monitored three times daily that is 08:30Am, 12:30Pm and 04:00 Pm during the experimental period is presented below in subheadings.

3.2.1 Variation in relative humidity at 8:30 Am:

Weekly variation of relative humidity in polyhouse ranged between 22 to 30 % during the experimental period, against the outside 20 to 28%. The difference of humidity in the polyhouse and ambient condition ranged from 2 to 10%. On an average, the relative humidity in polyhouse found high especially during the represented timings of the day, more so at 8:30 am in the morning.

3.2.2 Variation in relative humidity at 12:30 Pm:

The relative humidity in the polyhouse at 12:30 Pm varied from 22 to 28% throughout the experimental period against the outside relative humidity 21 to 26% with an average difference between the polyhouse and outside conditions of 1 to 7%.The temperature are recorded high during the afternoon, as a result the relative humidity was observed low.

3.2.3 Variation in relative humidity at 4:00 Pm:

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The weekly relative humidity in the polyhouse at 4 Pm varied from 21 to 26% and outside 21 to 27% with average difference between 1 to 7% between the polyhouse and outside condition. The relative humidity always found high in polyhouse than that of outside micro climatic condition during different times of day, especially in the morning and evening times.

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The variation of relative humidity in the polyhouse may be due to decrease in the internal temperature. Higher humidity was observed in the polyhouse in morning hours and gradually increased in the afternoon hours. Moreover, relative humidity in inside the polyhouse was found in the early morning hours. The possible reason for this might be the polyhouse was occupied with lush vegetation and plants were well watered and thereby the ground surface inside the polyhouse was always wet. During the night, certain quantum of water in the soil gets evaporated. Since polyhouse was covered with ultra violet stabilized sheet and also due to absence of solar radiation, the escape of water vapour from the polyhouse to outside was comparatively less during night. Besides, at early morning, when sun starts shining, there will be more transpiration from the leaves. Both these factors together caused higher relative humidity inside the polyhouse.

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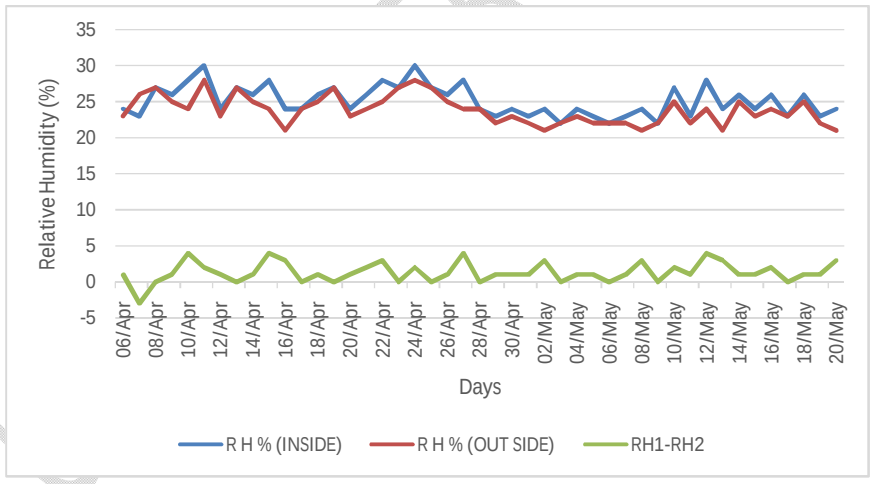

Fig 6. Variation of relative humidity inside and outside of polyhouse at 08:30 Am

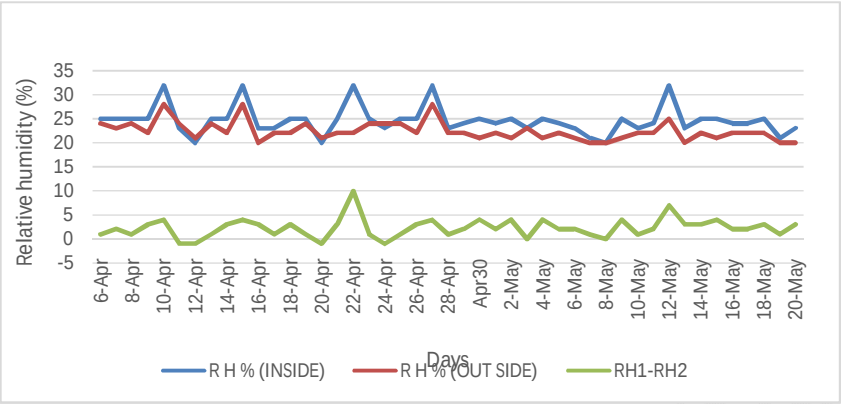

Fig 7. Variation of relative humidity inside and outside of polyhouse at 12:30 Pm

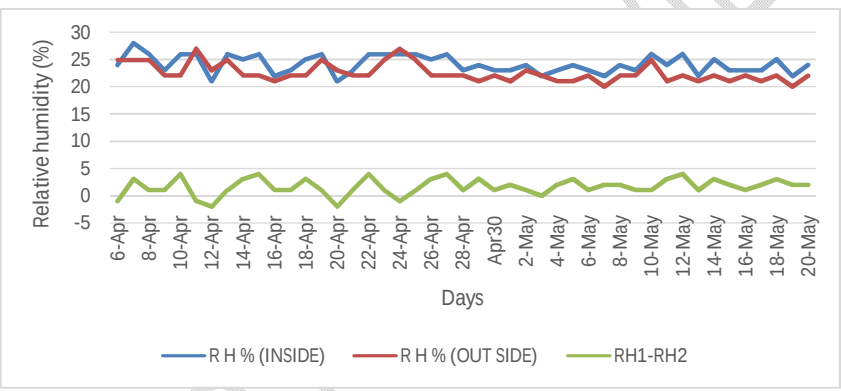

Fig 8. Variation of relative humidity inside and outside of polyhouse at 04:30 Pm

3.3 Light intensity variation

The light intensity was measured with suitable digital lux meter. The daily variation of light intensity monitored three times daily that is 08:30AM, 12:30PM and 04:00 PM during the experimental period is presented below in sub-headings.

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3.3.1 Variation in light intensity at 08:30 Am

The weekly average solar radiation levels in the naturally ventilated polyhouse ranged from 152 to 354 k lux at 08:30 Am against the outside ranges from 250 to 965 k lux respectively on an average, it is observed that 35% to 45% of light intensity was lowered in the polyhouse and outside the polyhouse, respectively against ambient condition at 08:30am.

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3.3.2 Variation in Light intensity at 12:30 Pm:

The daily solar radiation levels in the naturally ventilated polyhouse varied from 211 to 415 k lux outside varies from 321 to 1610 k lux at 12:30 pm. On an average, it is noticed that nearly 25% to 65% of light intensity was lowered in the polyhouse and outside respectively.

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3.3.3 Variation in light intensity at 04:00 Pm:

The variation of solar radiation in the polyhouse ranged from 132 to 611 k lux at 04:00 Pm against ambient and outside condition which varied from 251 to 1611 k lux respectively. On an average 26 % to 55% light intensity was lowered in the polyhouse an outside, respectively against the ambient condition during the period of experimentation at 04:00 pm.

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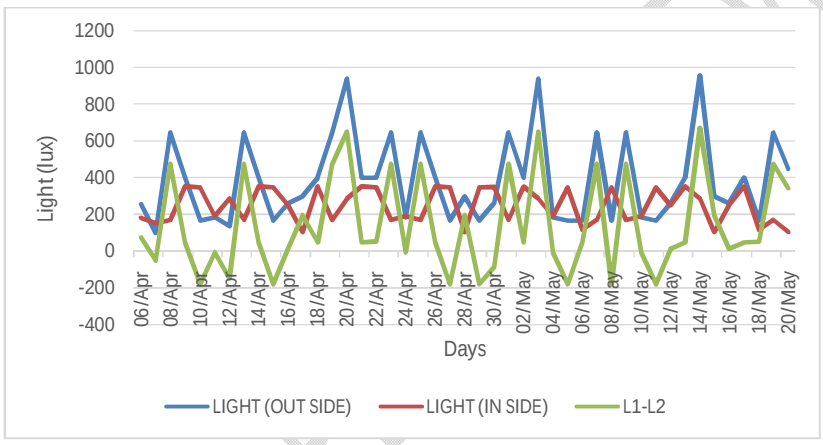

Fig 9. Variation of Light inside and outside of polyhouse at 08:30 Am

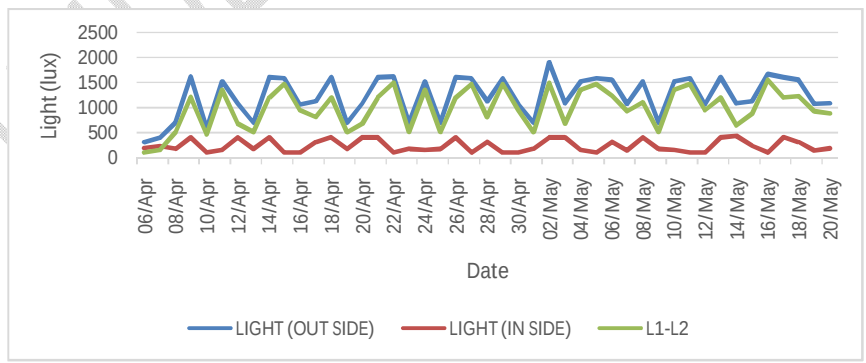

Fig 10. Variation of Light inside and outside of polyhouse at 12:30 Pm

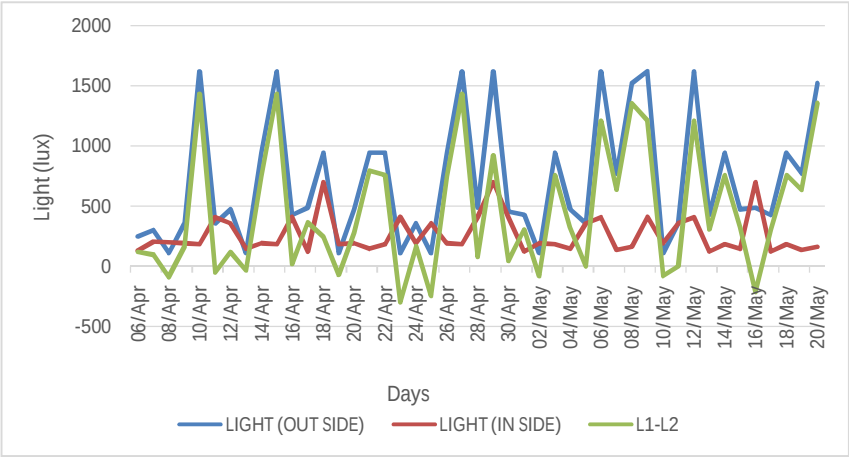

Fig 11. Variation of Light inside and outside of polyhouse at 04:30 Pm

4. Conclusion

• Air temperature persists in the naturally ventilated greenhouse (NVGH) reveals the fact that existing microclimate is favourable for cucumber production. Inside temperature is less in polyhouse as compared to outside temperature and maintaining the foggers in polyhouse to reduce the temperature and increase the humidity in polyhouse is highly necessary.

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